THE

# PRACTICE OF NAVIGATION

AND

## NAUTICAL ASTRONOMY.

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# NAUTICAL ASTRONOMY.

BY

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TO

REAR-ADMIRAL SIR FRANCIS BEAUFORT,

K C.B.

HYDROGRAPHER TO THE ADMIRALTY.

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SIR,

The eminent station which you occupy in the naval scientific world renders it highly gratifying to me to dedicate the following Work to you as a testimony of my regard and esteem; while the general accordance of my views on the subject with those of your more experienced judgment, gives me the greater confidence in laying my labours before the Public.

I have the honour to be,

Sir,

Your obedient Servant,

HENRY RAPER.

# PREFACE

## TO THE

# FIRST EDITION.

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THIS Work is intended for the use of all persons concerned either with the navigation of ships or with the determination of latitude and longitude on shore.

The present volume, which is devoted exclusively to the PRACTICE, contains all the rules and tables necessary in navigation, and for the determination of latitude and longitude by means of the sextant or reflecting circle. The study of its contents demands no previous attainments beyond the knowledge of the elements of arithmetic. Every endeavour has been made to render the whole easy of reference, and to adapt it to the use of those who may desire to instruct themselves. Rules which admit of more cases than one, as, for example, that for applying the equation of equal altitudes, are given in the form of *tables;* so that the several conditions involved, and their mutual connexion, being exhibited to the eye, the computer is relieved from the sense of complication, and the chance of a mistake is materially diminished. An ample alphabetical index is annexed, by which the reader is at once referred to all the information which the volume can afford him.

Those who have been brought up to the sea, and who have experienced the distaste for long calculations which that kind of life inspires, will not hesitate to admit that the only means of inducing seamen generally to profit by the numerous occasions which offer themselves for finding the place of the ship is extreme

brevity of solution. It is not, however, merely as a concession to indolence, that rules should be made as easy and simple as possible; the nature of a sea life demands that every exertion should be made to abridge computation, which has often to be conducted in circumstances of danger, anxiety, or fatigue, and so to separate the several points, that the seaman may be referred directly to what concerns his case, to the exclusion of all other matter. These considerations have been carefully kept in view in the rules, in the examples, and in the form and order of the tables.

Two kinds of solutions are employed, and, in general, two only; namely, an *approximate* method, and a complete, or, as it is called, *rigorous*, method. The former may often serve in cases of haste, or when precision is not necessary, and will also afford a convenient check against the effects of a mistake in the more elaborate method.

All the computations are effected by the well-known methods of inspection and logarithms; and as the former, it is presumed, leave but little to be desired in point of expedition, Gunter's scale, or other mechanical methods, are not employed.

Sailing on a Great Circle is, in this work, reduced, like Plane Sailing, to Inspection, by means of the SPHERICAL TRAVERSE TABLE.

Convenient rules are given for finding the distance of the land by its change of bearing, and by its altitude observed above the sea-horizon.

The seaman will find every necessary information on the subject of local magnetic deviation.

The highly useful problem of determining the latitude at sea, by the reduction of an altitude to the meridian, will be found greatly abridged; and a table is added for the purpose of shewing the limits within which the result may be depended upon when the time at ship is in error. This table will be found, it is presumed, of considerable utility, as it is perhaps from the want of some specific information as to the degree of confidence which it is safe to place in the result, no less than of a short and easy rule, that this excellent observation is almost entirely neglected; and, in consequence, the latitude, when the meridian altitude is not exactly obtained, is too often lost for the day.

The approximate solution of the double altitude, as a question of Time, will be found, it is hoped, well adapted to general use: since unless the latitude by account is very much in error this

method determines both the true latitude and the time at ship; and the computation of the time is one with which seamen are familiar in the next degree to that of the latitude by meridian altitude. The principle is not new, but rules have not hitherto been given for computing directly the error of the latitude by account.

The first approximate method of clearing the lunar distance is new, being effected, like many other problems, by the Spherical Traverse Table. The rigorous method is a modification of Borda's, and employs five logarithms, of which two only are taken out to seconds.

In a work in which many of the methods are new, I have felt it would be more satisfactory to the professional reader to find them illustrated by observations actually taken at sea. The examples are accordingly selected from the journals of Captain W. F. W. Owen, who kindly lent them to me for the purpose; though, necessarily, in proceeding by fixed rules, I could not introduce the solutions employed by that distinguished navigator. The remaining observations have been furnished to me by the Rev. G. Fisher, astronomer to Sir Edward Parry's expedition to the Polar Seas.

In order to enable the computer to judge of the degree of precision to which he attains, the *degree of dependance* to be placed on the result, or the limit of probable error, is indicated. This is the more important, as very indistinct and erroneous notions prevail among practical persons on the subject of accuracy of computation; and much time is, in consequence, often lost in computing to a degree of precision wholly inconsistent with that of the elements themselves. The mere habit of working invariably to a useless precision, while it can never advance the computer's knowledge of the subject, has the unfavourable tendency of deceiving those who are not aware of the true nature of such questions into the persuasion that a result is always as correct as the computer chooses to make it; and thus leads them to place the same confidence in all observations, provided only they are *worked* to the same degree of accuracy. By habitually following the short precepts laid down on this point, the computer will learn insensibly to estimate the value of his results; of which, since the limit of error is the sole criterion of the accuracy of any determination, he cannot otherwise be a judge. The degree of precision to which it is proper to carry the work in any case is observed, in general, in the examples.

In the Tables every endeavour has been made to render the

collection complete for the purposes required, and to compress the whole into small compass. For the sake of clearness, a different figure has been adopted for the argument and for the numbers in the body of each table. In the logarithms six places of figures only are employed, because a single result in which six places are necessary cannot be depended upon to the degree of precision obtained. On the same principle, some of the logarithms are given to three places only.

The log. sine square of half the arc, Table 61, universally familiar to seamen in finding the time, is given, for the convenience of this constant computation, to every second of the 12 hours. By means of this term tables of versed sines are dispensed with, all our solutions being either numeral or purely logarithmic.

I have not, either in the Rules or the Tables, aimed to make that additive which is in the nature of things subtractive. The precept *subtract* is as easy as the precept *add;* and when the student has the natural process before him he may be led to discover the reason of it; and must thus, by attention, always advance in knowledge of the subject. But an artificial process obstructs the exercise of the faculties, or leads the student, who reflects on what he does, to false conclusions.

The composition of the Table of Maritime Positions has been a very laborious task, and has caused great delay in the appearance of the Work. The numerous chronometric measures furnished of late years have rendered it necessary to deduce longitudes in a more systematic and accurate manner than that hitherto followed, which has chiefly consisted in modifying former determinations by means of those succeeding them. *Absolute*, or astronomical positions, and *relative* positions, being distinct things, and the latter being by far of the greater consequence to navigation, it is necessary, preparatory to a complete and final arrangement, to separate these two kinds of determinations. Accordingly, in a series of papers, some of which have been already published in the Nautical Magazine,* I have endeavoured to arrange the chronometric differences of longitude with reference to certain fixed points, convenient for the purpose, which it is proposed to call *Secondary Meridians*. These standard

* The *data* or evidence for the several positions being given in these papers, the value of each determination is easily appreciated ; and accordingly, individuals in possession of one or more good watches may, by correcting defective measures, or by establishing new links of connexion, render material service to maritime geography. See Nautical Magazine, 1839, and following years.

positions, of which the number assumed is eighteen, being considerably distant from each other, are determined nearly enough for present purposes, and would, according to the system proposed, be finally settled by long series of astronomical observations.

An account of the principles adopted in this arrangement, and of the several voyages and surveys from which the materials have been taken, will be found, together with some suggestions for the advancement of the subject, in the *Nautical Magazine*. But it is necessary to state here, that the late determinations of the longitude of Madras have, from the importance of that position, occasioned a long and intricate discussion. Mr. Riddle and Mr. Maclear have compared observations of moon culminating stars made at Madras, with like observations made in Great Britain and at the Cape of Good Hope respectively. According to their computations, which agree very nearly, the received longitude, 80° 17′ 21″, is about 3′ 21″ too great. The number and superior character of these observations, and the agreement of the results, have led me to adopt, without hesitation, 80° 14′ 0″; while the magnitude of the correction has rendered it indispensable to trace its effects on the longitudes of the Eastern Seas.*

Precision in the Maritime Positions, especially in the longitudes, becomes, as navigation advances to perfection, a matter of increasing importance; because, where longitudes are well determined, the error of a chronometer may be ascertained on every occasion of making the land.

It will not be out of place to remark here that it is high time the chronometer should be found, like the compass, among the stores of every vessel beyond a mere coaster. It would be superfluous to attempt to prove that the hardships and privations consequent on missing a port, the losses of ships from being out in their reckonings, and the evils incident to navigation generally from the want of a ready means of checking the enormous errors to which the dead reckoning is liable, would, in many cases, have been prevented by a chronometer.

In urging this recommendation, it is, of course, taken for granted that they to whose hands the chronometer is entrusted are qualified to make a proper use of it. Employed merely as a check, a single chronometer cannot fail to prove of great service; but too firm a reliance on such an instrument would lead to the dangerous error

* The accepted Longitude of Madras, India Trigonometrical Survey, 1878 (see page 194), is 80° 14′ 51″ E

of relaxing that vigilance which the known uncertainty of the dead reckoning keeps perpetually alive.

A list of times of high water, or, as they are now called, Establishments of Ports, is not given. The researches on the tides made of late years by Mr. Lubbock and the Rev. W. Whewell, have proved that the establishment cannot be truly deduced but from numerous observations, and consequently that a simple recorded time of high water is altogether insufficient. Moreover, if the establishment were correctly known, the time of high water, as also the height of the tide, cannot be determined without other elements, which, except in comparatively few places, are not afforded. But in navigation it is not the true instant of high or low water that is required so much as the time at which the flood or ebb stream turns, because this last affects every vessel when near the shore; and the proper place for information of this kind is, obviously, the Sailing Directions.

Although some results of the kind might be advantageously placed in a general work on navigation, yet the uncertainty of almost all that has been published, and the difficulty of collecting better materials, will, it is hoped, excuse the omission, at least for the present.

It may, however, be remarked, that under whatever form it may hereafter be found advisable to publish particulars of the tides, the observations required are so numerous, the discussions so tedious, and the whole subject so complicated, that no individual could undertake successfully to treat this branch of navigation unless in a work devoted exclusively to its consideration.

The subject of Maritime Surveying, usually treated in works of this kind, has been omitted. Surveying is no part of the navigation of a ship, and a survey having any pretensions to authority can scarcely be made by a person whose qualifications for the task are confined to the slender information contained in a few pages. A survey is a matter of too great consequence to the security of navigation to be received from incompetent hands; and the seaman who desires to acquire a knowledge of surveying should study works treating expressly of this branch of science.

The customary chapter on the Winds has likewise been omitted. The subject, generally, does not belong to the navigation of a ship; and, even if it did, the general information contained in a few pages, though interesting as a branch of natural philosophy, is

necessarily too vague to be effective in shaping the course. The same applies to Currents, and also to the Marine Barometer; which, though matters of important consideration in sea-voyages, are not concerned in the practice of navigation, since this term, in strictness, comprehends only the consideration of the place of the ship when her circumstances and destination are given.

The space gained by the omission of these collateral subjects, and other matters sometimes introduced, is appropriated to the numerous practical details of the proper subjects of such a treatise.

The Work will be completed by another volume, which will be entitled the THEORY OF NAVIGATION, and will contain the construction of the rules and tables, for the advantage of those who desire to confirm their practical knowledge by mathematical investigation. It will contain, likewise, those methods in which the transit and azimuth instruments are employed. The present volume being thus, in the ordinary practice of navigation, independent of the second, no notice of another volume appears in the title-page.

By the term Theory is commonly understood, in this particular subject at least, the scientific principles on which the rules are formed. Considerations of this kind are thus altogether excluded from the present volume; but, on the other hand, that *rationale*, or process of reasoning, which, in considering the nature of the case, is obvious to common sense or apprehension, is, in most cases, introduced, as necessary to a clear understanding of important points.

The theory and the practice are thus kept purposely distinct. The former is not always necessary to successful practice; and rules constructed for ready and general application approach to perfection in proportion as they leave less to individual judgment or skill. It is the custom, generally, to teach the theory first; the impression forced upon me is, on the contrary, that the practice is itself the best foundation for sound and rapid advancement in the theory. For he who has acquired the practice knows the nature and extent of the subject; and in proceeding to the theory he has a distinct perception of the object to be attained. This is not the place for a discussion on these points; but it was incumbent on me to state, in a few words, the grounds of the arrangement adopted.

It is manifestly the duty of a writer, who undertakes to treat a subject in a thoroughly practical manner, not only to discuss every point which presents itself, but also to pronounce a decided opinion in every case. It is proper to bring this point under the notice of

the reader, who, especially if he has more experience in these matters than myself, might otherwise be disposed to consider many things in this volume as laid down too positively.

I cannot close the preface to a work which has been some years in preparation, and in which I have endeavoured to reduce to a practical form every useful consideration which has been suggested by my own experience or by intercourse with eminent officers and men of science, without soliciting the indulgence of the reader to errors and to deficiencies. Absolute correctness, especially in tables, is scarcely attainable; and in a treatise which contains much that has not appeared before, I cannot reasonably flatter myself that, notwithstanding every care and attention, some small inaccuracies may not be found.

H. R

*September* 1840

# ADVERTISEMENT

TO THE

## THIRD EDITION.

In the Advertisement to the Second Edition I had the satisfaction of being able to state that the Royal Geographical Society had conferred the flattering distinction of their gold medal on the first edition, and that the Lords Commissioners of the Admiralty had honoured my work by ordering it to be supplied to Her Majesty's Navy as ship's stores.

The present edition has been greatly augmented. Much of the work has been rewritten. Two approximate methods of determining the time, though of inferior value, are introduced, since a work aiming to be complete for practice should contain provision for extreme cases. Nos. 789, 791.

The introductory portion, it had often been suggested, was insufficient for the purposes of elementary instruction. It is easier to allege this, than to lay down a condition which is to determine the extent of such preliminary matter. An attempt, however, has been made to fix a limit, on the following grounds:—

The most general defect, perhaps, in the education of seamen, as regards the present subject, is an insufficient knowledge of arithmetic; by which I mean, not of the more advanced rules, but of the elements, and especially of proportion. Now all questions to which arithmetical processes are applied involve some *proportion*, which the operation is to bring out, or distinctly assign; and it appears, accordingly, a great omission in our education that we are not more exercised on this point, which is the sole object or end of the processes which we learn to practise mechanically.

Again, in geometry, it is not the variety of problems which benefits the practical man, but a well-grounded and familiar knowledge of a few comprehensive propositions, which he applies readily, and with confidence; and the geometrical knowledge which appears to me to suffice to our present purpose is comprised in,—1, the property of the square of the hypothenuse; 2, the measure of an angle at the circumference; 3, the similarity of plane triangles. The first is of general importance; the second includes the problem of fixing a station by means of two angles subtended by three objects; and the third is the basis of trigonometry.

In this edition, therefore, proportions and fractions are treated at some length, and illustrated by numerous examples which afford the student abundant exercise; and a short course of geometry is given, after the manner of Euclid, sufficient to establish the above important theorems.

These limitations, the reader will bear in mind, are intended to apply only to that particular quantity of elementary matter which is assumed to be necessary and sufficient for the scale of attainment contemplated in the present volume.

In the Table of Positions many points of information of consequence to seamen are expressed by means of a new system of Symbols. In these days little apology is required for introducing a scheme which a few years ago would have been deemed a rash innovation. But a growing tendency to the use of symbols manifests itself on all sides. Efforts have been made to represent, as far as possible, all matters of instruction under a form addressed to the eye;* and symbols effect this object in an eminent degree, for their distinct and conspicuous forms, contrasting with the monotonous aspect of alphabetic writing, arrest and fix the attention, while their extreme conciseness admits the insertion of matters to which, for want of room, no allusion could otherwise be made.

The employment of symbols, therefore, on a more extensive scale than we have yet been used to, and that at no distant period, may be considered inevitable; and the present system, which has occupied my attention for several years, is proposed as so far deserving consideration that it is constructed with rigid adherence to principles.† The number of signs which I have ventured to

* The Physical Atlas is an example.

† The necessity for a uniformity in hydrographic symbols has already shewn itself. Symbols similar in character denote, on the French charts, rocks *above* the water, and on the Russian charts rocks *below* the water.

introduce is small, since, in matters waiting the sanction of experience, it is better to move too slow than too fast.

The introduction of symbols has necessarily modified the original design of the work, as described in the preface, and has justified allusion to many matters which otherwise would not have found a place in it.

The chief labour of this edition (as, indeed, of the two former) has been the Table of Positions, which, in consequence of the numerous references made to my labours in this country and abroad, I was desirous to extend. The list now contains 8,800 places; and as the degree of accuracy is indicated wherever I have found the means of forming a judgment, and as many physical details are supplied,—such as the dimensions of islands, heights, and the depths of shoals,—the table may be considered as representing the state of maritime geography at this day. The number of voyages, charts, and surveys, which it has been necessary to consult,—the labour of digesting and comparing the mass of materials collected, and the introduction, by a new method, of numerous details important to navigation,—will, it is hoped, excuse the long delay in the appearance of this edition, and account for the work having remained out of print for nearly three years.

In conclusion, I gladly express my obligation to the draftsmen and other gentlemen of the Hydrographic Office, whose patience during many years I have sorely taxed in the inspection and re-examination of thousands of documents, and without whose active and disinterested assistance I must have left much in a very unsatisfactory state.

# ADVERTISEMENT

TO

## THE NINETEENTH EDITION.

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The revision and enlargement of this edition of the "Practice of Navigation and Nautical Astronomy" was undertaken with considerable diffidence, it being felt, that while it was possible to spoil, little could be done to improve, this best of practical works on Navigation at Sea.

Compiled in the golden age of practical Navigation and Nautical Surveying by an officer in constant communication with Beaufort and Horsburgh, and the Captains and Masters who served under these distinguished chiefs in England and India, Lieutenant Raper's labours are founded upon a thorough practical experience, and may be looked upon as the work of a Sailor for the use and benefit of Sailors at Sea.

One chapter alone required to be re-written. The use of iron in modern shipbuilding, by its natural effect on the Mariner's Compass, having greatly increased the difficulties of navigation at sea, some additions have therefore been made to what Raper had already written upon this important subject. This chapter, as well as all parts of the book referring to the variation and deviation of the compass, has been re-written by Captain W. Mayes, R.N., late Superintendent of Compasses at the Admiralty.

Captain Mayes has also assisted in making a careful examination of the whole work, which is sufficient guarantee for its having been thoroughly done.

This scrutiny showed how well and earnestly Raper had carried out the intention expressed in the Preface to his First Edition* (see p. v) of "inducing seamen to profit by the numerous occasions

* Sailors are earnestly requested to read the Preface to the First Edition.

which offer themselves for finding the place of the ship;" by laying before them methods whose "extreme brevity of solution abridged computation." These short rules aid the prompt decision upon which the safety and success of a ship at sea so often depend. A brief study of the comprehensive index will call attention to "the numerous occasions" alluded to.

The key to most of the modern short methods for fixing the position of the ship will be found in Raper's "Practice of Navigation."

Under the head of "Degree of Dependance" is placed before the navigator the amount of possible error, a thought which should never be absent from his mind in considering the estimated position of a ship, with the view of determining his future proceedings.

The sailor's attention is earnestly called to the chapter entitled "Navigating the Ship," which contains what John Davis, the navigator, writing in 1607, aptly termed the "Seaman's Secrets."

In this, the concluding chapter of the work, Raper shows clearly the never ceasing watchfulness that is required, in both fair and foul weather, in obtaining the observations, terrestrial as well as celestial, necessary to conduct a vessel in safety from one port to another.

The simplicity of its mathematical theory makes Navigation appear an easy matter to men teaching or using it on shore; but Pilotage, common and proper, is a very different business when practised by sailors in a gale of wind, at night, or in hazy weather, on board a ship at sea. Proficiency in the science can never compensate for a lack of experience in the handicraft of navigation. This experience can be attained only by incessant practice at sea; by a capacity for taking trouble, unceasing caution, and a desire to do well.

In such labours the sailor will find no better friend and assistant than Raper's "Practice of Navigation."

No changes in the numbering of the paragraphs have been made, and great care has been taken to leave the book in the style in which it was originally written, so that old students will have no difficulty in finding the various methods with which they are familiar.

Some slight changes have been made in the Tables. Considering the great increase of speed attained by modern steamships, Table 1, formerly Table 2, has been enlarged from 300 to 600 miles of distance. The Table giving the Diff. lat. and Departure for every quarter point has been withdrawn.

Table 10, of Maritime Positions, upon which Raper bestowed a very large amount of labour, has been revised with great care from the latest Admiralty Charts, so that it may still "be considered as representing the maritime geography of this day" (see p. xv). These positions mainly depend on the Table of Longitudes accepted for Secondary Meridians, amended from telegraphic observations to 1887, published in the Admiralty "Instructions to Hydrographic Surveyors." This Table of Secondary Meridians has been inserted in the Explanation of Table 10.

Steam having in a great measure rendered Table 12 obsolete, it has been replaced by a Table of the navigable Mercatorial Distances between the principal ports and points of the world.

Tables 11 and 13 (Approximate Variation of the Compass, and Tide-hours, or Establishment of the Ports) have been taken out, as the Admiralty Charts, and Admiralty and Indian Tide Tables, published yearly; with the Chart of Curves of Equal Magnetic Variation (No. 2598), corrected up to date; always give the latest information. These tables have been replaced by others showing first: where docks &c. may be found and coals obtained; and second, the position and nature of the Time signals, in all parts of the world, for the correction and rating of chronometers.

Table 65, of natural sines, tangents, &c., to assist magnetic computations, has been inserted in lieu of that of log. sines, tangents, &c., to quarter points.

With these few exceptions the Tables retain the same numbers they held in former editions.

In conclusion, thanks are due to Captain John C. Almond, Nautical Inspector of the P. and O. Company, for his many valuable suggestions.

THOMAS A. HULL.

MAMRE, HONOR OAK:
*December* 21, 1890.

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In this reprint of the Nineteenth Edition, the Sun's declination, the Sidereal Time, and the Equation of Time have been given for the years 1901, 1902, 1903 and 1904, in Tables 60, 61, and 62. Table 60A, correction of Sun's declination in Table 60 to 1928, has been restored. Tables 10, 12, and 13 have been brought up to date. Table 88, Corrections of Altitudes of Sun and Stars, has been extended, and the gross corrections are given for 'Height of the eye' up to 60 feet. Table 47, Limits of the Reduction to the Meridian at Sea, has been recast. Table 70, Logarithms for computing the Reduction to the Meridian at Sea, has been extended to 85° of declination. Tables 41 and 52 have also been recast.

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## INTRODUCTION.



## NAVIGATION.

## NAUTICAL ASTRONOMY.

## NAVIGATING THE SHIP.

# TABLES.

## NAVIGATION.



## NAUTICAL ASTRONOMY.



* Table of Longitudes accepted for Secondary Meridians, 392.

Variation of the Compass:—

# INTRODUCTION.

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I. Fractions. II. Proportion. III. Logarithms. IV. Practical Geometry. V. Raising the Trigonometrical Canon. VI. Methods of Solution.

## 1. *Vulgar Fractions.*

1. A number which is a portion of 1, or unity, is properly called a *fraction*; thus, if we divide a foot into 3 equal parts, each of such parts is the fraction called a *third*, and written $\frac{1}{3}$.

These numbers arise, in arithmetical operations, in division, when the dividend is not divisible by the divisor in whole numbers, or, as they are called, *integers*; thus, if we divide 10 feet into 3 equal parts, each will measure 3 ft. and one-third, or 10 divided by 3 gives the quotient 3, and 1 over—that is, 1 not divided like the rest; but proceeding now to divide this 1 by 3, we call the result or quotient $\frac{1}{3}$; that is, 1 *divided by* 3.

2. If we divide 1 into four equal parts, each is one-*fourth*, written $\frac{1}{4}$; if into 5 equal parts, each is one-*fifth*, written $\frac{1}{5}$; thus, the *name of the fraction* is that of the *number of parts* into which the unity or entire quantity is divided; and this number is hence called the *denominator* of the fraction.

3. If we take two of three equal parts of subdivision, or two-thirds, we write $\frac{2}{3}$; if we take three of four equal subdivisions, we write $\frac{3}{4}$; if we take three of seven equal subdivisions, we write $\frac{3}{7}$; and so on: the number 2, 3, in these examples, which shews or enumerates the number of fractional parts taken, is hence called the *numerator*.

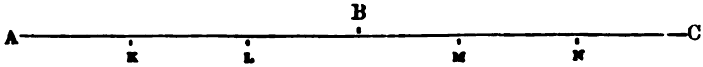
The term fraction is thus used to denote not only one part or subdivision, but any number of such.

4. In enumerating fractional parts we may go on, for example, $\frac{1}{5}$, $\frac{2}{5}$, $\frac{3}{5}$, $\frac{4}{5}$, $\frac{5}{5}$, $\frac{6}{5}$, $\frac{7}{5}$, &c. Here $\frac{5}{5}$ represents the whole, or entire quantity, since it enumerates as many parts as the whole is divided into; the fractions (so called) beyond this, as $\frac{6}{5}$, $\frac{7}{5}$, are all greater than 1, and are termed mixed or *improper* fractions.

5. The fractions to the left of $\frac{5}{5}$ are less than 1, and are *proper fractions*; hence, when the numerator is less than the denominator, the fraction is less than 1; when equal, the fraction represents 1; and when greater, it is greater than 1, and is capable of being resolved into a whole number with or without a fraction.

Hence also, the greater the denominator the smaller the fraction, and the smaller the denominator the larger the fraction.

6. If we take a line AB, and divide it into 3 equal parts by the points K, L; and another line BC equal to it, and divided similarly at M, N, then AL is $\frac{2}{3}$ of AB, or of 1.




Then the parts being all equal, AK and KL, are equal to LB and BM, and these to MN and NC; therefore AK and KL are $\frac{1}{3}$ of AC, that is, of 2. Hence AL is $\frac{2}{3}$ of 1, and $\frac{1}{3}$ of 2; or, $\frac{1}{3}$ of 2, and $\frac{2}{3}$ of 1 are the same thing. If AB is 1 yard, it is evident at once, since 2 ft. or $\frac{2}{3}$ of 1 yard are $\frac{1}{3}$ of 6 feet, or 2 yards.

7. The value of a fraction is not changed by multiplying the numerator and denominator by the same number.

The term one-half is equivalent to two-quarters, to four-eighths, and so on; that is $\frac{1}{2}$, $\frac{2}{4}$, $\frac{4}{8}$, &c. are all equal; since it is evident that the result is the same if we divide the whole into twice the number of parts, and take twice the number, or into 3 times the number of parts, and take 3 times as many of them. The above fractions are $\frac{1}{2}$, the numerator and denominator being both multiplied successively by 2.

Again, take $\frac{2}{5}$, multiply both numerator and denominator by 3, it becomes $\frac{6}{15}$: if now we take a line and divide it into 5 equal parts, and 15 equal parts, it will be the same thing whether we take two of the larger parts, or six of the smaller, which are $\frac{1}{3}$ the size.

8. The value of a fraction is not changed by dividing the numerator and denominator by the same number. This appears in exactly the same way as the above, in any case; thus, $\frac{6}{15}$, dividing both numerator and denominator by 3, gives $\frac{2}{5}$. The process is equivalent to dividing the unit into larger portions, and taking fewer of them in proportion

Fractions are thus often simplified: example, $\frac{22}{224}$ is evidently reducible to $\frac{11}{112}$; $\frac{35}{110}$ to $\frac{7}{22}$.*

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* A fraction is reduced to its simplest terms by finding their *greatest common measure*, that is, the largest number which will divide them both without a remainder. To find the greatest common measure of two numbers,

Divide the greater by the less. Consider the remainder as a new divisor to the former divisor as a dividend, and find the next remainder. Consider the last remainder as a new divisor, and find the next remainder, and so on. The last divisor is the number required.

If the last divisor is 1, the numbers have no common measure but 1, that is, are not further reducible.

Ex. 1. Find the greatest common measure of 24 and 124.

```
24)124(5
   120
   ---
     4)24(6
       24
Ans. 4. --
        0
```

Ex. 2. Find the greatest common measure of 48 and 11.

```
11)48(4
   44
   --
    4)11(2
       8
       -
       3)4(1
         3
         -
Ans.     1
```

[1.] *Reduction to a Common Denominator.*

9. Suppose it is required to add together $\frac{2}{3}$ and $\frac{3}{5}$; if we could at once express thirds in fifths, or fifths in thirds, we should then merely enumerate the number of parts; but as one of these fractions is no exact number of times greater than the other, (as may be seen by dividing a line into 5 parts and 3 parts), we cannot do this. But by multiplying the numerator and denominator of one by some number, and of the other by some other number, (which leaves the fractions unchanged in value, No. 6) we may select such multipliers as will produce the same number in the denominator; thus, multiplying the numerator and denominator of $\frac{2}{3}$ by 5, gives $\frac{10}{15}$, and multiplying the numerator and denominator of $\frac{3}{5}$ by 3 gives $\frac{9}{15}$, and the fractions $\frac{2}{3}$ and $\frac{3}{5}$ are thus reduced to 15ths.

Again, to reduce $\frac{5}{12}$ and $\frac{7}{11}$ to the same denominator, multiply the numerator and denominator of $\frac{5}{12}$ by 11, which gives $\frac{55}{132}$, and $\frac{7}{11}$, by 12, which gives $\frac{84}{132}$. These reductions are effected by multiplying each numerator by the *other* denominator, and the two denominators together; and the same applies to three or more fractions taken in succession. Hence the

Rule: Multiply the numerator of each fraction by every denominator, except its own, for the new numerator, and multiply all the denominators together for the new denominator.

Ex. 1. Reduce $\frac{2}{3}, \frac{1}{15}$, and $\frac{1}{7}$. $\quad \frac{2\times15\times7}{3\times15\times7}, \frac{1\times3\times7}{3\times15\times7}, \frac{1\times3\times15}{3\times15\times7}$, or $\frac{210}{315}, \frac{21}{315}, \frac{45}{315}$.

Ex. 2. Reduce $\frac{11}{17}, \frac{1}{2}$, and $\frac{4}{7}$. $\quad \frac{11\times2\times7}{17\times2\times7}, \frac{1\times17\times7}{17\times2\times7}, \frac{4\times17\times2}{17\times2\times7}$, or $\frac{154}{238}, \frac{119}{238}, \frac{136}{238}$.

Ex. 3. Reduce $\frac{2}{5}, \frac{5}{12}$, and $\frac{6}{7}$. $\quad \frac{168}{420}, \frac{175}{420}, \frac{360}{420}$.

10. The process of reduction to a common denominator is often necessary in the comparison of two fractions, to find which of the two is the greater; thus, to compare $\frac{3}{16}$ and $\frac{7}{34}$, these become $\frac{102}{544}$ and $\frac{112}{544}$ hence $\frac{7}{34}$ is the greater.

11. Whole numbers are written in the fractional form by employing 1 as the denominator; thus 3 is written $\frac{3}{1}$, the 1 is in the place of the unit divided into 1 part (No. 2), that is, left entire, and the 3 denotes that 3 such parts are taken (No. 3).

12. By means of this last notation whole numbers are reduced to fractions with the same denominator, by the rule No. 9. Thus 11 and $\frac{3}{4}$, or $\frac{11}{1}$ and $\frac{3}{4}$ become $\frac{44}{4}$ and $\frac{3}{4}$.

[2.] *Addition.*

13. Reduce the fractions to a common denominator, add the numerators (No. 9), and under the sum place the common denominator.

Ex. 1. Add together $\frac{3}{17}$ and $\frac{2}{3}$. These become $\frac{3\times3}{17\times3} = \frac{9}{51}$, and $\frac{2\times17}{3\times17} = \frac{34}{51}$; the sum of which is $\frac{43}{51}$.

Ex. 2. Add together $\frac{1}{2}$, $\frac{1}{4}$, and $\frac{1}{8}$. Ans. $\frac{7}{8}$.

Ex. 3. Add $\frac{8}{10}$, $\frac{2}{7}$, and $\frac{3}{100}$. Ans. $\frac{7810}{7000} = 1\frac{81}{700}$.

Ex. 4. Add $\frac{3}{10}$, $\frac{2}{16}$, and $\frac{1}{3}$. Ans. $\frac{364}{480} = \frac{91}{120}$.

[3.] *Subtraction.*

14. Rule: Reduce the fractions to a common denominator, and subtract the lesser numerator from the greater for a numerator. Thus, suppose it required to subtract $\frac{1}{6}$ from $\frac{1}{5}$, these become $\frac{5}{30}$ and $\frac{6}{30}$, and $\frac{5}{30}$ from $\frac{6}{30}$ leaves $\frac{1}{30}$, the remainder required.

Hence it appears that the difference between $\frac{1}{5}$ part and $\frac{1}{6}$ part is $\frac{1}{30}$ of the whole.

Ex. 1 Find the difference between $\frac{3}{7}$ and $\frac{2}{5}$. These become $\frac{15}{35}$ and $\frac{14}{35}$, the difference of which is $\frac{1}{35}$.

Ex. 2. Subtract $\frac{1}{33}$ from $\frac{2}{11}$. Ans. $\frac{55}{363}$.

Ex. 3. Subtract $\frac{12}{13}$ from $\frac{11}{5}$. Ans. $\frac{83}{65} = 1\frac{18}{65}$.

[4.] *Multiplication.*

15. To multiply a fraction by a whole number is to repeat the fraction a given number of times; that is, to multiply $\frac{1}{4}$ by 3, or to take $\frac{1}{4}$ three times, gives $\frac{3}{4}$. Hence to multiply a fraction by a whole number is to multiply the numerator.

Hence a number multiplied by a (proper) fraction is diminished; thus, 3 multiplied by $\frac{1}{4}$, which is $\frac{3}{4}$, is less than 3.

16. To multiply a fraction by a fraction, as for example $\frac{3}{7}$ by $\frac{2}{5}$. Since $\frac{2}{5}$ is the same as twice one-fifth, we have to take $\frac{1}{5}$ of $\frac{3}{7}$, and double the result.

To take $\frac{1}{5}$ of $\frac{3}{7}$ is to divide $\frac{3}{7}$ into 5 parts and take one of them; now $\frac{3}{7}$ is $3 \times \frac{1}{7}$ (by No. 6), and dividing $\frac{1}{7}$ into 5 equal parts gives $\frac{1}{35}$, since 5 such parts repeated 7 times make up 1. Hence 3 of these parts (or $\frac{3}{7}$ divided into 5 parts) is $\frac{3}{35}$, which is therefore $\frac{1}{5}$ of $\frac{3}{7}$, and $\frac{3}{35}$ doubled, or $\frac{6}{35}$, is $\frac{2}{5}$ of $\frac{3}{7}$.

Now, the numerator 6 is the product of the two given numerators, 2 and 3 (as appears by the process); and the denominator 35 is the product of the denominators 7 and 5. If we had to multiply this result by a third fraction, the process would be the same; hence the

Rule. Multiply all the numerators together for a new numerator, and all the denominators for a new denominator.

Ex. 1. Multiply $\frac{1}{3}$, $\frac{2}{5}$, and $\frac{6}{7}$. Ans. $\frac{12}{105}$. Ex. 2. Multiply $\frac{32}{63}$, by $\frac{2}{7}$. Ans. $\frac{64}{441}$.

Ex. 3. Multiply $\frac{11}{16}$, $\frac{7}{3}$, and $\frac{1}{5}$. Ans. $\frac{77}{240}$.

17. If we multiply $\frac{2}{3}$ by itself, we have $\frac{4}{9}$, this again by $\frac{2}{3}$ gives $\frac{8}{27}$; now $\frac{8}{27}$ differs little from $\frac{8}{28}$, and $\frac{8}{28}$ is equal to $\frac{2}{7}$, which is very

much less than $\frac{1}{3}$. Again, $\frac{1}{4}$ multiplied by itself is $\frac{1}{16}$, and this multiplied again by $\frac{1}{4}$ is $\frac{1}{64}$.

Hence a proper fraction is diminished by continually multiplying it by itself.

[5.] *Division.*

18. To divide a fraction, as $\frac{1}{3}$, by a whole number, as 4, is to find a new fraction which, repeated 4 times, shall produce $\frac{1}{3}$: that is, we have to divide a third into 4 equal parts.

It will be at once seen, on dividing a line into 3 equal parts, that to divide each third into 4 equal parts, is to divide the whole line into 12 equal parts, and since 4 of such parts, or twelfths, constitute a third, $\frac{1}{12}$ is the required fraction. Hence, as similar reasoning applies to any other fraction or whole number, the most general rule for dividing a fraction by a whole number is to multiply the denominator by the given whole number; but if the numerator be a multiple of the divisor, it is better to divide the numerator as it leaves the result in a more reduced state.

19. To divide a whole number, as 3, by a fraction, as $\frac{1}{4}$. Dividing 3 by 1, that is, finding how often 1 is contained in 3, gives 3. Now, it is easily seen, since $\frac{1}{4}$ is 4 times *smaller* than 1, that it must be contained in 3, four times *oftener*, that is 12 times; and 12 is the product of 3 by the denominator 4.

To divide 3 by $\frac{2}{5}$. Since $\frac{2}{5}$ is twice $\frac{1}{5}$, we have to divide 3 by $\frac{1}{5}$, and take half the quotient; and we know that to divide by the product of two numbers, $2 \times \frac{1}{5}$, is the same thing as to divide by them separately, that is, 3 divided by $\frac{2}{5}$ is 3 multiplied by 5 (No. 18), and divided by 2; or $3 \div \frac{2}{5}$ is the same as $3 \times \frac{5}{2}$, or $\frac{15}{2}$.

Here $\frac{5}{2}$ is the fraction $\frac{2}{5}$ inverted.

As similar reasoning applies to any numbers and fractions, we have the

Rule. To divide by a fraction, invert the fractional divisor, and proceed as in multiplication.

20. To divide a fraction by a fraction. We have evidently to treat the dividend as a whole number, and apply to the divisor the rule above.

Ex 1. Divide $\frac{7}{12}$ by $\frac{2}{3}$. $\frac{7}{12} \times \frac{3}{2} = \frac{21}{24} = \frac{7}{8}$. Ex. 2. Divide $\frac{3}{4}$ by $\frac{2}{5}$. Ans. $\frac{15}{8}$.

Ex. 3. Divide $\frac{2}{7}$ by $\frac{9}{11}$. Ans. $\frac{22}{63}$.

Hence it appears that the smaller the fractional divisor the greater is the quotient.

21. When a quantity is both multiplied and divided by the same number, it remains unchanged. Hence when the same number occurs in the numerator and denominator of a fraction, or of two or more fractions multiplied together, we simply omit or erase it; as,

$$\frac{1 \times 2}{2} = 1, \quad \frac{1}{4} \times \frac{4}{3} = \frac{1}{3}, \quad \frac{4}{7} \times \frac{1}{6} \times \frac{7}{16} = \frac{4}{16} \times \frac{1}{6} = \frac{1}{4} \times \frac{1}{6} = \frac{1}{24}, \quad 6 \times \frac{1}{6} = 1.$$

## II. *Decimal Fractions.*

22. Tenths, hundredths (which are tenths of tenths), and so on, are called *Decimal Fractions*, and may be written as fractions, having for denominators 10, 100, &c., thus, one-tenth, $\frac{1}{10}$; three hundredths, $\frac{3}{100}$, &c. But as these quantities are counted by *tens*, like common numbers, it is simpler and more concise to write them *in continuation* with the common numbers, only taking care to put a dot, called the *decimal point*, where the whole number ends and the fraction begins; that is, between the unit and the tenth: thus, 21·32 signifies 21 and 3-tenths and 2-hundredths; 432·9 signifies 432 and 9-tenths; 33·05 signifies 33, no tenths, 5 hundredths.

23. In the fractional part beyond the dot, each figure may be read in its separate denomination, or the whole may be read in the denomination of the last: thus, ·32 is read either as 3-tenths and 2 hundredths, or as 32-hundredths; just as 32 is read either as 3 tens and 2 units, or as 32 units.

24. As ·5, (or 5-tenths) is the half of 1, so ·05 is the half of 0·1, or 5 hundredth-parts are the half of one-tenth; 5 thousandth-parts are the half of a hundredth-part. The half of 5 tenths is 2 tenths and half a tenth, that is, 2 tenths and 5 hundredths, or 0·25. Hence the fractions, *quarter*, *half*, and *three-quarters* are written in decimals, 0·25, 0·5, and 0·75.

All the preceding rules apply equally to decimal fractions, but as these last, from their denominators being multiplied by 10, are of a uniform kind, special rules have been made for them, relating, however, almost entirely to the placing of the decimal point.

### [1.] *Addition and Subtraction.*

25. Place the quantities so that their decimal points shall be in the same vertical line; for then the quantities of the same denomination will stand together.

Then proceed as in the addition or subtraction of whole numbers.

Ex. 1. Add together 0·35, 47·4, and 9·12.

| | |
|---|---|
| | 0·35 |
| | 47·4 |
| | 9·12 |
| Sum | 56·87 |

Ex 2. Add together 72·99, 4·1, and 52·31.

| | |
|---|---|
| | 72·99 |
| | 4·1 |
| | 52·31 |
| Sum | 129·40 |

Ex. 3. From 31·8 subtract 11·62.

| | |
|---|---|
| | 31·8 |
| | 11·62 |
| Rem. | 20·18 |

Ex. 4. From 423·5 subtract 97·9.

| | |
|---|---|
| | 423·5 |
| | 97·9 |
| Rem. | 325·6 |

### [2.] *Multiplication.*

26. Multiply the numbers together as whole numbers, and point off as many decimal places in the product (beginning at the right) as there are decimal places in the multiplier and multiplicand together.

When the decimal places to be pointed off are more in number than the figures of the product, make up the proper number by prefixing ciphers to the product.

Ex. 1. Multiply 34·11 by 3·72.

```
      34·11
       3·72
       6822
     23877
    10233
Ans. 126·8892
```

In 34·11 are two decimals; in 3·72 are two; therefore four decimal places are pointed off.

Ex. 2. Multiply ·201 by ·06.

```
       ·201
        ·06
Ans. ·01206
```

The product of 201 by 6 is 1206; in ·201 are three decimals, in ·06 are two; to make up five decimals, a cipher is prefixed to 1206.

Ex. 3. Multiply 90·01 by 0.034. Ans. 3·06034.

Ex. 4. Multiply together 1·3, 1·2, and 0·09. Ans. 0·1404.

[3.] *Division.*

27. Divide as in whole numbers. The rule for placing the decimal point is, that the quotient and divisor together must contain as many decimals as the dividend.*

Ex. 1. Divide 17·34 by 3·4.

```
3·4)17·34(51
    170
     34
     34
```

Here 17·34 contains two decimals, 3·4 contains only one; therefore 51 must contain the remaining one required, and be written 5·1.

Ex. 2. Divide 541·2 by 66.

```
66)541·2(82
   528
    132
    132
```

Here 541·2 contains one decimal, 66 none; hence 82 must contain one, and be written 8·2.

Ex. 3. Divide 2·392 by 4·6.

```
4·6)2·392(52
     230
      92
      92
```

Here 2·392 contains three decimals, and 4·6 one, the remaining two required must therefore be obtained by pointing off both figures of 52 thus, ·52.

Ex. 4. Divide 338·4 by 9·4.

```
9·4)338·4(36
    282
     564
     564
```

Here the dividend has one decimal, and the divisor also one, or as many, and the quotient is therefore an integer.

28. When the dividend has no decimals, ciphers must be annexed, preceded by the decimal point.

Ex. 1. Divide 19 by ·04.

Annexing two ciphers to 19, gives the complete quotient 475.

Ex. 2. Divide 132 by 0·7.

Annexing five ciphers (decimals) gives quotient 1885714. Then the number which added to one decimal in 0·7 to make up five, is four. Ans. 188·5714.

29. When the number of figures in the quotient is not sufficient to make up the required number of decimals, ciphers must be prefixed.

* It is always easy to verify the quotient, since multiplying it by the divisor should reproduce the dividend: thus, in Ex. 1, 5·1 × 3·4 gives (by No. 26) 17·34. The learner should also exercise his common sense on the results as a security against gross mistakes; thus, 17·34 divided by 3·4 will be near 17 divided by 3; that is, less than 6 (as 5·1 is). Again, 2·392 divided by 4·6, is not far from 2 divided by 4, or a half (which is nearly ·52).

Ex. 1. Divide ·1734 by 3·4.

Here ·1734 contains four decimals, and 3·4 one; the quotient 51 (Ex. 1, above) contains only two figures, and three are required, hence 51 must be written 0·051.

Ex. 2. Divide 2·392 by 46.

Here 2·392 contains three decimals, and 46 none; the quotient (52) must contain three, and becomes 0·052.

Ex. 3. Divide 27·9 by 0·02. Annexing one cipher, the quotient is 1395.

Ex. 4. Divide 0·0296 by 5·2. Annexing two ciphers gives quotient 569, which is 0·00569, since the five in this added to one in 5·2 make up six.

30. The division may always be carried to any degree of accuracy by annexing ciphers to the dividend, as is seen in Ex. 2, No. 28.

31. The decimal point may be removed altogether from both the divisor and dividend, by continually multiplying each by 10; for the quotient will thus remain unaltered, No. 7. The first decimal in the quotient will then appear only with the first cipher annexed to carry on the division.

Ex. Divide 27·9 by 0·02. Multiplied by 10 they become 279 and 0·2; multiplied again they become 2790 and 2, the quotient of which is 1395.

This easy process furnishes a complete security against wrongly placing the decimal point in the quotient.

### [4.] *Reduction.*

32. The great convenience of decimals makes it often desirable to reduce vulgar fractions to the decimal form.

To reduce a Vulgar Fraction to a Decimal Fraction.

Divide the numerator by the denominator, adding ciphers as required. The quotient is the decimal required.

Ex. 1. Reduce $\frac{1}{5}$ to a decimal fraction. Dividing 10 by 5 (the cipher being added) we find $\frac{1}{5}$ is 0·2.

Ex. 2. Reduce $\frac{1}{3}$ to a decimal fraction. Dividing 10 by 3 gives 3; the next cipher added gives another 3, and so on continually. The fraction required is therefore 0·333, &c.

Ex. 3. Find what decimal of 1 (nautical) mile is 700 feet.

There are 6080 feet, nearly, in 1 such mile; hence 1 foot is $\frac{1}{6080}$ of 1 mile, and 700 feet are $\frac{700}{6080}$ of 1 mile, which gives 0·115 of 1 mile, nearly

Ex. 4. Find what decimal of 1 minute is 42 seconds.

1 second is $\frac{1}{60}$ of 1 minute, hence 42 seconds are $\frac{42}{60}$ or 0·7 of a minute; or, as it may be written, $0^{m}\cdot 7$.

Ex. 5. Find what decimal of 1 foot is $8\frac{3}{4}$ inches.

First, $\frac{3}{4}$ is 0·75 of 1 inch, hence $8\frac{3}{4}$ inches are 8·75 inches. Then, 1 inch is $\frac{1}{12}$ of 1 foot hence 8·75 inches are $\frac{8\cdot 75}{12}$, or 0·729, of 1 foot.

Ex. 6. Find what decimal of 1 degree is 8′ 37″.

37″ are $\frac{37}{60}$ of 1′, or 0·61 of 1′; then 1′ is $\frac{1}{60}$ of 1°; hence 8′·61 are $\frac{8\cdot 61}{60}$ of 1°, or $0^{\circ}\cdot 143$.

Ex. 7. Find what decimal of 1 day is $3^{h}\ 42^{m}$.

$42^{m}$ are $\frac{42}{60}$ of $1^{h}$, or $0^{h}.7$; and $1^{h}$ is $\frac{1}{24}$ of 1 day; hence $3^{h}\cdot 7$ is $\frac{3\cdot 7}{24}$ of 1 day or $0^{d}\cdot 154166$, &c.

33. Or, reduce the given quantity to the lowest of its denominations when there are more than one, and also the integer to which it is referred, to the same denomination; then divide the given quantity by the integer thus reduced.

Ex. 1. (Ex. 3, above.) The given quantity, 700 feet, being all in one denomination, requires no further reduction.
The integer 1 mile, reduced to the same denomination, is 6080 feet; then 700 divided by 6080 gives 0·115.

Ex. 2 (Ex. 5, above.) 8 inches and 3 quarters are 35 quarters; and 1 foot reduced to the same denomination, is 48 quarters; then 35 divided by 48 gives 0·729

34. To reduce a Decimal Fraction to a Vulgar Fraction.

Note the number of parts which the unit or integer of the given quantity contains of the next inferior denomination, and multiply the given decimal by this number; the product is the given quantity expressed in that denomination

If this product have a decimal part, multiply this decimal by the number of parts which the unit of the present denomination contains of the next inferior denomination to that just before employed: this product is the quantity which the given decimal contains of that *next denomination*.

Proceed (if there till be decimals), in like manner, to the lowest denomination in which the decimal is required to be expressed

Ex. 1. Find the number of feet in 0·115 of 1 mile.

The next inferior denomination to that of miles is here feet, of which the number in 1 mile is } ...... 0·115 × 6082

Ans. (in the lowest denomination required) 699·4 feet.

Ex. 2. Find the number of seconds in 0·7 of 1 minute.

The next inferior denomination to that of minutes is seconds, of which the number in 1 minute is } ...... 0·7 × 60

Ans. 42·0 seconds.

Ex. 3. Find the number of inches and eighths in 0·48 of 1 foot.

The next inferior denomination to that of feet is inches, of which the number in 1 foot is } ...... 0·48 × 12

5·76 inches.

The next proposed inferior denomination to inches is eighths, of which the number in 1 inch is } ...... 8

6·08 eighths.

Ans. 5 inches and 6·08 eighths, or $\frac{6}{8}$ nearly.

Ex. 4. Find the number of minutes and seconds in 0°·734.

The next inferior denomination to that of degrees is minutes, of which the number in 1° is } ...... 0·734 × 60

44′·040

The next inferior denomination to minutes is seconds, of which the number in 1′ is } ...... 60

2·400

Ans. 44′ 2″·4.

Ex. 5 Find the number of hours and minutes in 0·37 of a day.

The next inferior denomination to days is hours, of which the number in 1 d. is 24 } ...... 0·37 × 24

8·88 hours.

The next inferior denomination to hours is minutes, of which the number in 1h is 60 } ...... 60

52·80 minutes.

Ans. 8h 52m·8.

35. When we propose to use the nearest whole number, rejecting the decimals, if the decimal is less than ·5, we omit it, if greater than ·5, we count it as a unit. For example, if we propose to take 31·3 as a whole number, we call it 31; if we propose to take 31·7 as a whole number, we call it 32. The reason is, obviously, that 31·3 is nearer to 31 than it is to 32, whereas 31·7 is nearer to 32 than it is to 31.

In like manner, we may abridge the decimals themselves when accuracy is not required: thus, for ex. 11·567 may, when two places only are required, be written 11·57, or when one place only, 11·6 *

## II. Proportion.

36. By the term *ratio* we commonly understand the relative mangnitude or quantity of two things of the same kind; thus, when we speak of the ratio of two numbers, 12 and 4, we mean their relative magnitude, or the result of comparing them together in respect of quantity.

37. The most distinct and intelligible notion which we can form of the degree in which one quantity or magnitude is greater than another, is the number of times one contains the other; that is, the quotient of one by the other is the *measure* of the ratio. Thus, to compare 12 and 4, we find that 12 contains 4 three times, or the quotient $\frac{12}{4}$, or the number 3, is the measure of the ratio of 12 to 4.†

* The following signs, or symbols, of arithmetical operations are often used for abbreviation.

(1.) The sign +, called *plus* (which is the Latin for *more*), signifies *additive*, or to be *added*.

(2.) The sign −, called *minus* (which is the Latin for *less*), signifies *subtractive*, or to be *subtracted*.

Ex. +3 signifies 3 to be *added*. −3 signifies 3 to be *subtracted*.

(3.) The sign × signifies *multiplied by*.

Ex. 7 × 5 signifies 7 *multiplied by* 5.

(4.) The sign ÷ signifies *divided by*. The operation of division is also indicated by writing the divisor under the dividend, with a line between them.

Ex. 14 ÷ 2 signifies 14 *divided by* 2; which is as frequently denoted thus, $\frac{14}{2}$.

(5.) The sign = signifies *equal to* (or amounting to).

Examples of the preceding, with the results in each case, will stand thus:—

(1.) 14 and 3 = 17, or 14 + 3 = 17. (2.) 10 − 3 = 7.

(3.) 7 × 5 = 35. (4.) 14 ÷ 2 = 7, or $\frac{14}{2} = 7$.

These processes appear much more conspicuous to the eye than when written out in words at length.

† But, instead of saying that the absolute number 3 is the measure of the ratio 12 : 4, it is more correct to say that the measure is itself the ratio of 3 : 1; because, in all cases of measure, we employ a convenient quantity of the same kind as a unit, as 1 foot, or 1 mile for length, 1 second for time, &c.; so the measure of ratio is itself a ratio, but of the simplest form that can be found

The ratio or proportion (for the terms are often used indifferently) of two numbers, as 12 and 4, is written thus, 12 : 4, or, as above, $\frac{12}{4}$.

38. Suppose it required to find the ratio of 12 to 5. 12 contains 5 more than twice, but not three times. By actual division, $\frac{12}{5}$ gives $2\frac{2}{5}$; but this, instead of being simpler, is more complex than $\frac{12}{5}$. Hence, as we cannot simplify this fraction (12 and 5 having no common measure but 1), it remains as the measure, or represents the ratio of 12 : 5

39. In the same manner is represented the ratio of 4 to 12, in which the smaller term is taken first; for though 4 does not contain 12, yet it contains the third part of 12, so that there is still an exact relation between the numbers in this order: in other words, the ratio of 4 to 12 is the same as the ratio of $\frac{1}{3}$ to 1; but the ratio of $\frac{1}{3}$ to 1, or a third to the whole, is the same as that of 1 to 3, since each contains the other three times. Hence, 4 : 12, or $\frac{1}{3}$ : 1, is the same as 1 : 3, or $\frac{4}{12}$ the same as $\frac{1}{3}$, which is the measure of $\frac{4}{12}$.

40. There is an employment of *ratio* or fractions which is often embarrassing to unpractised arithmeticians. If we increase 6 to 7, we add 1-*sixth*, for 1 is $\frac{1}{6}$ of 6, and 6+1 make 7; but, if we now diminish 7 to 6, we take away 1-*seventh*, for $\frac{1}{7}$ of 7 is 1, and 7−1 is 6. In the first case, we take a fraction of 6, in the second, a fraction of 7; and it is obvious that the same quantity cannot be the same fraction of two different numbers. In like manner 3 increased by $\frac{1}{3}$ of itself becomes 4; but to pass back again from 4 to 3, we must take away $\frac{1}{4}$ of 4.

41. It may be convenient to express the change of a quantity in any ratio, by means of the increase or diminution it undergoes, measured by a fraction of itself.

To increase a number in the ratio of $\frac{5}{3}$. $\frac{5}{3}$ is composed of $\frac{3}{3}$ and $\frac{2}{3}$, or 1 and $\frac{2}{3}$; hence the number is to be increased by $\frac{2}{3}$ of itself.

To diminish a number in the ratio of $\frac{4}{5}$. $\frac{4}{5}$ is equivalent to $\frac{5}{5}$, deducting $\frac{1}{5}$, or to $1-\frac{1}{5}$; hence the number is to be diminished by $\frac{1}{5}$ of itself.

Ex. 1. A number is increased in the ratio of $\frac{71}{53}$, by what fraction of itself is it increased? Answer, $\frac{18}{53}$.

Ex. 2. A number is diminished in the ratio of $\frac{23}{51}$, by what fraction of itself is it diminished? Answer, $\frac{28}{51}$.

42. The first of two terms taken in order is called the *antecedent*, and the second the *consequent*: thus, in 12 : 4, 12 is the antecedent, and 4 the consequent; in 4 : 12, 4 is the antecedent.

### 1. *Direct Proportion.*

43. When two pairs of terms occur, each antecedent having the same ratio to its consequent, the four terms constitute an analogy, or proportion, as it is also called: thus, 18 and 6, 12 and 4, each pair

having for its measure the ratio $\frac{1}{4}$, form this proportion—18 is to 6 as 12 is to 4; or, as it is written for abbreviation, 18 : 6 :: 12 : 4.

The same is also written thus: $\frac{18}{6} = \frac{12}{4}$, and read "the ratio of 18 to 6 is equal to the ratio of 12 to 4."*

44. In every proportion the product of the two extreme terms is equal to the product of the two mean (or middle) terms: thus, in 18 : 6 :: 12 : 4, $18 \times 4 = 6 \times 12 = 72$.† This property affords the test by which we learn the various alterations that may be made in a proportion, the original proportionality being still preserved.

45. The following variations in the order of the four terms of a proportion occur the most frequently:—

| | | | |
|---|---|---|---|
| Given form, | 18 : 6 :: 12 : 4 | In like manner, | 4 : 6 :: 12 : 18 |
| Alternately, | 18 : 12 :: 6 : 4 | | 6 : 4 :: 18 : 12 |
| Reversing, | 6 : 18 :: 4 : 12 | | 12 : 18 :: 4 : 6 |
| Or, | 4 : 12 :: 6 : 18 | | 12 : 4 :: 18 : 6 |

46. In a proportion, either of the mean terms is equal to the product of the extremes divided by the other mean.

$$\text{Thus in } 18 : 6 :: 12 : 4, \quad 6 = \frac{18 \times 4}{12}, \text{ and } 12 = \frac{18 \times 4}{6}.$$

Also, either of the extremes is equal to the product of the means divided by the other extreme; as in

$$18 : 6 :: 12 : 4, \quad 18 = \frac{6 \times 12}{4}, \text{ and } 4 = \frac{6 \times 12}{18}$$

Hence, if any three terms of a proportion be given, the fourth may be found.

47. It is often required to increase or diminish a quantity in *a certain ratio*, or proportion. For example, to increase the number 12 in the ratio of 3 to 1, is to multiply by 3. For the increased quantity (which, being yet unknown, we will call $x$) is to be to the given quantity 12, as 3 to 1, or $x : 12 :: 3 : 1$. Whence (No. 44) $1 \times x = 12 \times 3$. Again, to reduce a number, as 13, in the ratio of 5 to 7, is to multiply it by 5 and then divide by 7, for the required number ($x$) is to be to the given number (13) as 5 is to 7, whence $x = \frac{13 \times 5}{7}$.

For example, if certain provisions last 122 men a given time, it is evident that, in order to last 146 men the same time, they must be *increased in the ratio* of 146 : 122; that is, multiplied by 146, and then divided by 122. Again, if certain provisions suffice 106 men, and they are required to serve only 74 men, they may be *diminished in the ratio* of 74 to 106; that is, $\times 74 \div 106$.

* Hence proportion is also described as being the equality of ratio.

† Hence, also, when the products of two pairs of numbers are equal, the four numbers may be written as a proportion. Ex. $22 \times 66 = 4 \times 363$; hence 22 : 4 :: 363 : 66. Care must be taken in the order of the terms, which, though indifferent in a product is every thing in a proportion.

[1.] *Rule of Three, Direct.*

48. Numerous arithmetical questions occur in a form more or less like this: if 5 men do 20 yards of work, how many yards will 11 men do, in the same time, and under the same circumstances.*

(1.) The most obvious and natural method of solving such questions is the *Method of Unity*. Thus, if 5 men do 20 yards, 1 man alone will do 4 yards, and therefore 11 men will do 11 times 4 yards.

(2.) The *General Method* is to arrange the terms in the manner of a proportion, and then to find the unknown term from the other three, (No. 46). Thus, it is obvious that a constant proportion obtaining between the men and their work, we have

5 men : 20 yards :: 11 men : number of yards required.

This process is called the Rule of Three.

(3.) They, however, who are practically familiar with ratio, or proportion, perceive, on considering the question, the ratio in which one of the given terms is to be changed, so as to suit the conditions; and thus the solution is effected at a single step. Thus, in the above question, it is evident that the given number of yards, 20, is to be increased in the ratio of 11 : 5; that is, in exactly the same ratio as the number of men is increased. The solution, therefore, is comprised in these figures, $20 \times \frac{11}{5}$, which gives 44.

49. Various precepts have been suggested for ensuring a correct order in the arrangement of the terms, or the *statement of the question*, as it is called; and one of such, which is often useful, is to consider the terms given as standing to each other in the relation of cause or agent, and effect (as, for instance, the men in the above example and their work). By this supposition (which, however, is arbitrary and unsatisfactory enough in many cases), the four terms are rightly *paired*, or the antecedents and consequents rightly taken. But the fact is, that no mechanical rules can so completely supersede the notion of proportionality as to absolve the mind from all necessity for estimating it; and, consequently, the student, if he clearly understands proportion, depends upon it alone; and if he does not, he cannot, from any number of precepts, feel the least confidence in the soundness of his result.

As a right apprehension of proportion is most essential to every one who has any thing to do with calculation, we have, for the sake of exercise, solved several examples in each of the above three forms.

Ex. 1. A steam-vessel consumes 13 tons of coal in $1\frac{3}{4}$ days; how long will 98 tons last?

(1.) Method of Unity: 13 tons in $1\frac{3}{4}$d. or $\frac{7}{4}$d., is 1 ton in $\frac{7}{4 \times 13}$ or $\frac{7}{52}$d., and 98 tons is $98 \times \frac{7}{52}$ or $13\frac{5}{26}$ days, or 13d. 5h. nearly.

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* In the application of the rules which follow, the circumstances are supposed to remain the same, that is, the change of the numbers does not imply any other change. If, for example, the increased number of men should be in each other's way, so as to interfere with their labour, this must be made a separate consideration.

B

(2.) General Method: 13 : $1\frac{3}{4}$d. :: 98 : d. req. = $1\cdot75 \times 98 \div 13$ = $13\cdot2$ days.

(3.) By Ratio: Here $1\frac{3}{4}$ (days) is to be increased in the ratio of 98 to 13.

$$1\cdot75 \times 98 \div 13 = 13\cdot2.$$

Ex 2 If 13 men make 420 yards in 20 days; how much will they make in 11 days?

Note.—The number of men remaining the same, while the time and the work change, need not be noticed.

(1.) 420 yds. in 20 d. is 21 yds. in 1 d., and $11 \times 21$, or 231 yds. in 11 days.

(2.) 420 yds. : 20 d. :: yds. req. : 11 yds. req. = $11 \times 420 \div 20 = 231$ yds.

(3.) Here 420 is to be diminished in the ratio of 11 to 20.

Ex. 3. A pump, A, delivers 1 ton in $5^m$; another, B, 1 ton in $8^m$; and a third, C, 1 in $15^m$: how much water will they deliver in $1^h\ 10^m$?

Ans. A, $\frac{70}{5} = 14$ tons; B, $\frac{70}{8} = 8\cdot7$; C, $\frac{70}{15} = 4\cdot7$. Total, $27\cdot4$ tons.

Ex 4. A boat, A, lands 52 men in $28^m$ (going and returning); another, B. lands 68 men in $41^m$; and a third, C, lands 20 men in $23^m$; how long will all take to land 220 men?

At these rates, in $1^h$, A lands $\frac{60}{28} \times 52$ men = $111\cdot4$; B, $\frac{60}{41} \times 68$, = $99\cdot5$; and C, $\frac{60}{23} \times 20$, = $52\cdot2$. Total in $1^h$, $263\cdot1$ men. Now, as the number landed is proportionate to the time, we have $263\cdot1$ : $1^h$ :: 220 : $220 \times 1 \div 263\cdot1$, or $0^h\cdot84$ nearly.

Ex 5. A boat, A, fills 8 tons of water in $3\frac{1}{2}^h$; another, B, fills 5 tons in $4^h$; and a third, C, fills $1\frac{1}{2}$ ton in $1\frac{3}{4}^h$; in what time will they fill 107 tons?

(1.) In $1^h$, A fills $\frac{16}{7}$ tons; B, $\frac{5}{4}$ tons; and C, $\frac{6}{7}$ tons; or altogether, $\frac{123}{28}$ tons. This is 1 ton in $\frac{28}{123}$ of $1^h$, 107 tons in $28 \times 107 \div 123 = 24^h\cdot4$.

(3.) Having found the fraction expressing the joint effect for $1^h$, or $\frac{123}{28}$ tons; $1^h$ is to be changed in that ratio, which will convert this into 1, ($\frac{28}{123}$ by Ex.), which gives the time for 1 ton; this is then to be increased in the ratio of 107 : 1.

Note.—Such questions as in Ex. 4 and 5 do not usually admit of exact solution; thus, in any whole number of trips that can be proposed, the boats carry too much or too little. Each boat performs a certain quantity in one particular interval of time, and not *continuously*, like a pump, or so much *per hour*; the reduction, therefore, to hourly rate, is not correct, but it is near enough for forming a tolerable estimate, which, in practice, is all that is wanted. To obtain as complete a solution as the question allows, we must take each boat's performance separately, and add them all up.

Ex. 6. The change of the sun's declination in 1 day is 18′ 21″; find the change for $1^h\ 34^m$.

$24^h$ ($1440^m$) : 18′ 21″ (1101″) :: $1^h\ 34^m$ ($94^m$) : $x$

or, less exactly, $24^h$ : $18'\cdot3$ :: $1^h\cdot6$ : $x$.

Ex. 7. In a Table, against 36° stands the term 27943, and against 37° stands 28504; find the term corresponding to 36° 23′.

| | |
|---|---|
| 36° | 27943 |
| 37 | 28504 |
| Diff. | 561 |

Hence 60 : 561 :: 23 . $x$

which *added* to 27943 (because the terms increase while the argument* increases), gives the term required.

Ex. 8. Against 11° in a Table stands 6726, and against 11° 30′ stands 6354; find the term corresponding to 11° 37′.

| | |
|---|---|
| 11° 0′ | 6726 |
| 11 30 | 6354 |
| Diff. | 372 |

30 : 372 :: 37 : $x$

to be *subtracted* from 6726, which gives the term required.

50. The process of finding a term which falls between two given terms, or, as it is called, *Interpolation*, is sufficiently exemplified above; but it is important to remark that it is not always necessary to work proportions at length. It is enough, for most practical

* The *argument* is the quantity at the side or head of the Table, for which the terms or quantities in the body of the table are given.

purposes, to take a quantity, somewhere between the given terms, as half way, or a third of the way, between them, according to the case. The power of guessing the proportional part is acquired by practice, and saves time which otherwise would often be wasted in working to a superfluous degree of accuracy.

On the other hand, when extreme precision is required, this proportioning alone is not enough, but a correction is necessary, for which see the explanation of the Table for finding the Equation of Second Differences.

### [2.] *Double Rule of Three, Direct.*

51. Questions in the Rule of Three occur also in a more complex form; thus, if 2 men do 7 yards of work in 3 hours, how many yards will 13 men do in 11 hours? in which the answer is required to correspond not merely to a certain number of men, but also to a certain number of hours.

This question resolves itself into two: 1st, if 2 men do 7 yds. how many will 13 men do in the same time, or 3 hours? The answer to which is 45·5 yds.; and, 2nd, if 13 men do 45·5 yds. in 3 hours, how many yds. will they do in 11 hours? Hence the solution of such questions is called the Double, or Compound Rule of Three.

**Ex 1.** The example above

(1.) 1 man does $\frac{1}{2}$ of 7 yds., or 3·5 yds. in $3^h$, and 13 men do 45·5 yds.
13 men do 45·5 yds. in $3^h$, or 15·17 yds. in $1^h$, and therefore 166·87 in 11 hours.

(2.) The two statements as given above.

(3.) 7 is to be increased in the ratio of 13 : 2, and then of 11 : 3.

**Ex 2.** If 9 men make 47 yds. in 4 days, how many yards will 17 men make in 31 days?

Ans. 688 yds.

**Ex. 3.** If 5 men do 64 yds. in 11 days, in how many days will 14 men do 37 yds.?

(1.) 1 man does 64 yds. in 55 days, or 1 yd. in 0·86 days, and
14 men do 1 yd. in ·86÷14, and 37 yds. in 2·27 days.

(2.) 5 m. : 64 yds. :: 14 m. : 179·2 yds. 179·2 : 11 :: 37 : 2·27 nearly.

(3.) 11 is to be diminished in the ratio of 37 : 64, and then of 5 : 14.

**Ex. 4.** A certain quantity of provisions lasts 170 men for 3 months; how much is required for 210 men for 2 months?

(2.) 170 : 1 (whole) :: 210 : $x$ = 210÷170. And $y$ : 210÷170 :: 3 : 2.

(3.) The quantity is to be increased in the ratio of 210 : 170, and diminished in the ratio of 2 : 3.

**Ex. 5.** A steam-vessel has fuel for steaming 13 days at 11 hours a-day; how much must she take to steam 15 days at 18 hours a-day?

(3.) The fuel must be increased in the ratio of 15 : 13, and then of 18 : 11. $\frac{15}{13} \times \frac{18}{11} = \frac{270}{143}$, which is $1\frac{127}{143}$, or $1\frac{9}{10}$ nearly, or nearly doubled.

**Ex. 6.** Three boats fill 16 tons of water in 7 hours; how many boats, at the same average performance, will fill 78 tons in 10 hours?

(1.) 3 boats fill 16 tons in $7^h$, or $\frac{1}{7}$ of 16 = 2·3 tons in $1^h$, and 23 tons in 10 hours. Then, since 23 tons employs 3 boats, 1 ton employs $\frac{3}{23}$ of 1 boat, and 78 tons will employ $\frac{78 \times 3}{23}$ or 10·2 boats.

(2.) $7^h$ : 16 t. :: $10^h$ : $x$ tons (=22·9). 22·9 t. : 3 b. :: 78 t. : 10·2 b.

(3.) 3 is to be increased in the ratio of 16 : 78, and then diminished in the ratio of 10 : 7.

## 2. *Inverse Proportion.*

52. In direct proportion, as we have seen, more is always followed by more, and less by less. But when the nature of the question is evidently such that *more* will be followed by *less*, or *less* by *more*, the proportion is no longer direct. For example, if 5 men do certain work in 4 days, in how many days will 7 men do the same work? Here it is evident that the *greater* number of men will require *less* than 4 days. Again, if a ship going 8 knots, sails a certain distance in 5 hours, it is evident that, if she goes at a *greater* rate, she will perform the same distance in *less* than 5 hours.

53. In a question of work performed, the result is represented by the number of agents multiplied by the time each works; thus, $6\times5$ or 30, represents the labour of 6 agents working for 5 hours, the unit of work being that performed by 1 man. If now, the work remaining the same, we double the number of agents, we shall obviously halve the time, since 12 men will do the work of 6 in half the time, and $12\times2\frac{1}{2}=30$. Or, again, trebling the number of agents, gives $18\times\frac{1}{3}$ of 5, or $18\times\frac{5}{3}=30$. That is, while one factor of a given product is *increased* in the ratio of $3:1$, the other must be *diminished* in the ratio of $1:3$, which last ratio contains the same terms as the other, but in a reverse or *inverted* order. The four numbers constituting two equal products are hence said to be in *inverse proportion* to each other

In the example, No. 52, the number of men is *increased* in the ratio of $7:5$, and the time is accordingly to be *diminished* in the ratio of $5:7$; hence 4 days becomes $4\times\frac{5}{7}$, or $2\frac{6}{7}$ days.

### [1]. *Rule of Three Inverse.*

54. In regard to the solution of these questions:

(1.) In the method of unity, the consideration of inversion does not present itself.

(2.) As a question of proportion, the solution may be effected thus. Suppose the proportion were direct, then (example above, keeping the antecedents and consequents in their given order) 5 men : 4 days :: 7 men : $x$ days. Now, we require a direct comparison between the number of men in the two cases, and the times in the two cases; hence we alter this to 5 men : 7 men :: 4 days : $x$ days. But this would give $x$ greater than 4, as 7 is greater than 5, whereas we know it must be less; hence, inverting the last two terms, gives $5:7::x:4$, or $7:5::4:x=\frac{4\times5}{7}=\frac{20}{7}$, or $2\frac{6}{7}$ days. Hence the process (which is, perhaps, as little liable to mistake as may be expected in a question of some perplexity), is, 1, to write, in the form of a direct proportion, the given antecedents and their consequents; 2, to close terms of like denomination; 3, to invert the last two terms, and then to find the unknown term.

Ex. 1. If 7 men do certain work in 4 days, in how many days will 10 men do it?

(1.) 7 men in 4 days is 1 man in 28 days, and 10 men in 2·8 days.

(2.) Direct form, 7 men : 4 d. :: 10 men : days required.
Like terms, 7 : 10 :: 4 : days required.
Inverting, 7 : 10 :: d. req. : 4. Ans. 2·8 days

(3.) It is evident that 4 is to be diminished in the ratio of 7 to 10.

Ex. 2. If 27 men do certain work in 14 days, how many men will do the same work in 4 days?

(1.) 27 men in 14 days, is 1 man in 378 days; and 378 ÷ 4 gives $94\frac{1}{2}$ men.

(2.) Direct form, 27 m. : 14 d. :: men req. : 4 d.
Closing like terms and inverting, men req. $= 27 \times 14 \div 4 = 94\frac{1}{2}$ men.

(3.) 27 is to be increased in the ratio of 14 : 4.

Ex. 3. If 12 men do certain work, working 4 hours a-day; how many men will it take to do the same work, working 7 hours a-day?

(1.) 12 men in 4 h. is 48 men in 1 h., and $\frac{48}{7}$ in 7 hours, or 7 men nearly.

(2.) Direct form. 12 m. : 4 h. :: men required : 7 h.
Closing like terms and inverting, $12 \times 4 \div 7 = 7$ men nearly.

(3.) 12 is to be diminished in the ratio of 4 : 7.

Ex. 4. Certain tons of fuel last a steam-vessel 11 days, steaming 4 hours a-day; how long will they last steaming $6\frac{1}{2}$ hours a-day?

(1.) 4 h. for 11 d is at the rate of 1 h. a-day for 44 d., and therefore $6\frac{1}{2}$ h. for $44 \div 6\frac{1}{2}$, or $88 \div 13$, which is 6·77 d., or 6 d. $18\frac{1}{2}$ h.

(2.) Direct form, 11 d. : 4 h. :: $x$ days : $6\frac{1}{2}$ h.
Closing like terms and inverting, $x = 44 \div 6\frac{1}{2} = 6{\cdot}77$ d.

(3.) Here 11 days is to be diminished in the ratio of 4 to $6\frac{1}{2}$.

Ex. 5. A certain quantity of fuel lasts a steam-vessel 12 days, steaming day and night; how long will it last steaming 14 hours a-day? Ans. $20\frac{4}{7}$ days.

Ex. 6. A pump, A, empties a cistern in 3 hours; another, B, in $2\frac{1}{2}$ hours; in what time will they empty it both working together?

(1.) In $1^h$, A empties $\frac{1}{3}$ of it, and B empties $1 \div 2\frac{1}{2}$, or $1 \div \frac{5}{2}$, which is $\frac{2}{5}$. Hence in $1^h$ both together empty $\frac{1}{3} + \frac{2}{5}$, or $\frac{11}{15}$. Suppose, for greater convenience, the cistern to hold 10 tons; then in $1^h$ both empty $\frac{110}{15}$ tons, or 1 ton in $1^h \div \frac{110}{15}$, or $1^h \times \frac{15}{110}$, $= \frac{3}{22}$ of $1^h$, which is 10 tons in $\frac{15}{11}$ of $1^h$, or $1\frac{4}{11}{}^h$.

(2.) Stating the question directly, we should say,
$\frac{1}{3} + \frac{2}{5}$ $(= \frac{11}{15})$ : the whole, or 1 :: time required : $1^h$.
But, the greater the fraction representing the hourly work done, the smaller must be the time required for any given quantity of work.
Hence $\frac{11}{15}$ : 1 :: $1^h$ : time required $= \frac{15}{11}$ of $1^h$.

(3.) Here $1^h$, in which the fraction $\frac{11}{15}$ is done, is obviously to be increased in that ratio which will turn $\frac{11}{15}$ into 1, or the whole; and this ratio is $\frac{15}{11}$, for $\frac{15}{11} \times \frac{11}{15} = 1$.

Ex. 7. A can do certain work in $8^h$, and B the same work in $6^h$; in what time will they both complete it together?

(1.) In $1^h$ A does $\frac{1}{8}$, and B $\frac{1}{6}$, hence both together $\frac{1}{8} + \frac{1}{6}$, or $\frac{7}{24}$. Let the work be represented by 10, then in $1^h$ both do $\frac{70}{24}$, and therefore they do the unit of work in $1^h \div \frac{70}{24}$, or $\frac{24}{70}$ of $1^h$. Hence they do the whole in $10 \times \frac{24}{70} = \frac{24}{7}$ of $1^h$, or $3\frac{3}{7}{}^h$.

(2.) Direct form, $\frac{1}{8} + \frac{1}{6}$ : 1 (whole) :: time required : $1^h = \frac{24}{7}$.

(3.) $1^h$ is to be increased in the ratio of 24 : 7.

Ex. 8. Five pumps empty a cistern in 13 hours; how many must be put on to empty it in $3\frac{1}{2}$ hours?

(1.) 1 pump in 65 hours gives 18·6 in $3\frac{1}{2}$ hours.

(2.) 5 p. : $13^h$ :: $x$ : $3\frac{1}{2}{}^h$. Ultimately, $x = 5 \times 13 \div 3{\cdot}5$.

(3.) 5 is to be increased in the ratio of 13 : $3\frac{1}{2}$.

Ex. 9. Four pumps empty a cistern in 10 hours; how long will 7 such pumps take?
Ans. $40 \div 7 = 5^h{\cdot}7$.

Ex. 10. A certain quantity of bread lasts 110 men 21 days; how long will it last 74 men?

(1.) 21 d. for 110 men is 1 d. for 2310 men, and $2310 \div 74$ gives 31·2 days.

(2.) Direct form, 110 m. : 21 d. :: 74 m. : $x$ d.
Closing like terms and inverting, $x = 21 \times 110 \div 74 = 31{\cdot}2$ days.

(3.) It is evident that 21 is to be increased in the ratio of 110 : 74.

Ex. 11. A quantity of bread lasts a ship's crew 21 days at four-fifths allowance; how long will it last at two-thirds allowance?

(1.) $\frac{4}{5}$ lasts 21 d., $\frac{1}{5}$ will last $4 \times 21$ or 84 days, and $\frac{5}{5}$, or whole allowance, $\frac{84}{5}$ or 16·8 days. Hence $\frac{1}{3}$ allowance will last $3 \times 16{\cdot}8$ d., or 50·4 d., and $\frac{2}{3}$, one half of this, or 25·2 days.

(2.) $\frac{4}{5}$ : 21 :: $\frac{2}{3}$ :: required days.
Closing and inverting, days required $= 21 \times \frac{4}{5} \div \frac{2}{3} = 25{\cdot}2$ days.

(3.) 21 days are to be increased in the ratio of $\frac{4}{5} : \frac{2}{3}$, that is $21 \times \frac{4}{5} \div \frac{2}{3}$.

Ex. 12. If it takes 54 yds. at $\frac{3}{4}$ of a yard wide, to cover a surface; how many yards will it take at $\frac{4}{5}$ of a yard in width?

(1.) 54 yds. at $\frac{3}{4}$ wide is $3 \times 54$, or 162 yds. at $\frac{1}{4}$ wide, or 40·5 yds. at 1 yd. wide. This is $5 \times 40{\cdot}5$ or 202·5 yds. at $\frac{1}{5}$ wide, and $\frac{1}{4}$ of this, or 50·62 yds. at $\frac{4}{5}$ wide.

(2.) Direct form, 54 yds. : $\frac{3}{4}$ width :: yds. req. : $\frac{4}{5}$.
Closing like terms and inverting, yds. req. $= 54 \times \frac{3}{4} \div \frac{4}{5} = 50{\cdot}62$ yds.

(3.) Here 54 is to be diminished in the ratio of $\frac{3}{4} : \frac{4}{5}$, or of 15 : 16.

[2.] *Double Rule of Three, Inverse.*

55. As the inversion arises from a product remaining constant while both factors vary, questions of this kind may be solved directly by taking, in each of the two proportions necessary, those terms only which are directly proportional to each other. For example, in a question of agents, work, and time, the first proportion would include work and time, and the second, agents and work.

## III. Logarithms.

56. These are numbers calculated for the purpose of converting multiplication into addition, and division into subtraction.

### 1. *Use of Logarithms.*

57. Every logarithm consists of two parts, the *index* and the decimal part;* thus, in the logarithm 2·80618, the index is 2, and the decimal part ·80618.

58. *To find the Logarithm of a given number.* Find in the Table of Logarithms of Numbers the decimal part (for which see also the Explanation of that table); and then apply the index by one of the two following rules:—

(1.) When the number consists of a whole number, with or without decimals, the index is 1 less than the number of figures in the whole number.

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* This part is also called the *mantissa*.

Ex. 1. Find the log. of 522.

Against 522, in the Table, stands ·717671; then, since there are three figures in 522, the index is 2; hence the log. is 2·717671.

Ex. 2. Find the log. of 5·22.

The log. of 5·22 is 0·717671, because there is one figure in the whole number, and one less than 1 is 0.

(2.) When the number consists of decimals only, count the number of ciphers between the decimal point and the first significant* figure after it, and subtract this number from 9; the remainder is the index.

Ex. 1. Find the log. of ·005814.

The decimal part of 5814 is ·764475; there are two ciphers before the 5, which 2 takes from 9 leaves the index 7: hence the log. is 7·764475.

Ex. 2. The log. of ·5814 is 9·764475, for the number of ciphers before the ·5 is nothing which leaves 9 for the index.

59. *To find the natural number of a given Logarithm.* Look for the decimal part of the given log. in the body of the table, and take out the number from the side column and top.

To place the decimal point. Add 1 to the given index of the log., and mark off to the left this number of figures; these will be whole numbers; the rest, if any, will be decimals.

If the index is 9, put the dot before the first figure; if it is 8, prefix one cipher to the first figure, and place the dot before the cipher; if it is 7, prefix two ciphers, and so on.†

Ex. 1. Find the number to the log. 1·717671.

The number (to 4 places) to ·717671 is 5220: adding 1 to the index 1, gives 2, which, marked off to the left, gives 52·2, the number required.

Ex. 2. Find the number to the log. 8·581381.

The number to 581381 is 3814; prefixing one cipher gives ·03814, the number required.

When the number exceeds four figures, see the explanation of the table.

60. In using logarithms, it is proper to observe that the number (whether it contain decimals or not), and the decimal part of the logarithm, are in general true to the same number of figures, rejecting prefixed ciphers; thus, for instance, the log. 3·7575 corresponds to the number 5721, and the log. 3·7576 to 5722, nearly. So also, 8·7575 to ·05721, and 8·7576 to ·05722.

This remark should be kept in view, because it is mere waste of time to employ more figures than are required to insure a certain degree of precision in the result.

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* That is, the first figure not a cipher.

† As the index of the log. is 1 less than the number of figures in the natural number itself, it would follow that the index of ·3814 (for example) in which there are no significant figures, would be 1 less than nothing, the meaning of which is, that such a log. is reckoned on the opposite direction from a certain point, which need not here be further discussed. The index of such a log. is called *negative;* and as this is embarrassing to beginners, 10 is added to the index 0, whereby 1 less gives 9. But 9 is the index, properly, of a number consisting of 10 figures; however, as we have no such numbers to deal with, the ambiguity of the double meaning is not experienced.

61. The remark (No. 35) applies also to logarithms; thus, for example, if we propose to use only four figures of the log. ·881385, we write ·8814, which is evidently nearer to ·881385 than ·8813 would be. Again, if we take four figures of ·881343, we write ·8813.

62. To find the *arithmetical complement* of any number or logarithm.

Take every figure from 9, except the last, which take from 10. It is necessary to begin at the left.

Ex. 1. Find the arith. comp. of 1·87043
arith. comp. log. required 8·12957

Ex. 2. Find the arith. comp. of 0·91350
arith. comp. log. 9·08650

63. A subtractive quantity is, by this means, made additive The process is equivalent to subtracting the number from 10, and the reason of it is evident on considering that to add 3, for example, and subtract 10, is the same as to subtract 7. In like manner, instead of subtracting $47^m\ 32^s$, for example, we may add $12^m\ 28^s$ (the complement to 60), provided we subtract 1 hour (or 60); and thus any number of quantities, of which some are additive and some subtractive, may be rendered all additive, provided that the larger numbers which are employed in taking the complements be themselves subtracted.

## 2. *Certain Arithmetical Operations by Logarithms.*

### [1.] *Multiplication.*

64. To multiply numbers together, add their logarithms together; the sum is the logarithm of the product required.

Ex. 1. Multiply 530·9 by 27·22.

| | |
|---|---|
| 530·9 | log. 2·725013 |
| 27·22 | log. 1·434888 |
| Ans. 14451. | log. 4·159901 |

Ex. 2. Multiply ·079 by 3·142.

| | |
|---|---|
| ·079 | log. 8·897627 |
| 3·142 | log. 0·497206 |
| Ans. 0·2482 | log. 9·394833 |

### [2.] *Division.*

65. From the log. of the dividend subtract the log. of the divisor; the remainder is the log. of the quotient required.

If the logarithm of the dividend is the lesser of the two, increase its index by 10.

Ex. 1. Divide 4280 by 365.

| | |
|---|---|
| 4280 | log. 3·631444 |
| 365 | log. 2·562293 |
| Ans. 11·73 | log. 1·069151 |

Ex. 2. Divide 69·3 by 71·7.

| | |
|---|---|
| 69·3 | log. (+10) 1·840733 |
| 71·7 | log. 1·855519 |
| Ans. 0·9665. | log. 9·985214 |

### [3.] *Involution.*

66. Involution is the process of multiplying a quantity by itself: the quantity thus multiplied is said to be *raised to a power*.

67. The *first power* is the number itself. The second power is the number multiplied by itself; this is also called the *square*. The third power is the number again multiplied by itself; this is also called the *cube*.

The number or quantity to be raised to a power is called the *root*; the number which indicates the power to which the quantity is raised is called the *index*.

68. To *square* a number. Multiply the log. of the number by 2; the product is the log. of the number required.

When the number is a decimal fraction, subtract the index (after being doubled) from 10 multiplied by 2 (or 20), diminish the remainder by 1, and prefix the number of ciphers indicated by this remainder to the number corresponding to the logarithm.

Ex. 1. Square 12·39.

| | |
|---|---|
| 12·39 | log. 1·093071 |
| | 2 |
| Ans. 153·5. | log. 2·186142 |

Ex 2. Square ·0592.

| | |
|---|---|
| ·0592 | log. 8·77232 |
| | 2 |
| Ans. ·003505 | log. 17·54464 |

17 from 20 leaves 3; deducting 1 gives 2; 2 ciphers are, therefore, prefixed to 3505.

69. To *cube* a number. Proceed by the above rule, only reading 3 for 2, and 30 for 20. In like manner, to raise a number to the *fourth power*, read 4 for 2, and 40 for 20, and so on.

[4.] *Evolution.*

70. Evolution is the reverse of involution, and is the process of finding that number which, multiplied by itself a certain number of times, will produce the given number.

This number is called the *root* of the given number.

71. To extract the *square root* of a number. Divide the log. of the given number by 2, the quotient is the log. of the square root required.

When the given number is a decimal fraction (that is, when the index of its logarithm is 9, 8, 7, &c.), increase the index by 10.

Ex. 1. Find the square root of 1·535.

| | |
|---|---|
| 1·535 | log. 0·186108 |
| | 2)0·186108 |
| 1·239 Sq. root req. | 0·093054 |

Ex. 2. Find the square root of ·003505.

| | |
|---|---|
| ·003505 | log. 7·54469 |
| | 10 |
| | 2)17·54469 |
| 0·0592 Sq. root req. | 8·77234 |

72. To extract the *cube root*. Proceed by the above rule, only reading 3 for 2, and 20 for 10. To extract the *fourth root*, read 4 for 2, and 30 for 10, and so on for other roots.

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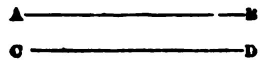
## IV. Practical Geometry.

### 1. *Definitions.*

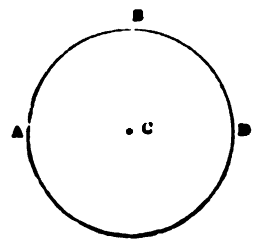
73. Geometry is the name of that science which relates to the measures of space.

A problem is something required to be done.

Parallel lines are lines so placed that the shortest distance between them is every where the same, as A B, C D. Such lines evidently never meet.



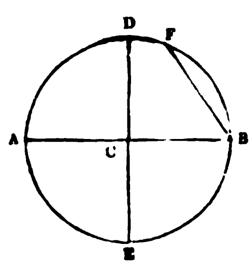

74. A circle is a figure bounded by a curve line called the *circumference*,* of which every point is at the same distance from a point within, called the *centre*. Thus, A B D is a circle, and C the centre.




75. The circumference is divided into 360 equal parts, called *degrees*, written thus, 360°; each degree, into sixty equal parts, called minutes (60′); each minute into sixty seconds (60″); and also each second, into sixty thirds (60‴). Example, 11° 19′ 46″, eleven degrees, nineteen minutes, forty-six seconds.

76. The circumference is also divided into 32 equal portions of 11° 15′ each, called *points of the compass*. These are again subdivided into half points and quarter-points. The term point is used indifferently for the *arc* of 11° 15′, and for a mere point of division of the circumference.

77. A straight line, A B, drawn through the centre, divides the figure into two equal parts, called *semicircles*, as A D B, A E B. The half circumference measures 180°.




78. The line A B is called the *diameter*: it is evidently equal to twice the distance from the centre, C A, which is called the *radius*.

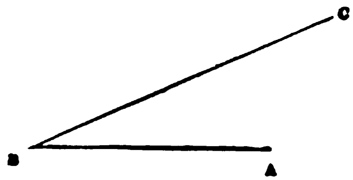
---

* In common language, circle and circumference are often used indifferently the one for the other, but circle is properly the *surface* or *area* of the figure included within the circumference.

79. If another diameter, D E, cross this, and divide each semicircle into two equal parts, the four equal parts, A D, B D, B E, E A, are called *quadrants*, and each of such portions of the circumference measures 90°.

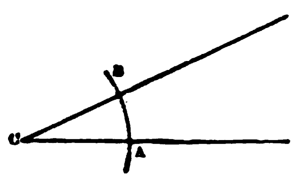
80. Any portion of the circumference is called an *arc*, and the line joining its extremes is called a *chord:* thus the line B F is the chord of the arc B F.

81. An ANGLE is the inclination of two straight lines to each other; that is, the difference of the directions in which they lie: thus A B C, or B, is the angle contained by the two lines B A, B C which are called the *legs*.




An angle is not changed by increasing or diminishing the length of the legs, because the *length* of these lines has nothing to do with the *directions* in which they lie.

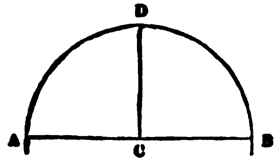
82. Since in describing a circle the radius moves round the centre C, exactly as the point of the compasses advances on the circumference, the angle A C B is measured by the number of degrees in the arc A B.




83. The arc A B is said to *subtend* the angle A C B.

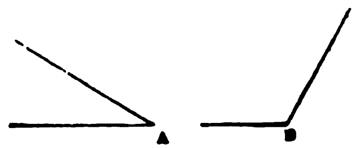
84. An angle of 90°, as A C D (fig. in No. 77), which is subtended by a quadrant, as A D, is called a *right* angle. A circle contains four right angles, a semicircle two.

85. The angles A C D, B C D, being each 90°, are equal; and C D, which makes these adjacent angles equal, is said to be *perpendicular* to A B.




86. The difference between an angle and 90° is called its *complement;* the difference to 180° is called its *supplement.*

An angle less than 90° is called *acute*, as A.
An angle greater than 90° is called *obtuse*, as B.



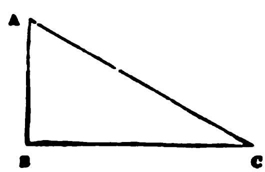
87. A PLANE TRIANGLE is a figure contained by three straight lines.

When the three sides are equal, the triangle is called *equilateral*; when two of them are equal, it is called *isosceles*.

88. When one of the angles is 90°, the triangle is said to be *right-angled*; when each angle is less than 90°, it is said to be *acute-angled*; when one is greater than 90°, it is said to be *obtuse-angled*.

Triangles that are not right-angled are called in general *oblique-angled*.

89. In a right-angled triangle, as A B C, the side A C, opposite the right angle is called the *hypothenuse*; one of the other sides, as B C, is called the *base*; and the third side, A B, the *perpendicular*.



90. A SPHERE, or GLOBE, is a solid figure bounded by a curve surface, of which every point is at an equal distance from the centre.

## 2. *Geometrical Problems.*

91. The instruments necessary in constructing the figures in these problems are, a pair of compasses and a straight edge of any kind, as of a ruler, or, when such cannot be had, the back of the fold made by doubling a piece of thick paper. Also the parallel rulers are convenient. These may be of the common form, which needs no description here, or those called Marquoi's Rulers.*

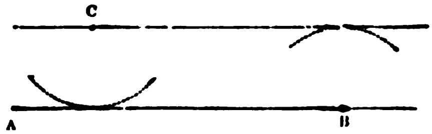
92. The accuracy of a straight edge is tested thus. Draw a line with a fine pointed pencil, or steel pen, along the edge, between two points near the extremities. Then turn the ruler over and draw another between the same two points: if the edge is perfect, the two lines will appear as one; if not, there will be a space between them.

* These last consist of a right-angled triangle, having one of its angles about 20°, and a flat ruler somewhat longer than the hypothenuse of the triangle, both of the same thickness. By sliding the triangle along the edge of the ruler, which is kept fixed, two sides of it move parallel to themselves. This parallel motion is perfect, which is not always the case with the common parallel rulers, especially after long use; and besides this, the triangle being right-angled, dispenses with the trouble of drawing perpendiculars by points.

93. PROBLEM. To draw a line through a given point parallel to another line.

C is the given point, A B is the line.

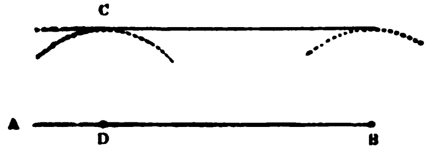
Take the shortest distance from C to A B in the compasses; set one foot on A B as at B, and describe a small arc; then the line drawn through C, so as to touch this arc, is the line required




94. PROBLEM. To draw a line parallel to another line at a given distance from it.

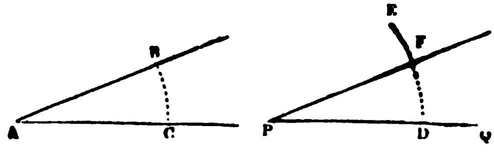
A B is the line, C D the given distance.

Take C D in the compasses, place one foot near each end of A B, and describe two arcs; the line drawn touching these arcs is the line required.



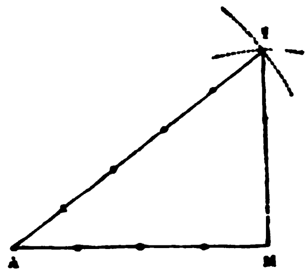

95. PROBLEM. At a given point in a line to make an angle equal to a given angle.

P is the point in the line P Q; A is the given angle. From the centre A, with any convenient radius (the longer the more accurate), describe an arc, C B; from the centre P, with the same radius, A B, describe an arc, D E; take the distance from C to B in the compasses, and put one foot on D and the other on the arc at F, and join P F: then the angle F P D is equal to B A C, their measures, F D and B C, being the same.




96. PROBLEM. From a point M, in a straight line A M, to draw a perpendicular to it (fig. p. 26).

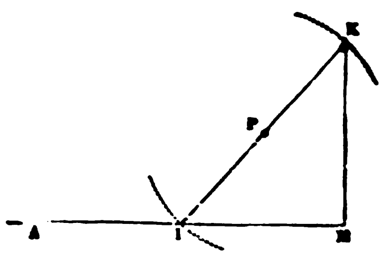
(1.) Draw a straight line any where, and set off by the compasses 5 equal parts upon it. With 3 of these parts in the compasses, as radius, describe from M, as a centre, an arc at I; then lay off 4 parts from M to A; with 5 parts, as radius, describe from the centre A an arc cutting the former arc at I; join I M: this is the perpendicular required.




The following methods are also used:

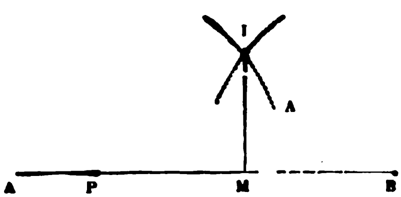
(2.) When the point M is at or near the end of the line.

Take a point P, such that a line supposed to join P and M may make the angle P M A about 45°; and from P as a centre, with the radius P M, describe a small arc I, and another opposite, as K, draw the line I P K, and join the point where it crosses the arc K with M. K M is the perpendicular required.




(3) When the point M is not near the end of the line.

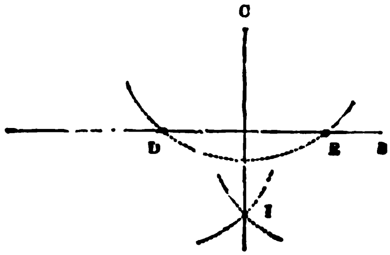
Take two points P, B, at equal distances, from M, and at P and B as centres with a radius exceeding P M, describe two arcs, cutting each other at I; join I M. This line is the perpendicular required.




97. Problem. From a given point without the line, as C, to draw a perpendicular to it.

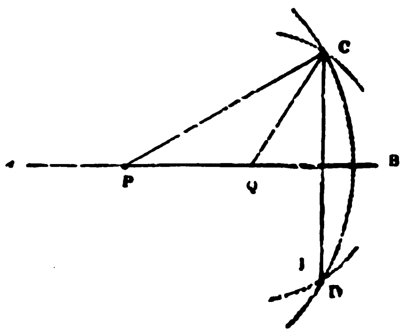
(1.) When the point is nearly opposite the middle of the line.

Take in the compasses a distance exceeding the distance from C to the line; and from C, as a centre, describe an arc, D E; then, from D and E as centres, with a convenient radius, describe two arcs cutting each other at I. C I is the perpendicular required.



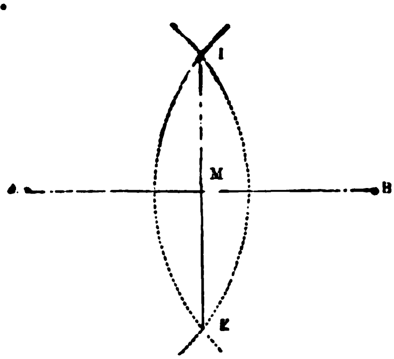

(2.) When the given point is towards the end of the line.

Take a point P as centre, and with P C as radius describe an arc C D. Take another point Q as centre, and with Q C as radius describe another arc cutting C D in I. C I is the perpendicular required.




98. PROBLEM To bisect a line A B, or to divide it into two equal parts.

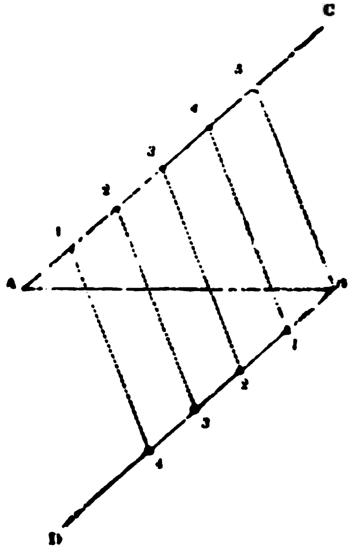
Take in the compasses a distance exceeding half the line, and from A and B, as centres, describe two arcs. The line I K, joining the points of their intersection, divides the line A B into two equal parts, A M, M B.




99. PROBLEM. To divide a line, A B, into any proposed number of equal parts, as five, for example.

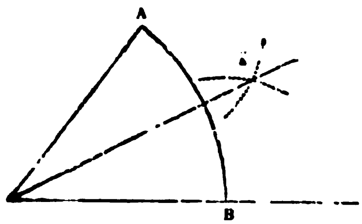
Draw a line A C, making about half a right angle with A B. Draw another line, B D parallel to A C. On A C and B D lay off

five equal parts; join the points 1 and 4, 2 and 3, &c.; these lines will divide A B into 5 equal parts.



In like manner, the line might be divided into any other number of equal parts.

100. PROBLEM. To bisect an arc A B, or an angle A C B.

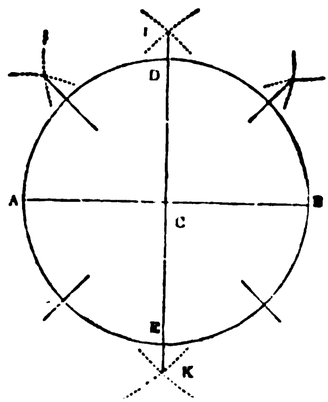


From the points A and B, as centres, with a radius exceeding half the distance A B, describe two arcs cutting each other in I, and draw the line C I; C I bisects the arc A B, and the angle A C B. If the angle alone is given, and not the arc subtending it, describe this arc from C as a centre, with any convenient radius.

101. PROBLEM. To divide a circle into 2, 4, 8, &c. equal parts.

Draw the diameter A B; this divides the circle into two equal parts. From A and B, as centres, with a radius exceeding half A B, describe the arcs I and K, cutting each other above and below A B; join I K: the line E D is a diameter crossing A B at right angles, and dividing the circle into the four quadrants, A E, E B, B D, and D A. Bisect the arc A D (No. 100); draw the diameter through C: this will bisect B E also. Bisect, in like manner, B D and A E. The circle is now divided into 8 equal parts, of 4 points each; bisecting these last arcs divides the circle into 16 equal parts, of 22°½ each.

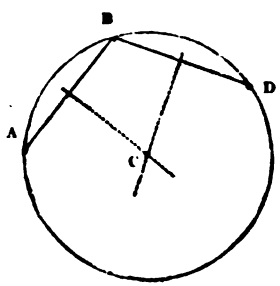
and again bisecting these divides it into the 32 points of the compass of $11^{\circ}\frac{1}{4}$ each.




An arc is divided into a number of parts not divisible by 2, as into 3, 5, 7, &c. parts, by trial.

102. PROBLEM. To find the centre of a circle, or circular arc.

Take two points, as A B, on the circumference, and join them; bisect the line A B (No. 98), and at the middle point draw a perpendicular (No. 96, 3d). Take a third point, D, join it with B; bisect the line B D, and draw a perpendicular at the middle point. The two perpendiculars will cross at the centre.




103. PROBLEM. To draw a circle through three given points.

Suppose the three points to lie in a circle, and proceed to find the centre as above.

It is easy to see that however three points may be placed, some one circle will always pass through them; for an infinite number of circles may be drawn passing through two points, and therefore some one of these must likewise pass through a third point wherever situated.

### 3. *Use and Construction of the Scales.*

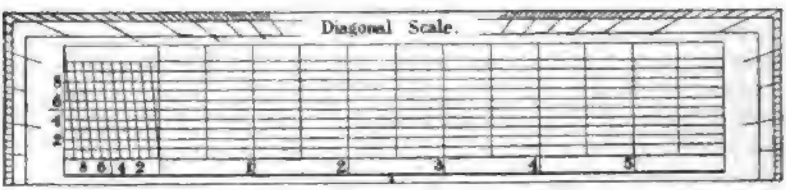
104. These are flat, thin pieces of brass, ivory, or wood divided into certain portions by lines, and serve for measuring or laying off *lines or distances*, and *angles*.

The common scale of equal parts has generally on one side four or five different scales for different measures, on each side of which one division is subdivided into 10 equal parts.

105. In the diagonal scale, the shorter lines dividing the length into equal portions (units) are crossed perpendicularly by 10 others extending the length of the scale. The end division, or unit, has its upper and lower edge subdivided into 10 equal parts, and diagonal lines are drawn from the beginning of one division to the end of the opposite one. This effects a further subdivision by 10, as an example will shew. To take the No. 5·28 from this scale by the compasses. Set one foot at 5, and the other at the second line on the lower edge of the subdivided unit,—this gives 5·2. Now follow up the diagonal line at the ·2 to the eighth of the long parallel lines, and, fixing the point there, extend the other point to meet the line which rises at 5, crossing the breadth; and the number is taken.

The same process serves for tens and units, as for units and tenths, and so on; thus the No. 52·8, or 528, is taken as above.

By placing the points of the compasses *between*, instead of *on*, the 10 long parallel lines, we may obtain a still further subdivision.

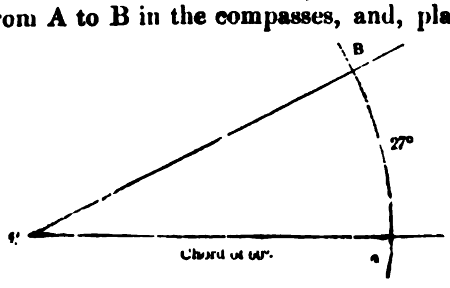



106. Angles are measured, or laid off, either by means of the lines marking the divisions of degrees, or half degrees, at the edge of the scale, and which are numbered at each 10° or 5°, or by means of the

**Scale of Chords.**

(1.) To measure an angle by the marked divisions. Place the middle point of the scale (which is strongly marked) upon the angular point, and lay the edge along one of the legs; the other leg, produced, if necessary, shews, on the graduated edge, the degrees which the angle contains.

(2.) To measure an angle by the scale of chords. Take in the compasses the chord of 60° off the scale, and describe an arc: take the distance from A to B in the compasses, and, placing one foot at



the beginning of the scale of chords, look how many degrees the other foot extends to. Thus, for example, if A B extends to 27°, the arc A B, or angle, C, contains 27°.

107. To lay off an angle from a given line, as, for example, 27°. Describe an arc A B (fig. 106), with the chord of 60°, from C, as centre, and set off the chord of 27° from A on A B; join C B, and A C B is the angle required.

When the angle to be measured or laid off exceeds 90°, measure or lay off 90°, and then the excess above 90°.

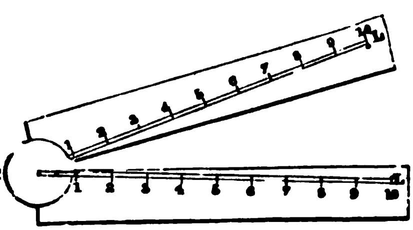
108. The semicircle with a graduated edge is useful for this purpose; but the most convenient instrument, especially for using with the chart, is a transparent horn semicircle, with a long silk thread attached to its centre.*

109. To construct a scale of chords to any proposed radius. The radius is equal to the chord of 60°; describe, therefore, a quadrant, divide it into portions of 30°, 20°, 10°, and so on; draw the several chords, and transfer them to the proposed scale.

### 4. *The Sector.*

110. The Sector is a ruler, or scale, which folds into half its length by moving round a large circular joint on which it is accurately centered. Several lines, or scales, are laid off from the centre to the extremity on both legs of the sector, as tangents, sines, &c., and others parallel to the edges. We shall refer here only to that one which is called the *line of lines* (marked C L in the figure), on account of the great convenience of the sector in reducing a plan, or a figure, to another on a different scale, dividing lines proportionally,† and in solving some simple questions which depend on proportion alone.

C



The line of lines is divided into 10 equal parts, and these again are similarly subdivided. The distance from the centre to any point in the line of lines is called the *lateral distance;* and that between any point in the line of lines on one leg, and the corresponding point on the other, the *transverse distance.*

* Such semicircles, made of horn or other transparent material, and having a long silk thread attached to the centre to extend a straight line to any point beyond the circumference, are most useful, especially for chart work. They are commonly called protractors.

† Another instrument, equally convenient and portable, but more expensive, is the *proportional compasses.* These compasses open on a movable centre, so that the opening of one pair of points may, by moving the centre, be made to bear any proportion to the opening of the other pair of points.

The following examples will illustrate the use of the Sector.*

Ex. 1. To divide a line into a number of equal parts, as for ex. 7.

Take the given line in the compasses; place one point on the division 7 on one leg of the sector, and open it till the other falls on the other 7. Then the transverse distance 1 to 1 is 1-7th, 2 to 2 is 2-7ths, and so on; or the line 7, 7 is equally divided into the parts 1, 1; 2, 2; &c.

Ex. 2. To reduce a plan on the scale of 3 inches to a mile, to another scale of 2 inches to a mile.

Take the lateral distances on the scale of the 3-inch plan. Take 2 in the compasses; place one point at the division 3, and open the sector till the other point falls on the other 3. Then the transverse distances will be the distances on the proposed plan.

Ex. 3. A line of a given figure measures 85; find the measure of another line in the same figure.

Take the given line 8·5 in the compasses and open the sector till their points measure the transverse distance 8·5, 8·5. Then any other line of the figure taken in the compasses is measured by finding the corresponding points in the two legs which exactly contain it, and multiplying the number shewn by 10.

* *See* J. F. Heather on Mathematical Instruments, Lockwood & Co., Ludgate Hill.

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## V. Raising the Trigonometrical Canon

111. This term implies forming the proportions or analogies proper for the solution of problems concerning right-angled triangles.

Before, however, the student proceeds to the actual composition of these analogies, he should be acquainted with the few propositions of geometry which are given in the following section.

112. Definition. An Axiom is a proposition assumed to be so obvious as to require no demonstration.

The principal axioms which have been employed as the foundation of geometrical reasoning are the following:—

(1.) Geometrical magnitudes are said to be equal when one being placed on another coincides with, or exactly covers, it.

(2.) Two magnitudes which are each equal to a third, are equal to each other.

(3.) If equals be added to equals, the wholes will be equal.

That is, if two magnitudes be equal, and a third be added to each, the two sums will be equal.

(4.) If equals be taken from equals, the remainders will be equal.

(5.) If the same or equal quantities be added to unequals, the sums will be unequal.

(6.) If equals be taken from unequals, the remainders will be unequal.

(7.) The halves of equal things are equal.

(8.) The doubles of equal things are equal.

113. Def. A Geometrical Theorem is a proposition in which some property of a figure is demonstrated.

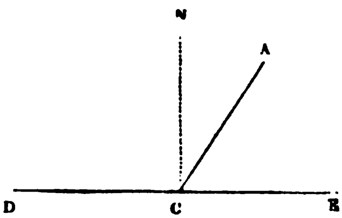
The term Proposition includes both Problems and Theorems.

114. Def. A Corollary is an obvious conclusion or necessary inference, from a proposition.

## I. *Theorems of Geometry.*

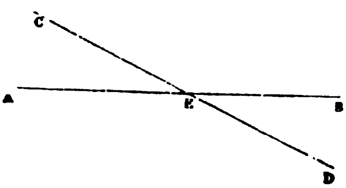
115. **A straight line, as A C, standing on another, as D E, makes the adjacent angles, A C E and A C D, together equal to two right angles.**

For, draw C N at right angles to D E; then D C N and N C E are two right angles; that is, D C N, with N C A and A C E, are two right angles; and since D C N and N C A make up D C A, therefore, D C A and A C E are two right angles.




116. **If two straight lines, as A B, C D, intersect or cross each other, the opposite and vertical angles, as C E A, B E D, are equal.**

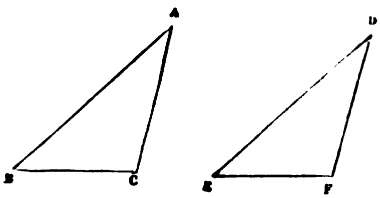
Since C E stands on A B, the angles C E A and C E B are equal to two right angles (No. 115). Again, since B E stands on C D, the angles C E B and B E D are equal to two right angles. Hence C E A and C E B are equal to B E D and C E B. Take away the angle C E B, common to both these sums, and the remaining angles C E A, B E D are equal. (No. 112, 4).




117. **If two triangles, as A B C, D E F, have two sides of the one, as A B, A C, equal to two sides of the other, as D E, D F, and have likewise the angles A, D, contained by those sides, equal, the two triangles are equal in all respects.**

For if the point A be laid on D, and the line A B on D E, the point B will coincide with E because A B is equal to D E.

Also, since the angles A, D, are equal, the line A C will coincide with D F, and the point C of A C will coincide with the point F of D F, because A C is equal to D F.




Then since B coincides with E, and C with F, the base B C coincides with the base E F, and is therefore equal to it.

Since therefore the three sides of the triangles are equal, the triangles are equal, and either laid on the other (two equal sides being laid on two equal sides) will exactly cover it. Hence the two remaining angles must be equal, or B is equal E, and C to F; or, the triangles are equal in all respects.

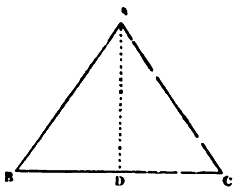
The above proves the method No. 100. For suppose A and I, B and I to be joined by lines, then the two triangles C A I, C B I, have the sides C A, A I equal to C B B I, and the third side common. Hence they are equal, and the angles A C I, I C B being equal, each is half of A C B.

118. If two triangles A B C, D E F (fig. No. 117) have the angles B, C, in one, equal to two angles E, F, in the other respectively, and also the sides B C, E F, adjacent to the equal angles, equal to each other, the two triangles are equal.

Suppose the point B to be laid on E, and the side B C on E F, the points C and F will coincide because B C is equal to E F.

Again, since the angles B and E are equal, the side B A will fall on E D; and because the angles C and F are equal, the side C A will fall on F D. Hence, as the point A belongs to both the sides B A and C A, and D to E D and F D, the point A will coincide with D, and the angles A and D are equal. Hence the two triangles are equal.

119. In an isosceles triangle, as A B C, the angles B, C, opposite the equal sides A B, A C, are equal.



Suppose the angle B A C bisected by the line A D. Then since A B and A C are equal, and the side A D common to the two triangles A D B, A D C, and the angle B A D equal to C A D, each being half of B A C, these two triangles are equal in all respects (No. 117), and therefore the angles B and C are equal.

Cor. 1. Since the base B D is equal to the base C D, a line bisecting the angle contained by the two equal sides of an isosceles triangle likewise bisects the third side.

Cor. 2. Also, since the adjacent angles A D B, A D C are equal, they are right angles, or the said line is perpendicular to the third side.

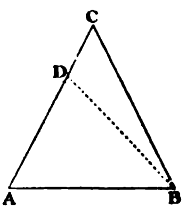
Cor. 3. If the third side is equal to A B or B C, the angle A is equal to B or C; or an equilateral triangle is equiangular.

This proves the method No. 97 (1); for supposing C D, D I, and C E, E I joined, the two C D, D I are equal to C E, E I, and C I is common; hence the triangles are equal. And the angles D C I, E C I are equal, and each is half D C E; hence C I bisects D C E and is perpendicular to A B.

The like proof applies to No. 97 (2); for suppose P I, Q I to be joined; then C P, C Q are equal to P I, Q I, and P Q is common; hence C P Q is equal to I P Q, and P B which thus bisects C P I, is perpendicular to C D.

The same kind of proof applies to Nos. 96 (3) and 98.

120. Every triangle which has two angles, A, B, equal, is isosceles; or the sides C A, C B are also equal.



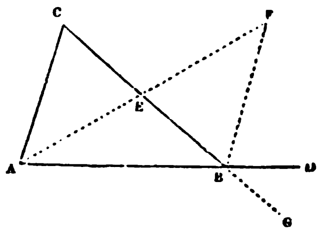
If C A is not equal to C B, let it be greater, and take a part of A C, as A D, equal to C B.

Then since D A, C B are equal, add to each of them A B, and the two D A, A B, are equal to the two C B, A B (No. 112, 3). Also, since D A is equal to C B, the angles D A B, C B A are equal (No. 119). Hence the triangle A D B, having the two sides D A, A B, and the included angle D A B equal to the sides C B, A B, and the angle C B A, is equal to the triangle C B A (No. 117), or the less to the greater, which is absurd. Hence A C, C B are not unequal, that is, they are equal.

Cor. If the third angle C is equal to A or B, the side A B must

in like manner be equal to C B, or to C A; that is, every equiangular triangle is equilateral.

121. If a side of a triangle A B C, as A B, be produced, the exterior angle C B D is greater than either of the interior and opposite angles A and C.

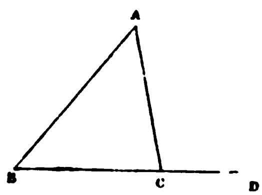



Bisect C B in E, join A E and produce the line till E F is equal to A E; and join F B.

Then since A E is equal to E F, and B E to E C, and also the angle A E C to the angle B E F, the two triangles A E C, B E F have two sides and the included angle equal in each. Hence these two triangles are equal (No. 117), and therefore the angle C (opposite the side A E) is equal to the angle E B F (opposite the equal side E F). Hence C B D which contains C B F is greater than C.

In like manner, by producing C B to a point G, and bisecting A B, it would be proved that the angle A B G, or its equal C B D, is greater than A.

122. Any two angles of a triangle are together less than two right angles.




Produce the side B C of the triangle A B C, to D. Then the exterior angle A C D of the triangle is greater than the interior and opposite angle A B C (No. 121). Add to each angle A C B, then A C D and A C B, are greater than A C B and A B C (No. 112, 5); and since A C D, A C B are equal to two right angles, A C B, and A B C are less than two right angles. The same may be proved of the other angles by producing the other sides.

123. If a straight line A B meeting two other lines C D, E F, makes the alternate angles C G H, G H F equal, the two lines are parallel.

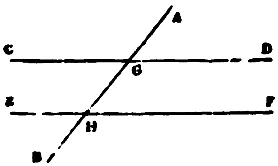



*Fig.* 1.

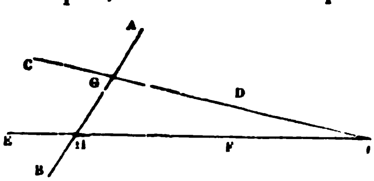



*Fig.* 2.

For if they are not, they will meet on one side of A B; let them meet at I, then G H I is a triangle, and the exterior angle C G H is greater than the interior and opposite angle G H F (No. 121). But these angles are equal by the supposition, therefore the lines do not meet towards I.

In like manner it may be shewn that they do not meet on the

other side of A B, and hence that they do not meet at all; that is, they are parallel.

It appears by fig. 2, that the lines meet on that side on which the two interior angles are less than two right angles. For I G H, I H G are together less than two right angles (No. 122).

124. If a straight line A B (fig. 1, No. 123) falling on two lines C D, E F, make the exterior angle A G D equal to the interior and opposite angle G H F (on the same side of A B), the two lines are parallel. Also, if the two interior angles D G H, G H F, are equal to two right angles, the lines are parallel.

The angle A G D is by supposition equal to G H F, and A G D is equal to C G H (by No. 116); hence C G H and G H F are equal, and they are alternate angles, and C D, E F are parallel.

Again, since D G H, G H F are equal to two right angles by the supposition, and since C G H, D G H are equal to two right angles by No. 115, C G H, D G H, are equal to D G H, G H F; take away the common angle D G H, and the remaining angle C G H is equal to G H F, and they are alternate angles, therefore C D, E F are parallel.

125. If a straight line A B (fig. 1, No. 123) fall on two parallel lines C D, E F, it makes

(1.) The alternate angles C G H, G H F, equal;

(2.) The exterior angle A G D equal to the interior and opposite angle G H F;

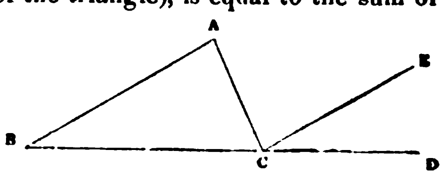
(3.) The two interior angles D G H, G H F, equal to two right angles.

(1.) If C G H be not equal to G H F, let it be greater; add to each the angle D G H; then the angles C G H, D G H are greater than the angles D G H, G H F, and C G H, D G H are equal to two right angles (No. 115); therefore D G H, G H F are less than two right angles. But, by fig. 2, No. 123, this is the case in which the two lines meet at I, whereas they are here parallel by the supposition; therefore C G H is not greater than G H F. In like manner it might be shewn that it is not less; it is therefore equal to G H F.

(2.) Since A G D is equal to C G H (No. 116), and C G H to G H F, therefore A G D is equal to G H F.

(3.) Hence, adding D G H to A G D, G H F, the two A G D, D G H are equal to the two D G H, G H F. But A G D, D G F are equal to two right angles; therefore D G H, G H F are equal to two right angles.

126. Prop. The exterior angle, as A C D, of a triangle (formed by producing one of the sides of the triangle), is equal to the sum of the two interior and opposite angles, A B C and B A C.




Produce the side B C to D, and draw C E parallel to B A. Then the angle E C D is equal to A B C since B D meets the

parallels B A and C E (No. 125). Again, the alternate angles B A C, A C E, formed by A C, which crosses the same parallels, are equal (No. 125). Hence A C E and E C D are together equal to B A C and A B C; that is, A C D, which is made up of A C E and E C D, is equal to B A C and A B C.

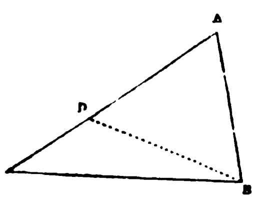
127. Prop. The three interior angles of a triangle are together equal to two right angles (fig. No. 126).

By the above proposition, A C D is equal to the sum of A B C and B A C. Add to each A C B; then A C D and A C B are equal to the three angles A B C, B A C, and A C B, (No. 112). But A C D and A C B are equal to two right angles, therefore the angles A B C, B A C, and A C B, are equal to two right angles.

Cor. 1. In a triangle which has one right angle, the other two angles make up a right angle; each of them, therefore, must be less than a right angle, and each is the complement of the other to 90°.

Cor. 2. If two triangles have two angles in the one equal, respectively, to two angles in the other, they will also have the third or remaining angles equal.

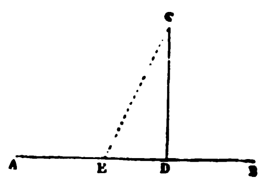
128. Prop. The greater side of any triangle, as A C, is opposite to the greater angle A B C.




C A being greater than A B, make A D equal to A B, and join D B; then since A D is equal to A B, the triangle A B D is isosceles, and the angles A D B and A B D are equal (No. 119). But A B D which is contained within A B C is less than A B C. Hence A D B is less than A B C. Now A D B is equal to the sum of A C B and C B D (No. 125); hence A D B is greater than A C B, that is A B D is greater than A C B, therefore A B C is greater than A C B.

In like manner, by taking C D equal to C B, it would be proved that the angle B is greater than the angle A; and, by taking D on B C, and B D equal to B A, that the angle A is greater than the angle C.

129. Prop. The line drawn perpendicularly from a given point C, to a right line A B, as C D, is the shortest that can be drawn from C on A B.



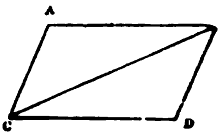

Take any point E in A B, and join C E. Then since in the triangle C E D, C D E is a right angle, the angle C E D is less than a right angle (No. 127, Cor. 1), and therefore (No. 128) C E is greater than C D.

The same proof applies to any point whatever taken in A B.

Cor. As the angle C E D is acute, wherever E may be taken, there is but one line which can be drawn perpendicular to A B from C.

130. Def. A Parallelogram is a four-sided figure of which the opposite sides are parallel.

131. The opposite sides of a parallelogram, as A B, C D, are equal; also the opposite angles are equal; and the diameter, or diagonal, C B divides it into two equal parts.




Since A B and C D are parallel, and C B meets them, the alternate angles A B C and B C D are equal (No. 125). Also, since A C, B D, are parallel, and B C meets them, the alternate angles A C B, C B D are equal. Hence the two triangles A B C, B C D having two angles equal in each, and the side B C adjacent to them common, are equal (No. 118). Hence A B is equal to C D, and A C to B D; also the third angle A to the third angle opposite, D.

Since the two triangles are equal, and make up the whole figure, each is half the parallelogram, or C B bisects A D.

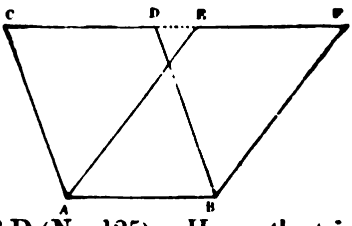
132. The straight lines C A, B D (fig. No. 131) which join the extremities of two equal and parallel lines A B, C D are themselves both equal and parallel.

The triangles A C B, C B D, having the two sides A B, C D equal, and the side B C common, and also the included angles A B C, B C D equal, are equal; hence A C and B D are equal.

Again, since the other angles are equal, A C B and C B D are equal, and hence A C, B D are parallel.

This proves the method No. 93; for the equal distances laid off from C and B perpendicular to A B, form two sides of a parallelogram, of which the other sides also are parallel.
And the like reasoning applies to No. 94.

133. Parallelograms, as A B C D, A B E F, on the same base A B and between the same parallels A B, C F, are equal to each other.

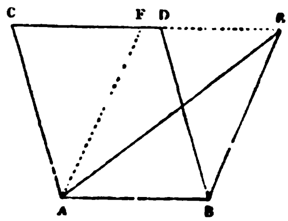



Since C D and E F are each equal to A B, they are equal to each other. Add to each D E, then C D, D E, are equal to E F, D E (No. 112, 3), or C E is equal to D F. Also A C is equal to B D, and A E to B F, hence A C, C E are equal to B D, D F, and the angles A C E, B D F, are equal, because A C is parallel to B D (No. 125). Hence the triangle A C E is equal to the triangle B D F (No. 117).

Take away the triangle A C E from the whole figure A B C F, and the remainder is A E F B; again, take away the triangle B D F from the same figure, and the remainder is A B C D; therefore since these triangles are equal the remainders are equal (No. 112, 4), or the parallelograms A B C D, A B E F are equal.

Cor. Parallelograms on equal bases, and between the same parallels, are equal. For since the bases are equal, either of them placed on the other will coincide with it, and the above proof applies.

134. A Parallelogram A B C D is double of a triangle A B E on the same base, A B, and between the same parallels, A B, C E.

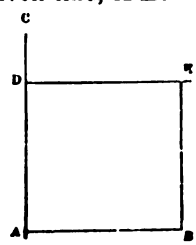



Draw A F parallel to B E, then A B F E is a parallelogram, and it is equal to A B C D (No. 133). Hence the triangle A B E, which is half of A B E F, is equal to half A B C D, or the parallelogram is double of the triangle.

Cor. Triangles on the same or equal bases, and between the same parallels are equal. For parallelograms under these two conditions are, by No. 133, and Cor, equal, and the triangles being the halves of equal parallelograms, are equal.

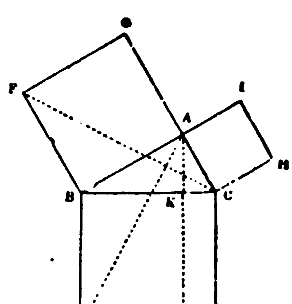
135. Def. A Square is a four-sided figure of which all the sides are equal, and all the angles right angles.

136. Prob. To describe a square, A E, on a given line, A B.




Draw A C perpendicular to A B, take A D equal to A B, and through D draw D E parallel to A B; and through B draw B E parallel to A D (or take D E equal to A B, and join B E). Then A D E B is a parallelogram, of which the opposite sides, being equal, are each equal to A B. Also since D E is parallel to A B, and A D meets them, the angles E D A, D A B, are equal to two right angles, and since A is a right angle, D is a right angle, and the opposite angles to these being equal to them are also right angles.

137. In any right-angled triangle, as A B C, the square B E, on the hypothenuse B C, is equal to the sum of the squares G B and C I on the other two sides.




Draw A K L perpendicular to B C, or parallel to B D, which is perpendicular to B C, and join F C and A D.

Then, since B D is equal to B C, and F B to B A (No. 135), the two sides F B, B C are equal to the two A B, B D (No. 112, 3). Also, the angles A B D and F B C are equal, since each contains a right angle and the common angle A B C Hence the triangles A B D and F B C are equal (No. 117).

Now the triangle A B D is half the parallelogram B L, because they are on the same base B D, and between the same parallels B D, A L (No. 134). Likewise the triangle F B C is half the square B G, since G C and F B are parallel. Hence the parallelogram B L and the square B G are equal.

In like manner, by joining the points B H, and A, E, it would

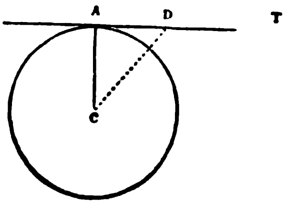
be proved that the parallelogram C L and the square C I are equal.

Hence the sum of the squares B G, C I, is equal to the sum of the parallelograms B L, C L, that is, to the square B E.

Hence in a right-angled triangle if we have two sides we can always find the third: thus, suppose the hyp. is 100, and the base 64, the squares of these are 10000, and 4096; the diff. of these squares, or 5904, is therefore the square of the unknown side, which is 76·8.

**The theorem above proves that the triangle of the dimensions in No. 96 (1) is right-angled For 3, and 4, squared, are 9 and 16, and the sum of these, or 25, is the square of 5, the third side.**

138. The perpendicular on the extremity of the radius of a circle, as A T, is a tangent to the circle.




Take any point D in A T, and join C D; then since C A D is a right angle, C D A is less than a right angle (No. 127), and therefore C D is greater than C A (No. 128) or falls beyond the circumference, that is, A T touches the circle at A only.

Cor. As only one line can be perpendicular to A T (No. 129), the centre of the circle must be in the line perpendicular to the tangent.

139. The angle at the centre of a circle, as A C B, is double the angle at the circumference, as A D B, both angles standing on the same arc A B.

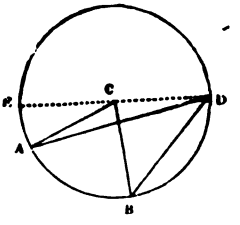



*Fig.* 1.

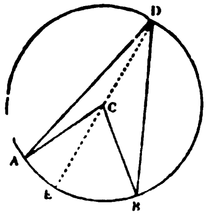



*Fig.* 2.

Join D on the circumference and C the centre, and produce the line D C to E; then the exterior angle A C E of the triangle A C D is equal to the sum of the two interior and opposite angles C A D, and C D A (No. 126). But C A D is equal to C D A, because C A and C D being equal, A C D is an isosceles triangle (No. 119). Hence A C E at the centre is equal to twice A D E at the circumference.

Again, the exterior angle B C E of the triangle B C D is equal to the sum of C B D and C D B. But these angles also are equal, because C B and C D being equal, C B D is an isosceles triangle; hence B C E at the centre is equal to twice B D E at the circumference.

Now, in fig. 1 (where the diameter of the circle passes clear of the arc A B), A C B is the difference of B C E and A C E, and is double of A D B, the difference of B D E and A D E.

When E falls on A B, as in fig. 2, A C B is the sum of A C E and B C E, and is double the sum of the angles A D E and B D E, or the angle A D B.

140. The angle at the circumference is measured by half the arc subtending it (fig. No. 139).

As A C B at the centre is measured by the arc A B, it is evident that A D B at the circumference (which, by the prop. is half A C B) is measured by half A B. Thus, if A B is 58°, the angle A D B will be 29°, for any point of the circumference at which D may fall, except between A and B.

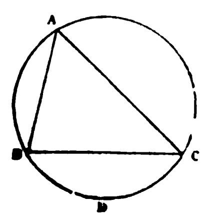
This proves the method No. 100, for, since C A, A I (supposing A, I, and B, I, joined) are equal to C B, B I, and C I common, the triangles C A I, C B I are equal,—hence A C I and I C B are equal; each therefore is half of A C B, and is measured by half the arc A B.

141. The angle in a semicircle is a right angle.

If the arc A B increases to a semicircle, A moving to E and B to D, A C and C B (fig. 1, prop. 139) falling into the same line, form a diameter, the angle A C B becomes two right angles or 180°, and then A D B, or half A C B, is 90°. Hence the angle in a semicircle is a right angle.

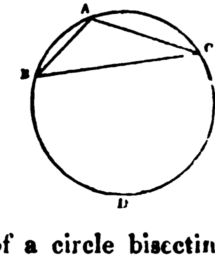
This theorem proves the method No. 96 (2), for since I K is a diameter, the angle at M, a point on the circumference, is the angle in a semicircle.

142. The angle in a segment greater than a semicircle is less than a right angle.



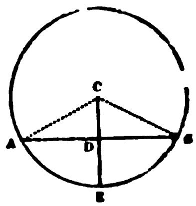

The segment B A C of the circle being greater than a semicircle, the other segment B D C must be less than a semicircle; and the angle B A C in the greater segment being measured by half the arc B D C, that is, by a quantity less than half 180° (No. 140), is less than a right angle.

143. The angle in a segment less than a semicircle is greater than a right angle.




The segment B A C being less than a semicircle, the segment B D C must be greater than a semicircle, and therefore the angle B A C, which is measured by half B D C (No. 140) is greater than half two right angles or than one right angle.

144. A line, C D, drawn from the centre of a circle bisecting any chord A B, is perpendicular to the chord.



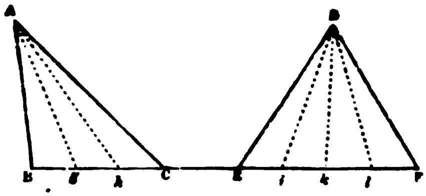

Join C A, C B, then C A and C B are equal by the def. of a circle (No. 74). Also A D and D B are equal, each being half of A B, and C D is common to the two triangles C A D, C B D. These triangles, therefore, having their three sides equal, are equal; hence the equal angles C D A, C D B, opposite the equal sides C A, C B, being adjacent angles, are right angles.

Cor. The line from the centre bisecting the chord bisects the arc A B. For since the two triangles, as above, are equal, the angles A C D and B C D, opposite the equal sides A D, D B, are equal, and being at the centre are measured by the arcs on which they stand.

The above proposition is the principle of the method of finding the centre of a circle, No. 102.

145. Triangles having the same altitude are proportional to their bases.

The altitude is the perpendicular distance of the vertex, or summit, from the base.



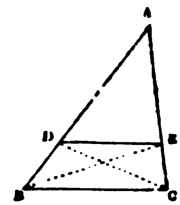

Let the base B C of the triangle A B C be divided into any number of equal parts, as three, B $g$, $g$ $h$, $h$ C, and E F the base of the triangle D E F, into four like parts, E $i$, $i$ $k$, $k$ $l$, $l$ F, then B C is to E F as 3 to 4.

Join the points A $g$, A $h$, and D $i$, D $k$, D $l$. Then the triangles A B $g$, A $g$ $h$, A $h$ C, and D E $i$, D $i$ $k$, D $k$ $l$, D $l$ F are all equal, being on equal bases, and having the same altitude (No. 134, Cor.)

Hence the triangle A B C contains three parts, of which D E F contains four, and, therefore A B C : D E F :: 3 : 4, which is the ratio of the bases.*

146. A line D E parallel to a side B C of a triangle A B C divides the sides A B, A C, in the same proportion, that is, A D : A B :: A E : A C.

* If it be impossible to find a quantity, or measure, B $g$, which shall divide B C and E F into an exact number of equal parts, as 3 and 4 above (that is, when B C and E F are said to be incommensurable) we must take a smaller quantity, and a greater number of triangles; and by taking this measure sufficiently small we may make the error of using it instead of the true proportion as small as we please.



Join B E, C D Then the triangles B D E, C D E on the same base D E, and between the same parallels D E, B C, are equal (No. 134, Cor.) Add to each the triangle A D E, then the whole triangle A B E is equal to the triangle A D C (No. 114, 3). Hence the triangle A B E : A B C : : A D C : A B C.

Now triangle A B E : triangle A B C :: base A E : base A C, since they have the same altitude, viz. the perpendicular drawn from B on A C or A C produced (No. 145). Also,

triangle A D C : triangle A B C :: base A D : base A B,

And the triangle A B E is equal to the triangle A D C, hence the two proportions are the same, and A E : A C :: A D : A B.

In like manner, as the triangles A D E, E D B, have the same altitude, viz. the perpendicular drawn from E on A B, we have

triangle A D E : triangle E D B :: A D : D B.

Also since the triangles A D E, E D C have the same altitude, viz. the perpendicular from D on A C,

triangle A D E : triangle E D C :: A E : E C.

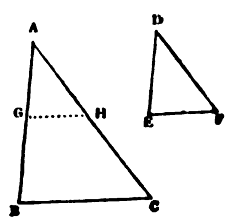
But the triangles E D C and E D B are equal, hence

A D : D B :: A E : E C.

This proof applies to the sector. The line of lines on each leg is the side of an isosceles triangle, and the transverse distances 1, 1, 2, 2, &c., are the bases of so many isosceles triangles; the angles at these bases being equal, the bases are parallel, and the sides of the several triangles so formed are proportional.

147. Def. Similar triangles are such as have the sides about the equal angles proportional.

148. Equiangular triangles, as A B C, D E F, have the corresponding sides about the equal angles proportional, that is, A B : A C :: D E : D F.



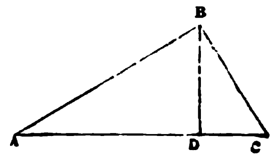
Let the angles A and D be equal, as also B and E, C and F.

Place the triangle D E F on A B C, D being placed on A, and D E on A B, and let G be the point where E falls.

Then since the angles A and D are equal, and D E is on A B, D F will fall on A C; let, therefore, H be the point where F falls. Then since A G H is equal to E, and B to E, A G H is equal to B, and the lines G H and B C, which make equal angles with A B, are therefore parallel. Hence, by No. 146, A B : A C :: D E : D F.

Cor. Hence equiangular triangles are similar (No. 147.)

149. In a right-angled triangle A B C, a line B D drawn from the right angle perpendicular to the hypothenuse, divides the triangle into two similar triangles A B D, B D C.



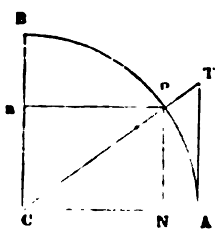

The triangles A B C, A D B, having each a right angle, and the angle A common, have the third angle also equal (No. 127), they are, therefore, equiangular.

For the like reasons A B C and B D C are equiangular; therefore the two triangles A B D, B D C, are equiangular, and the sides about the equal angles are proportional (No. 148). Hence

(1) A C : A B :: A B : A D.
(2) A C · C B :: C B : C D.
(3) A B : A D :: B C : B D.*

## 2. *Terms of Trigonometry.*

150. These terms occur in all calculations in which lines and angles are concerned.




151. P N C is a right-angled triangle; a quadrant is described with the radius C P, from the centre C; C N and C P are produced, and A T is drawn parallel to P N.

152. The perpendicular P N, drawn from the extremity of the arc A P, upon the radius C A, is called the *sine* of the angle P C A (to which it is *opposite*).

When the arc is very small, or P very near A, P N and A P, or the arc and sine, nearly coincide. When the arc is 0, the sine is 0. When the arc is 90°, P falls at B, or the sine of 90° is equal to the radius. Thus the sine is always less than the radius, though near 90° it becomes very nearly equal to it.

153. The line C N, between the centre and the foot of the sine, is called the *cosine* of P C A (to which it is *adjacent*). It is called cosine because its equal P n, is the *sine* of P C n, the *complement* of P C N.

When the arc is small, N falls near A, and C N falls nearly on C A, or the cosine of a small arc is nearly equal to the radius; for the arc 0, they are equal. When the arc is near 90°, the cosine is very small; and the cosine of 90° is 0. Thus the cosine is always less than the radius, though it may approach indefinitely near to it.

---

* By (1) A C × A D = A B × A B, or, as it is written, A $B^2$, and read A B square; and by (2), A C × C D = C $B^2$; hence the products A C × A D and A C × C D are together equal to A B square and B C square. But A C × A D and A C × C D, is the same as A C × A D and C D, or as A C × A C, which is called A C square; hence A C square is equal to A B square and B C square. The term square here denotes the number of units (in the line) multiplied by itself; thus, if A B is 3, A $B^2$ is 9, and this is the number of square units contained in the square described on A B. Hence this is another form of the propos. in No. 137.

154. The line A T, drawn from the extremity of one radius (as C A), touching the circle, and meeting the other radius produced, is called the *tangent* of the angle P C A, or arc P A.

When the arc is small, A T but little exceeds P N; when the arc is 0 the tangent is 0; when the arc is small, the tangent and sine may be taken for each other, and for the arc. When the arc is 90°, the tangent is infinitely great. The tangent is less than the radius, according as the angle is less or greater than 45°.

The *cotangent* is the tangent of P C n, which is the complement of P C N, and would be drawn from the extremity of the radius C B, meeting C P produced.

155. The line C T meeting the tangent, is called the *secant*.

The *cosecant* is the secant of P C n, and meets the cotangent.

When the arc is 0, the secant is equal to the radius. When the arc is 90°, the secant is infinitely great. The secant is always greater than the radius, as is also the cosecant.

156. The line A N is called the *versed sine*.

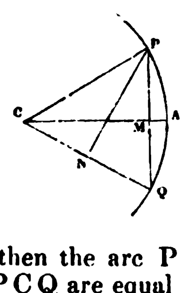
157. These quantities are calculated for a radius of the same constant length, and to each minute or smaller division of the quadrant, and are inserted in Tables. Then, since the sides of all right-angled triangles having the same angles are proportional (No. 148), the tables afford the means of finding the relations among the parts of a right-angled triangle, of any kind or dimensions, by simple proportion. For example, the sine of 30° is $\frac{1}{2}$ the rad. (see No. 159, Cor.), or 0·5, the log. of which, by No. 58 (2), is 9·698970, as inserted in Table 68.

These are the principles on which the Traverse Tables and the Trigonometrical Tables are constructed.

### 3. *Propositions of Trigonometry.*

158. The sine of an arc is half the chord of twice the arc.

Take the arcs A P, A Q equal to each other, and join P Q. Then the angles P C A, A C Q are equal (No. 82). And since C P = C Q, and C M is common to the two triangles C P M, C Q M, these triangles are equal (No. 117); hence P M = M Q; therefore P M, the sine of A P, is half P Q, the chord of twice A P.

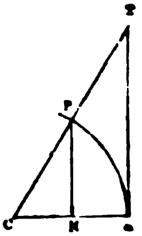



159. The chord of 60° is equal to the radius.

Let A P and A Q (fig. No. 158) be each 30°, then the arc P Q is 60°; and since the three angles of the triangle P C Q are equal to 180° (No. 127), C P Q and C Q P are together equal to 120°. Also, since C P = C Q, these two angles are equal (No. 119), and each, therefore, is 60°. The triangle is, therefore, equiangular, and consequently, equilateral, No. 120. Hence P Q = C P.

Cor. Since P M is half P Q, it is equal to half C P: or the sine of 30°, which is the cosine of 60°, is half the radius.

160. The secant of 60° is equal to twice the radius.



Since P N and A T are both perpendicular to C A, they are parallel (No. 124), and the triangles C P N, C T A, are similar (No. 148), hence

C T : C P :: C A : C N, that is, as rad. : cos. 60°, or as 1 to $\frac{1}{2}$, that is, as 2 : 1.

161. The tangent of 45° is equal to the radius.

Let P C A (fig. No. 160) be 45°, then C T A is also 45° (No. 127), hence the triangle is isosceles and the sides C A, A T are equal.

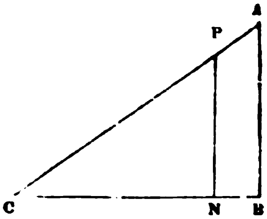
Cor. Hence also, by similar triangles, C N = N P, or the sine and cos. of 45° are equal; as are also the tangent and cotangent.

### 4. *Constructing the Canons, and working them by Logarithms.*

162. Take a right-angled triangle, as A B C, and suppose another similar to it, as P N C, drawn in a quadrant, as in No. 151; then

C A : A B :: C P : P N;

that is, C A : A B :: rad. : sin C (by 152).



The second triangle, P N C, is, in fact, here referred to for illustration only; for it is evident, without it, that C A and A B themselves stand in the same relation to each other as that of *radius* and *sine*; hence

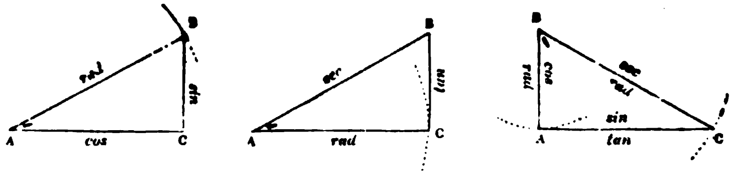
| | | | | | |
|---|---|---|---|---|---|
| By No. 152. | C A : A B | :: | rad. : sin. C. | (1.) |
| By No. 153. | C A : C B | :: | rad. : cos. C. | (2.) |
| By No. 154. | C B : B A | :: | rad. : tan. C. | (3.) |
| By No. 155. | C B : C A | :: | rad. : sec. C. | (4.)* |

163. It is easy to recollect these analogies, each of which begins with two sides, by observing these conditions.

1. One of the three sides must be made radius, and the analogy always begins with that side.

2. The other sides will then become sine, cosine, tangent, cotangent, secant, or cosecant, of one or the other of the two acute angles.

The figures below sufficiently illustrate the application of the terms.




* The learner will much more speedily apprehend the purposes which the expressions of trigonometry answer in the sciences of calculation by considering these proportions as representing the change of quantities in a certain ratio, as in No. 48 (3). Thus A B is C A *diminished* in the ratio of the sine of C to 1; C B in that of cosine to 1. A B is also C B *diminished* or *increased* in the ratio of tan. to 1, according as C is less or greater than 45° and C A is C B *increased* in the ratio of secant to 1.

To employ rightly the terms *sine*, *cosine*, &c., observe—

3. That when the *hypothenuse*, or longest side (which is opposite the right angle), is made the radius,

The side *opposite* either of the acute angles is the *sine* of that angle; and the side *adjacent* to either angle is the *cosine* of that angle.

4. When either of the sides containing the right angle (or *legs*,* as they are called), is made radius, the other side becomes the *tangent* of the angle *opposite* to it; and the hypothenuse becomes the *secant* of that angle which is contained or included between *itself* and the *radius*.

The learner should be able to construct the above analogies (which he will find very easy) before he proceeds to the solution of any question, without regard to what is given or what is not given.

164. We now proceed to the calculation of a problem. The above analogies or proportions consist of four terms each. Hence, if three are given, the fourth may be found (No. 46). But the radius is assumed in the trigonometrical tables as 1 (which is the simplest of numbers), and hence, of the three remaining terms, if two are given, the third may be found.

Hence, in any right-angled triangle, consisting of three sides and two angles besides the right angle, if two parts which enter into any one of the above analogies are given, the third term of that analogy may be found.

165. The proportions may be solved by multiplication and division; thus, suppose, C A (fig. No. 162) measures 37 feet, and the angle C is 29° 52′, and we want to find A B.

We have by No. 162 (1), C A : A B :: 1 : sin. C,

whence (No. 46) A B = C A × sin. C (the 1 not being written).

Now the sine of 29° 52′, given in tables of natural sines (of which the *logs*. are given in Table 68) is 0·498 nearly, hence A B = 37 × 0·498 = 18·426.

But in order to save such tedious processes, logarithms are employed in the manner described, Nos. 64 and 65. Thus, A B = 37 × sin. C, becomes log. of A B = log. of 37 + log. sin. C.

Again, if C A were required, and A B given, we should have C A = A B × 1 ÷ sin. C; or, (suppressing the 1).

log. C A = log. A B − log. sin. C.

The following rules are deduced from these principles.

The learner will do well to verify all his work by the Traverse Tables. This proceeding is described in the explanation to the Traverse Tables.

166. The rule for working any analogy by logarithms is very simple, and there are but two cases: 1. In which it is required to find one of the mean terms; and, 2. In which it is required to find one of the extreme terms.

* The two legs are also called the *base* and *perpendicular* (No. 89). These terms, being usually given to the sides which are horizontal and vertical, as the reader holds the figure before him, are employed entirely at convenience.

(1.) To find a *mean* term. Add together the logarithms of the two extremes, and subtract from the sum the logarithm of the other mean. The remainder is the logarithm of the term required.

(2.) To find an *extreme* term. Add together the logarithms of the two means, and subtract from the sum the logarithm of the other extreme. The remainder is the logarithm of the term required.*

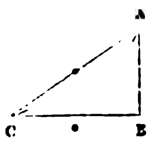
*Note.*—The log. of the *radius* (as employed in the analogies) is 10, this being used for convenience, as stated at p. 19, note †.

Case I. Given the angles and the hypothenuse, to find the two sides.

Ex. B is the right angle. The angle A is $50^\circ$ (whence C is $40^\circ$, because the two acute angles are together $90^\circ$. (See No. 127, Cor.) C A is 28 feet. It is required to find B C and B A.

We must employ two sides, and one of them must be the unknown, or required side: hence,

to find C B,
we must take C A and C B.




If C A, the hypothenuse, be radius, C B becomes the sine of A (No. 163), hence

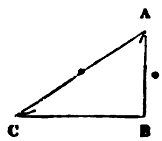
C A : C B :: rad. : sin. A;

in which C B, a *mean* term, is required. Hence, by No. 166 (1), we have to add the logs. of C A and sin. A, and subtract the log. 10.

| | | |
|---|---|---|
| C A 28 | log. (tab. 64) | 1·4472 |
| A $50^\circ$ | log. sin. (tab. 68) | 9·8843 |
| | log. | 11·3315 |
| | sub. | 10· |
| C B = 21·4 | log. | 1·3315 |

We might have used C B as cos. C,
that is, C A : C B :: rad. : cos. C,
otherwise C B : C A :: rad. : sec. C.

to find A B,
we must take C A and A B.




If C A, the hypothenuse, be radius, A B becomes the cosine of A (No. 163).

C A : A B :: rad. : cos. A;

in which A B, a mean term, is required. Hence, by No. 166 (1), we have to add the logs. of C A and cos. A, and subtract the log. 10.

| | | |
|---|---|---|
| C A 28 | log. (tab. 64) | 1·4472 |
| A $50^\circ$ | log. cos. (tab. 68) | 9·8081 |
| | log. | 11·2553 |
| | sub. | 10· |
| A B = 18·0 | log. | 1·2553 |

We might have used A B as sin. C,
that is, C A : A B :: rad. : sin. C,
otherwise A B : A C :: rad. : sec. A.

---

* It is necessary to remark here that the process above differs from that followed by seamen in general, the object of which is simply that the required quantity may stand last. The example in Case III. by that method stands thus:

To find the Angles.

| | |
|---|---|
| As the hypoth. A B | 2·3430 |
| Is to radius | 10·0000 |
| So is the perp. A C | 2·0082 |
| | 12·0082 |
| | 2·3430 |
| To sine of angle B $27^\circ\ 33'$ | 9·6652 |
| Hence, A is $62^\circ\ 27'$. | |

To find the side B C.

| | |
|---|---|
| As rad. | 10·0000 |
| Is to hypoth. A B | 2·3430 |
| So is sin. A | 9·9478 |
| | 12·2908 |
| | 10·0000 |
| To B C 195·4 | 2·2908 |

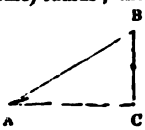
Now the method proposed is more natural than this last; because, when the two sides are taken together, their trigonometrical relation to each other is immediately perceived, which, when they are separated, is not so apparent. Again, since the term sine, or cosine, is determined altogether by that side which we make radius, these terms should, according to the natural progress of ideas, *immediately follow* the term radius. The method followed is also shorter and more elegant. Moreover, the method just quoted, not being employed in

**Case II.** Given the angles and one leg, to find the hypothenuse and the other leg.

Ex. C is 90°. Angle A is 30° 14′, hence B is 59° 46′. B C is 171. Find A B and A C.

To find A B.

Take the two sides, A B, B C make A B (the hypothenuse) radius; then, No. 163.



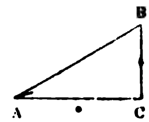

A B : B C :: rad. : sin. A;

in which A B, an *extreme* term, is required. Hence, by No. 166 (2), we have to add the logs. of B C and rad., and subtract the log. of sin. A.*

| | | |
|---|---|---|
| B C 171 | log. + 10, | 12·2330 |
| A 30° 14′ | log. sine | — 9·7020 |
| A B = 339·6 | log. | 2·5310 |

To find A C.

Take two sides, A C, C B, make A C radius; then, by No. 163 (3).




A C : C B :: rad. : tan. A,

in which A C, an *extreme* term, is required. Hence, by No. 166 (2).

| | | |
|---|---|---|
| C B 171 | log. + 10, | 12·2330 |
| A 30° 14′ | log. tan. | — 9·7655 |
| A C = 293·4 | log. | 2·4675 |

This might, like Case I., be worked differently. Thus, to find A B, we may make B C radius; then A B : B C :: rad. : cos. B. Again, to find A C; making B C radius, we have A C : C B :: rad. : tan. B.

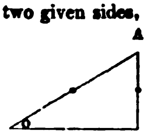
We might also, having found one of the unknown quantities, employ this quantity as a means of finding the rest; but in general it is better, when practicable, to depend only on the original quantities given.

**Case III.** Given the hypothenuse and one leg, to find the angles and the other leg.

Ex. Angle C is 90°, B A = 220·3, A C = 101·9; find the angle B, and then B C.

To find B.

Taking the two given sides, we have




B A : A C :: rad. : sin. B;

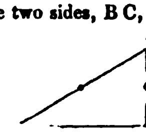
in which sin. B, an *extreme* term, is required.

| | | |
|---|---|---|
| A C 101·9 | log. + 10, | 12·0082 |
| B A 220·3 | log. | — 2·3430 |
| B = 27° 33′ | sin. | 9·6652 |

Hence A = 62 27

To find B C.

Taking the two sides, B C, C A, we have




B C : C A :: rad. : tan. B;

in which B C, an *extreme* term, is required.

| | | |
|---|---|---|
| C A 101·9 | log. + 10, | 12·0082 |
| B 27° 33′ | log. tan. | — 9·7174 |
| B C = 195·4 | log. | 2·2908 |

(Here, in computing by the canons, we are obliged to employ B, as found.)

---

any other scientific process, every seaman who may require to extend his scientific knowledge of these subjects will have to unlearn it and to adopt the other. The rules laid down above will be found, after very little practice, simpler and more intelligible, and therefore easier to recollect, than those of the old method.

* Instead of *subtracting* the log. sine, cosine, and tangent, it is the same thing to *add* the log. cosecant, secant, and cotangent, because these last are the arithmetical complements of the first. We have omitted this in the examples, to avoid confusing the learner.

Case IV. Given the two legs, to find the hypothenuse and the angles.

Ex. The angle C (fig. in Case III., only marking B C as given instead of B A) is 90°. B C = 195·4, C A = 101·9: find B A and the angle A.

To find angle A.

A C : B C :: rad. : tan. A.

Hence, by No. 166 (2),

| | | |
|---|---|---|
| B C | 195·4 | log. + 10, 12·2909 |
| A C | 101·9 | log. − 2·0082 |
| A = 62° 27′ | | log. tan. 10·2827 |
| and B = 27 33 | | |

To find B A.

Making B C radius, B A will become the secant of B; hence,

B C : B A :: rad. : sec. B.

Hence, by No. 166 (1),

| | | |
|---|---|---|
| B C | 195·4 | log. 2·2908 |
| B | 27° 33′ | log. sec. 10·0523 |
| B A = 220·3 | | log. 2·3431 |

As 10 is to be subtracted it is omitted in the index 12.

Ex. 1. The hypothenuse A C is 144, the angle A 39° 22′, whence C is 50° 38′, required A B and B C. Ans. A B is 111·3, and B C 91·5.

Ex. 2. The hypoth. A C 250, the angle C = 35° 30′; find C B and A B. Ans. C B = 203·5, A B = 145·2.

Ex. 3. The perp. B C = 360, the angle A opposite 58° 20′; required the base and hypothenuse A C. Ans. A B = 222, A C = 423

Ex. 4. Given the base A B 208, and angle A 35° 16′; find the hypoth. A C and the perpend. B C. Ans. A C = 254·8, B C = 147·1.

Ex. 5. Given the hypoth. A C 272, and base A B 232, to find the angles A and C, and B C Ans. A = 31° 28′, C = 58° 32′, B C = 142.

Ex. 6. Given the hypoth. C A 980, and base B C 720, required the angles and remaining leg. Ans. A 47° 17′, C 42° 43′, A B 664·8.

## VI. Methods of Solution.*

167. The solution of a question in which the result is required in numbers is obtained in three ways, namely, 1. Inspection; 2. Calculation or Computation; 3. Construction.

(1.) Inspection usually implies taking out, ready calculated, from a table, the result corresponding to the elements of the particular question proposed. The term has, however, a more general acceptation, being applied to the taking out, not merely of the result itself, but of quantities which compose it.

This method being easy and expeditious, is the best for general practice when precision is not required; but as the tables adapted to this kind of solution are necessarily limited, it is, on many occasions, not sufficient.

(2.) The general term Computation may be applied to every mode of solution by the composition of numbers only. Since, however, Inspection includes the simplest cases of this kind, namely, those in which either the required quantity itself, or the parts com-

* The matter in this section is, from its nature, adapted only to the reader who has made some progress in the subject.

## THE SOLUTION OF OBLIQUE-ANGLED PLANE TRIANGLES.

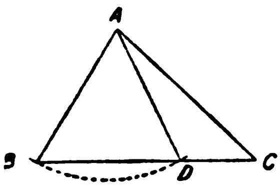
Case I. In any oblique-angled plane triangle, given two sides and an angle opposite to one of them, or two angles and a side opposite to one of them, the remaining angles and sides are found by the following simple proportions :—

As one of the given sides : sin. of its opposite angle
:: the other given side : sin. of its opposite angle.

To find an angle, begin with a side opposite to a known angle.

Again, as sin. of one of the given angles : its opposite side
:: sin. of the other given angle : its opposite side.

To find a side, begin with an angle opposite to a known side.




Ex. 1. In the triangle A B C, given A C B 41° 13′, A C 282 yards, and A B 210 yards, to find the rest.

Now A B 210 being less than A C 282, the case is ambiguous, and there are two solutions.

At point C in the line B C make angle B C A = 41° 13′, from C lay off C A = 282, and from A lay off A B = 210, cutting B C in B and D, join A D.

To find A B C and A D C.

| | |
|---|---|
| As A B 210 | log. 7·677781* |
| : A C B 41° 13′ | log. sin. 9·818825 |
| :: A C 282 | log. 2·450249 |
| : A B C 62° 14′ | log. sin. 9·946855 |

A B C = A D B ∴ A D B = 62° 14′ − 180 = A D C 117° 46′

A D C = 117° 46′ + A C B = 41° 13′ = 158° 59′ − 180° = D A C 21° 1′

A C B = 41° 13′ + A B C = 62° 14′ = 103° 27′ − 180° = B A C 76° 33′

To find B C.

| | |
|---|---|
| As A C B 41° 13′ | log. cosec. 0·181175* |
| : A B 210 | log. 2·322219 |
| :: B A C 76° 33′ | log. sin. 9·987922 |
| : B C 310′ | log. 2·491316 |

To find D C.

| | |
|---|---|
| As A C B 41° 13′ | log. cosec. 0·181175* |
| : A B 210 | log. 2·322219 |
| :: D A C 21° 1′ | log. sin. 9·554658 |
| : D C 114′ | log. 2·058052 |

* See note to p. 49 on the "Arithmetical Complement."

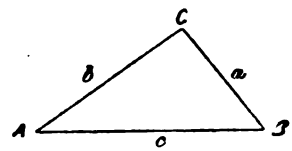
Case II. In any oblique-angled plane triangle, given two sides and the included angle, to find the rest.

As the sum of the given sides : their difference
:: tan. ½ sum of the unknown angles : tan. ½ their difference.

The ½ difference being added to ½ sum will give the greater angle, and being subtracted from it will give the less.

The greater angles will be opposite the greater side.

Ex. 2. In the triangle A B C, given $a = 512$ yards, $c = 907$ yards, and B 49° 10′, to find the rest.




$c$ 907 + $a$ 512 = $c + a$ 1419, $c$ 907 − $a$ 512 = $c - a$ 395,
B 49° 10′ − 180 = A + C 130° 50′ ÷ 2 = $\frac{A+C}{2}$ 65° 25′.

To find A and C.

| | | |
|---|---|---|
| As $a + c$ 1419 | log. | 6·848018* |
| : $a - c$ 395 | log. | 2·596597 |
| :: $\frac{A+C}{2}$ 65°25′ | log. tan. | 10·339642 |
| : $\frac{A-C}{2}$ 31°19′ | log. tan. | 9·784257 |

To find $b$.

| | | |
|---|---|---|
| As A 34° 6′ | log. cosec. | 0·251345* |
| : $a$ 512 | log. | 2·709270. |
| :: B 49°10′ | log. sin. | 9·878875 |
| : $b$ 691 | log. | 2·839490 |

$\frac{A+C}{2}$ 65° 25′ + $\frac{A-C}{2}$ 31° 19′ = C 96° 44′, and 65° 25′ − 31° 19′ = A 34° 6′.

Case III. In any oblique-angled plane triangle, given the three sides, to find the angles.

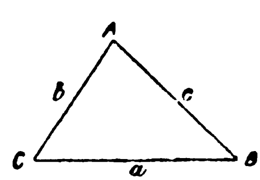
From the half sum of the three given sides (S) subtract the two sides containing a required angle. To the logs. of these numbers add the arithmetical complement of the logs. of the sides; the sum of these 4 logs., rejecting 10 from the index, will be the log. sin. square, Table 69, of the required angle.

Ex. 3. In the triangle A B C, given $a = 6$, $b = 5$, and $c = 4$, to find the rest.

$a + b + c = 6 + 5 + 4 = 15 \div 2 = 7·5$(S), S 7·5 − $b$ 5 = 2·5, S 7·5 − 4 = 3·5.

To find A.

| | | |
|---|---|---|
| S − $b$ 2·5 | log. | 0·397940 |
| S − $c$ 3·5 | log. | 0·544068 |
| $b$ 5 | Ar. Co. log. | 9·301030 |
| $c$ 4 | Ar. Co. log. | 9·397940 |
| A 82°49′ | log. sin. square | 9·640978 |




* See note to p. 49 on the "Arithmetical Complement."

posing it, are taken from tables, the term Computation will be employed in other cases, and always when precision is required and logarithms are concerned.*

(3.) Construction implies (in our present subject) drawing a figure of the actual case on a convenient scale, and in the proper proportions, the number of parts contained in the quantity required to be measured being taken from a scale adapted to the purpose.

This process is tedious, and not, in general, capable of much precision, but it is the most readily intelligible of the three methods, and is, therefore, the least open to mistake. The seaman should, accordingly, be able to produce a figure of every case that admits one, and should acquire the habit of referring to the figure, in the mind as the only real security against mistakes in his work.

The figure or natural representation of the case is, moreover, the foundation of the mathematical treatment of the question.

### 1. *Limits of Methods or Observations.*

168. In every process of calculation, the elements which enter into it, and which are either observed at the time by instruments, or taken from tables, are liable to error. Every result, therefore, is, to some extent, uncertain; but the *amount* of error of the final result

* Solutions of this kind are usually divided into "rigorous" and "approximate," or indirect, as the latter are also called. In all solutions, however, we either deal directly with the quantities themselves, as arcs, angles, &c., in their entire or *integral* state, or we compute a *difference* from a certain value assumed or given, and thence find the required quantity. This last process is indirect, but the former may be effected indirectly also. The terms Integral and Differential would then, it is presumed, be more satisfactory, for the degree of approximation obtained is altogether beside the question of the character of the solution. We do not, however, on the present occasion, depart from the usual terms. We shall merely add, as some indistinctness prevails as to the properties of these different solutions, that both are equally affected by errors of observation (as must of course follow, if they be both true), and thus the essential distinction between them, in practice, lies in the different numbers of figures which they respectively require.

There is another point on which we shall take the opportunity to make some remarks for the satisfaction of the scientific reader. In the present subject we are obliged, in most cases, to consider the required quantity, though really unknown, as if it were given, as it is an indispensable argument in reducing the elements;—thus, in finding the longitude by chronometer, by the sun, we must assume a longitude in order to deduce the declination and equation of time. Such solutions are, therefore, *solutions by assumption*, and the question naturally arises, What is the criterion by which to know whether the result is nearer the truth or further from it than the temporary value employed?

In general we have to solve, not the equation $u=f(x, y, z)$, but $u_1=f(x, y, z, u')$, in which $u'$ is an assumed value of $u$, and $u_1$ a first approximation. The second approximation is $u_2=f(x, y, z, u_1)$, and so on. Now, it is evident, without examining the successive differences $u'-u_1$, $u_1-u_2$ .... that the process is convergent, if $u$ varies more slowly than $u'$, that is, when $\frac{du}{du'}<1$. This is the case with all our problems within the limits assigned. When $\frac{du}{du'}>1$, the process is divergent, or the results are worse and worse; and when $=1$, the assumption is reproduced. Again, when $\frac{du}{du'}$ is positive, the results are all greater or all less than the truth; when negative, they are alternately too great, and too small. Hence, in general, it depends on the *data*, and not on the greatness or smallness of the error of assumption, whether the process converge or not. The above, however, applies, in strictness, only to small errors of assumption; for large errors higher terms must be considered.

caused by an error in any one of the *data* (or quantities given for the solution of the question) is very different under different circumstances, being in some cases scarcely perceptible, while in others it may far exceed the very error to which it is due.

If we agree beforehand that a probable error of observation shall not cause an error beyond a certain amount in the result, we must exclude all those cases in which it would produce a greater effect, and we thus assign *limits* to the method or observation.

169. Generally speaking, every element that enters into the computation is liable to error, and, therefore, each element will have its own independent influence in limiting the observation; that is, in strictness, there will be *different limits* for each separate element, but, for practical purposes, it is enough to assign the limits according to that element of which the error is most important. For instance, in finding the time by a single altitude of a celestial body, we employ its altitude and declination, and the latitude of the place. Now the latitude will often, and the declination sometimes, be correctly known, but the altitude can never, from various causes, be exempt from suspicion of inaccuracy; besides, in general, an error of altitude produces a greater effect on the result than an equal error in latitude or declination. Hence we limit the method of "time by an altitude off the meridian" in respect of altitude only; and assuming that 1′ error of altitude shall not cause more than 10ˢ error in the time, we limit, for the more frequented latitudes, the celestial body to a certain bearing.

## 2. *Degree of Dependance.*

170. The result of every computation is, as above remarked, No. 168, more or less uncertain. If we knew the error in one of the elements, we could easily find the effect it would produce on the result, by working the computation over again; and if, under the circumstances, such error in the data is not likely to exceed a certain quantity, we should thus find the *limit of probable error*;* for example, suppose in finding the time, the error of altitude is not likely to exceed 2′, and that the effect of this in working over again is 9ˢ, we say that 9ˢ is the limit of probable error.

171. Since all the elements are more or less uncertain, there is a limit of probable error or degree of dependance in respect of each. Hence the extreme probable error of the result is the sum of all these errors, supposing they lie on the same side. But, in practice, they will, in general, tend to neutralise each other, and it is enough to estimate the degree of dependance in respect of the most important of them.

172. In some cases a small error of observation will produce a very great error in the result; in others, a large error may not pro-

* The term "Degree of Dependance" is preferred here to "limit of probable error." because it describes in direct terms the application or use of that limit, which is, to point out how near the result may be depended upon.

duce a sensible effect. For example, an error of 1′ in the lunar distance, causes an error of 30′ or 40′ in the longitude, while an error of several miles of latitude may not, in certain cases, produce an error worth notice in the time as found by an observation. As no nicety in the mere working of the computation can, in any way, meet or counteract errors of observation, it is necessary, in forming a true judgment of the place of the ship, to try the effects of probable errors; in other words, to try the degree of dependance. Thus, in the example of the lunar alluded to above, a novice might conclude that his longitude was, to the exact minute and second, that found by computation; but a more experienced computer, knowing that all his elements are not absolutely correct, and that his result can scarcely be perfectly exact but by an accidental compensation of errors, makes an allowance for error; and assuming that the distance may be too much or too little by 30″, for example, considers the observation as merely having established with certainty the ship's place within 15′E. or W. of the position deduced.

173. But the degree of dependance, besides being indispensable to rightly judging of the true place of the ship, or, rather, of the space on latitude and longitude within which she is to be found, has another important application, as it governs the amount of labour bestowed on the computations. For example, if the latitude is uncertain several miles, it is at once evident, that to proceed with as much care and precision as if it were ascertained to a few seconds, is mere waste of time. Similar remarks have already been offered in the Preface, and they are particularly directed to the student's attention, who should be early impressed with the importance of improving his judgment by continual exercise, instead of trusting on all occasions to a mechanical routine of computation.

174. It is worth while to notice, that in working to a certain degree of accuracy, as, for example, to minutes, it is generally enough to employ the nearest whole minute; but when one of the quantities varies very rapidly, it may be proper to work closer; for it is easy to see that the inaccuracy of half a minute in a quantity which is multiplied by a number greater than 1, is increased, and appears as a whole minute.

[1.] *Personal Error.*

175. The several errors to which each observation is exposed, and which accordingly enter into the estimation of the degree of dependance, are described in their proper places; but there is one which, though sensible only in cases where a considerable step has been made towards precision, is of universal application, and is, therefore, properly noticed here.

It is found that different persons do not agree in the precise instant of observing the same phenomenon. Again, some persons are in the habit of observing more or less closely than others. The kind of error which is obviously present in such cases, is called the *personal error*, or *equation*.

Two observers have been found to differ 0$^s$·4 in the sun's transit over the wire of a telescope.

176. When two images, in contact, lie stationary before two observers, it is difficult to understand why one of them should see them overlap, or the other open, or why they should not agree in the measure. But when the images are in motion, the observer's anxiety is roused lest he may miss the observation, and the excitement may lead him to think that he sees the contact before it really takes place. Hence there is reason to believe that the personal equation is, in some degree, a matter of temperament.

It also seems well ascertained that the personal equation is not the same for the same individual at all times, and that it is greatly influenced by fatigue, by the effort of observing, and, in fact, by every cause that affects the nervous system. It may, therefore, be advantageous to bear these circumstances in mind preparatory to undertaking observations in which much accuracy is required.

177. The existence of this error shews that when much precision is required, observations taken by different persons should not be mixed together until cleared of personal errors, since they may at the outset be presumed to be affected by unequal errors; and it is probable that many discrepancies are due to this cause, in observations whether by the same or different observers.

## SPHERICS, DEFINITIONS AND PRINCIPLES.

SPHERICS is that part of mathematics which treats of the positions and magnitudes of arcs of circles described on the surface of a sphere.

A SPHERE is a solid formed by the revolution of a semicircle about its diameter; this diameter is immovable during the motion of the semicircle.

THE CENTRE AND AXIS of a sphere are the same as the centre and diameter of the generating semicircle, and as a circle has an indefinite number of diameters, so a sphere may be considered to have an indefinite number of axes, round any one of which it may be conceived to be generated.

EVERY SECTION OF A SPHERE made by a plane passing through its circumference is a circle.

A GREAT CIRCLE is formed by a plane passing through the centre of the sphere. A SMALL CIRCLE is formed by a plane that does not pass through the centre of the sphere. A sphere is therefore divided into two equal parts by the plane of every great circle, and into two unequal parts by the plane of every small circle.

THE POLES OF A CIRCLE of a sphere are those points on the surface of the sphere which are equally distant from the circumference of that circle. Thus the poles of a circle are the extremities of that diameter or axis of the sphere which is perpendicular to the plane of that circle. All points in the circumference of a great circle are equally distant from *both* its poles.

SMALL CIRCLES of the sphere are those circles which are unequally distant from both their poles.

THE POLES of every great circle are each 90° distant from that great circle on the surface of the sphere, and no two great circles can have the same poles.

THE DIAMETER of every great circle passes through the centre of the sphere, but the diameters of small circles do not pass through the centre. Thus the centre of the sphere is the common centre of all its great circles.

PARALLEL CIRCLES of a sphere are those small circles the planes of which are parallel to the plane of some great circle. All parallel circles have the same poles, and may be conceived to be concentric to the great circle they are parallel to.

A SPHERICAL ANGLE is the inclination of two great circles of the sphere meeting one another. It is measured by an arc of a great circle intercepted between the legs of that angle, 90° distant from the angular point.

A SPHERICAL TRIANGLE is a figure formed on the surface of the sphere by the intersection of three great circles.

THE SHORTEST DISTANCE between two points on the surface of a sphere is an arc of the great circle passing through those points.

THE STEREOGRAPHIC PROJECTION * of the sphere is such a representation of its circles upon the plane of some great circle, and thence called the plane of projection, as would appear to an eye placed in one of the poles of that circle, and thence viewing the circles of the sphere.

The place of the eye is called the projecting point or lower pole, and the pole opposite is called the opposite or exterior pole; also the projection of any point on the sphere is that point in the plane of projection through which the visual ray passes to the eye.

THE PRIMITIVE CIRCLE is that great circle on the plane of which the representation of all other circles is supposed to be drawn.

A RIGHT CIRCLE is one which is perpendicular to the plane of the primitive circle, and, if it be a great circle, its plane passes through the eye and it is seen edgewise, consequently it is represented by a straight line drawn through the centre of the primitive circle.

AN OBLIQUE CIRCLE is that which has its plane oblique to the eye, and is represented by a curved line.

SPHERICAL TRIGONOMETRY is the art of computing the measures of the sides and angles of such triangles as are formed on the surface of a sphere, by the mutual intersection of three great circles described thereon.

A SPHERICAL TRIANGLE has three sides and three angles.

A RIGHT-ANGLED SPHERICAL TRIANGLE has one right angle. The sides about the right angle are called legs; the side opposite the right angle is called the hypothenuse.

A QUADRANTAL SPHERICAL TRIANGLE has one side equal to 90°.

AN OBLIQUE SPHERICAL TRIANGLE has all its angles oblique.

THE CIRCULAR PARTS of a triangle are those arcs which measure its sides and angles.

Two spherical triangles are said to be *supplemental* to one another when the sides and angles of the one are supplemental of the sides and angles of the other, and one in regard to the other is called the supplemental triangle.

Two arcs or angles when compared together are said to be *alike* when both are less or greater than 90°. But when one is greater and the other less than 90°, they are said to be *unlike*.

In every spherical triangle equal angles are opposite equal sides, and equal sides are opposite equal angles.

---

* Stereographic means representing a solid on a plane surface.

Any two sides of a spherical triangle are together greater than the third side.

Each side of a spherical triangle is less than a semicircle or 180°.

In every spherical triangle the greater side is opposite the greater angle. The sum of the three sides of a spherical triangle is less than 360°.

The sum of the three angles of a spherical triangle is greater than two right angles and less than six, or always will fall between 180° and 540°.

In right-angled spherical triangles, the oblique angles and their opposite sides are of *like affection*; that is, if a leg is less or greater than 90°, its opposite angle is also less or greater than 90°.

In right-angled spherical triangles the hypothenuse is *less than* 90° when the legs are of a *like kind*; but *greater than* 90° when the legs are of a *different kind.*

In any spherical triangle

As sine of either angle : sine of its opposite side
:: sine of another angle : sine of its opposite side.

## RIGHT SPHERICS.

The celebrated Lord Napier, inventor of logarithms, contrived a general rule, easy to be remembered, by which the solution of every case of right-angled spherical triangles is readily obtained.

In any right-angled spherical triangle there are five parts beside the right angle—viz., two legs, two angles, and the hypothenuse. The two legs, the complements of the two angles, and the complement of the hypothenuse are called circular parts.

In any case relating to right-angled spherical triangles three of these circular parts are concerned—viz., two given and one sought.

If the three concerned are all joined together, ignoring the right angle, the central one is called the middle, and the other two adjacent parts.

But if only two are joined together these are called the opposite, and the other the middle part.

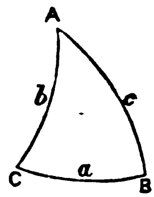
These being known, all the cases of right-angled spherical triangles may be solved by Napier's rules.

1. The product of radius and sine of the middle part = the product of the tangents of the adjacent parts.

2. The product of radius and sine of the middle part = the product of the cosines of the opposite parts.

*N.B.*—As an aid to memory the letter *a* occurs in t*a*ngent and *a*dj*a*cent; and the letter *o* in c*o*sine and *o*pp*o*site. In the following examples, instead of *subtracting* the log. sine, cosine, and tangent, it is the same thing to *add* the log. cosec., sec., and cot.; because these last are the arithmetical complements of the first (*see* note, p. 49).

Ex. 1. In the right-angled spherical triangle A B C, given C 61° 50′, B C ($a$) 40° 30′, B 90°, to find the other parts.




**To find A.**

Rad. cos. A = sin. C . cos. $a$
cos. A = sin. C . cos. $a$

| | |
|---|---|
| C = 61° 50′ | log. sin. 9·945261 |
| $a$ = 40 30 | log. cos. 9·881046 |
| A = 47 54 | log. cos. 9·826307 |

**To find A C ($b$).**

Rad. cos. C . = cot. $b$ . tan. $a$
cot. $b$ = cos. C . cot. $a$

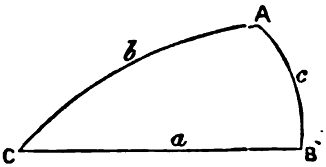
| | |
|---|---|
| $a$ = 40° 30′ | log. cot. 0·068501 |
| C = 61 50 | log. cos. 9·673977 |
| $b$ = 61 4 | log. cot. 9·742478 |

**To find A B ($c$).**

Rad. cos. $b$ = cos. $a$ . cos. $c$
cos. $c$ = sec. $a$ . cos. $b$

| | |
|---|---|
| $a$ = 40° 30′ | log. sec. 0·118955 |
| $b$ = 61 4 | log. cos. 9·684658 |
| $c$ = 50 29 | log. cos. 9·803613 |

Ex. 2. In the right-angled spherical triangle A B C, given A B ($c$) 50° 40′, A C ($b$) 113° 26′, B 90°, to find the other parts.




**To find C.**

Rad. sin. $c$ = sin. $b$ . sin. C
sin. C = sin. $c$ . cosec. $b$

| | |
|---|---|
| $b$ = 113° 26′ | log. cosec. 0·037383 |
| $c$ = 50 40 | log. sin. 9·888444 |
| C = 57 28 | log. sin. 9·925827 |

**To find B C ($a$).**

Rad. cos. $b$ = cos. $c$ . cos. $a$
cos. $a$ = cos. $b$ sec. $c$

| | |
|---|---|
| $c$ = 50° 40′ | log. sec. 0·198027 |
| $b$ = 113 26 | log. cos. 9·599536 |
| 51 8 | log. cos. 9·797563 |
| 180 0 | |
| $a$ = 128 52 | |

**To find A.**

Rad. cos. A = tan. $c$ . cot. $b$
cos. A = tan. $c$ . cot. $b$

| | |
|---|---|
| $c$ = 50° 40′ | log. tan. 0·086471 |
| $b$ = 113 26 | log. cot. 9·636918 |
| 58 4 | log. cos. 9·723389 |
| 180 00 | |
| A = 121 56 | |

Note.—In the triangle A B C, $b$ the hypothenuse being greater than 90°, and $c$ less than 90°, A is of unlike affection to C, or greater than 90°. Also A being greater than 90° its opposite side $a$ must also be greater than 90°.

Quadrantal spherical triangles are also solved by Napier's rules reversed: using the quadrantal side as the right angle, the angles adjacent to it, the complements of the other two sides, and of the angle opposite to the quadrantal side, as circular parts.

## Oblique Spherics.

Case I. Given two sides and an angle opposite to one of them, to find the angle opposite to the known side.

As sin. of a given side : sin. of its opposite angle
:: sin. of the other given side : sin. of its opposite angle.

**To find the 3rd side.**

As sin. ½ diff. of the two known angles
: sin. ½ their sum
:: tan. ½ diff. of the two known sides
: tan. ½ the third side.

Or, as cos. ½ diff. of the two known angles
: cos. ½ their sum
:: tan. ½ sum of the two known sides
: tan. ½ the third side.

Case II. Given two angles and a side opposite to one of them, to find the side opposite to the known angle.

As sin. of a given angle : sin. of its opposite side
:: sin. of the other given angle : sin. of its opposite side.

To find the 3rd angle.

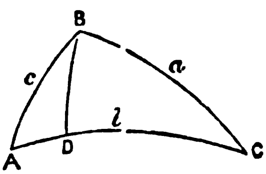
| | |
|---|---|
| As sin. ½ diff. of the two known sides<br>: sin. ½ their sum<br>:: tan. ½ diff. of the two known angles<br>: cot. ½ the third angle. | Or, as cos ½ diff. of the two known sides<br>: cos. ½ their sum<br>:: tan. ½ sum of the two known angles<br>: cot. ½ the third angle. |

Cases I. and II. may also be solved by drawing a great circle from the unknown angle perpendicular to the opposite side. This divides the triangle into two right-angled triangles. The segments of the divided side may then be found by right-angled spherics.

In the spherical triangle A B C, given A 84° 52′, BC or ($a$) 67° 5′, and A B or ($c$) 55° 38′.

To find the other parts.

| As sin. $a$ : sin. A :: sin. $c$ : sin. C. | | |
|---|---|---|
| $a$ = 67° 5′ | log. cosec. | 0·035706 |
| A = 84 52 | log. sin. | 9·998255 |
| $c$ = 55 38 | log. sin. | 9·916687 |
| C = 63 12 | log. sin. | 9·950648 |




From B draw a great circle B D perpendicular to A C. Angles A and C being of like affection, both less than 90°, B D falls within the triangle. Then by Napier's rules:

To find A C ($b$).

Rad. cos. C = cot. $a$ . tan. D C
tan. DC = cos. C . tan. $a$

| | | |
|---|---|---|
| $a$ = 67° 5′ | log. tan. | 0·373907 |
| C = 63 12 | log. cos. | 9·654059 |
| DC = 46 51 | log. tan. | 10·027966 |
| A D = 7 27 | | |
| $b$ = 54 18 | | |

Rad. cos. A = cot. $c$ . tan. A D
tan. A D = cos. A tan. $c$

| | | |
|---|---|---|
| $c$ = 55° 38′ | log. tan. | 0·165033 |
| A = 84 52 | log. cos. | 8·951696 |
| A D = 7 27 | log. tan. | 9·116729 |

To find B.

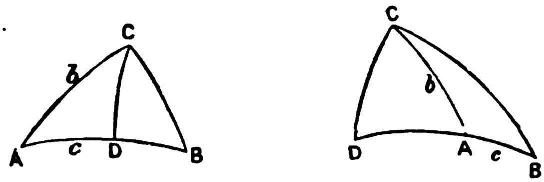
| As sin. $a$ : sin. A :: sin. $b$ : sin. B. | | |
|---|---|---|
| $a$ = 67° 5′ | log. cosec. | 0·035706 |
| A = 84 52 | log. sin. | 9·998255 |
| $b$ = 54 18 | log. sin. | 9·909601 |
| B = 61 25 | log. sin. | 9·943562 |

If A and C are of unlike affection—*i.e.* one greater and one less than 90°—the perpendicular will fall without the triangle, and the difference between A D and D C must be taken to find $b$.

This also will solve Case II., given two angles and a side opposite to one of them, to find the other parts

E

## Case III. Given two sides and the included angle.




Let A B, A C and the included angle A be given. From one of the unknown angles at C draw a great circle perpendicular to the opposite side. Then in the right-angled triangle A D C find A D. If the perpendicular falls within the triangle subtract A D from A B to find D B, and if the perpendicular falls without the triangle add A D to A B, and the sum is B D.

To find B C.

As cos. of A D : cos. of B D :: cos of A C : cos of B C.

To find the unknown angles.

As sin. of side just found : sin. of the given angle
:: sin. of either of the given sides : sin. of its opposite angle.

### *Second Method.*

To find ½ sum of the unknown angles.

As cos. ½ sum of the two given sides : cos. ½ their diff.
:: cot. ½ the included angle : tan. ½ sum of unknown angles.

NOTE.—This ½ sum of the unknown angles is of the same name as the ½ sum of the sides.

To find ½ diff. of the unknown angles.

As sin. ½ sum of the two given sides : sin. ½ their diff.
:: cot. ½ the included angle : tan. ½ diff. of the unknown angles.

The ½ diff. being added to the ½ sum will be the greater angle, and being subtracted from it will be the less.

In the spherical triangle A B C, given B 125° 36′, B C ($a$) 81° 17′, and, A B ($c$) 59° 13′, to find the other parts:

| | | |
|---|---|---|
| $c =$ 59° 13′ | $a =$ 81° 17′ | B = 125 36 |
| $a =$ 81 17 | $c =$ 59 13 | 62 48 $\frac{B}{2}$ |
| 140 30 $a+c$ | 22 4 $a-c$ | |
| 70 15 $\frac{}{2}$ | 11 2 $\frac{}{2}$ | |

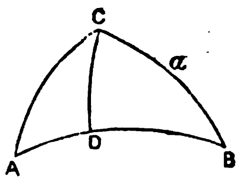
To find angles C and A.

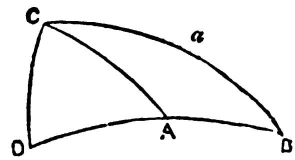
| | | | |
|---|---|---|---|
| $\frac{a+c}{2}$ = 70° 15′ | log. sec. 0·471190 | $\frac{a+c}{2}$ = 70° 15′ | log. cosec. 0·026329 |
| $\frac{a-c}{2}$ = 11 2 | log. cos. 9·991897 | $\frac{a-c}{2}$ = 11 2 | log. sin. 9·281897 |
| $\frac{B}{2}$ = 62 48 | log. cot. 9·710904 | $\frac{B}{2}$ = 62 48 | log. cot. 9·710904 |
| $\frac{A+C}{2}$ = 56 11 | log. tan. 10·173991 | $\frac{A-C}{2}$ = 5 58 | log. tan. 9·019130 |
| $\frac{A-C}{2}$ = 5 58 | | $\frac{A+C}{2}$ = 56 11 | |
| 50 13 C | | 62 9 A | |

To find side $b$.

| | | |
|---|---|---|
| C = 50° 13′ | log. cosec. | 0·114373 |
| $c$ = 59 13 | log. sin. | 9·934048 |
| B = 125 36 | log. sin. | 9·910144 |
| $b$ = 114 38 | log. sin. | 9·958565 |

Case IV. Given two angles and the included side.




In the triangle A B C given angles B, C, and side B C, *a*: to find the other parts. Where two angles and an included side are given, a great circle may be drawn from one of the given angles perpendicular to the opposite side, and the angle B C D instead of the segment B D found. The difference between B C D and the given angle C will give A C D. Then

To find the 3rd angle.

As sin. B C D : sin. A C D :: cos. B : cos. A.

If the perpendicular falls within the triangle the angles B and A are of the same name; if it falls without the triangle they are of different names.

*The Second Method* is the same as in Case III., only for *cots.* of half included angle use *tans.* of half included side.

Case V. Given the three sides of a spherical triangle, to find the three angles.

Find the half-sum of the three sides. Take the difference between this half-sum and the side opposite to a required angle, then add together the log. cosecs. of the two sides containing the angle, the log. sines of the half-sum, and of the difference between the half-sum and the side opposite the required angle: Half the sum of these four logs will be the log. cos. of half the required angle.

In the spherical triangle A B C, given A B ($c$) 79° 56′, B C ($a$) 119° 36′, and A C ($b$) 64° 5′, to find angle B.

| | | | | | | |
|---|---|---|---|---|---|---|
| $a$ = | 119° | 36′ | | log. cosec. | ·060733 | |
| $c$ = | 79 | 56 | | log. cosec. | ·006738 | |
| $b$ = | 64 | 5 | | | | |
| 2) | 263 | 37 | | | | |
| | 131 | 48 | 30 | log. sin. | 9·872377 | |
| | 67 | 43 | 30 | log. sin. | 9·966318 | |
| | | | | 2) | 19·906166 | log. sin. square of 127° 41′ 20″, supplement B. |
| $\frac{B}{2}$ = | 26 | 9 | 20 | log. cos. | 9·953083 | |
| | | | 2 | | | |
| B = | 52 | 18 | 40 | | | |

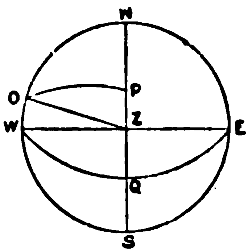
Case VI. The three angles being known, to find a side.

Add together the log. cosecs. of the two angles adjacent to the required side and the log. cosines of the half-sum of the three angles and the difference between the half-sum and the angle opposite the required side. Half-sum of these four logs. will be the log. sine of half the required side.

## Application of the Preceding Cases in Spherical Trigonometry to Questions in Nautical Astronomy.

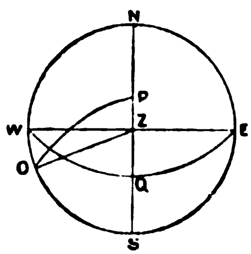
### The Amplitude.

In these figures N E S W represents the horizon, S and N being its south and north points; N Z S the celestial meridian; O the place of the body observed on the horizon, O W the amplitude, P the pole of the heavens, P O the polar distance, less or greater than 90°, as the declination of the body observed is of the same or of a different name to the latitude; Z the zenith, W E the prime vertical, and W Q E the equator.




From Right Spherics, p. 57A.

In the problem to find the amplitude of a heavenly body, No. 884, there are given P N the lat. and P O the polar distance to find O W the amplitude.




Then in right-angled triangle P O N

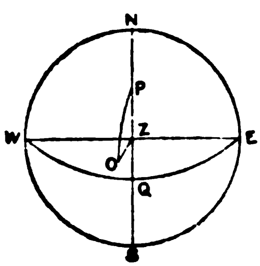
$$\text{Rad.} \times \cos. PO = \cos. PN \cos. ON$$
$$\cos. ON = \cos. PO \sec. PN, \text{ or}$$

$$\text{Log. sec. } PN \text{ (lat.)} + \text{log. sin.} \begin{Bmatrix} 90^\circ - PO \\ PO - 90^\circ \end{Bmatrix} \text{(dec.)}$$
$$= \text{log. sin.} \begin{Bmatrix} 90^\circ - ON \\ ON - 90^\circ \end{Bmatrix};$$

*i.e.* O W the amplitude.

The question can also be solved by the quadrantal triangle Z P O, where P Z O, and therefrom O W, may be found.

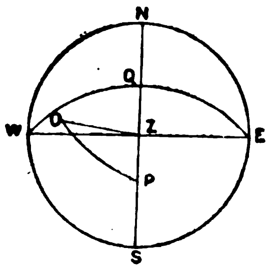
### Latitude from Reduction to the Meridian.

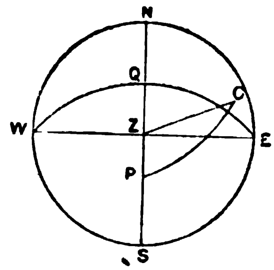



From Oblique Spherics, Case I., p. 58A.

Given Z P O the hour angle, P O the polar distance, and Z O the zenith distance, or two sides and an angle opposite to one of them, to find the remaining side P Z, or the colat. at the time of observation, see Nos. 700 to 704 and explanation of Table 70, page 427.

### The Hour Angle and Azimuth.



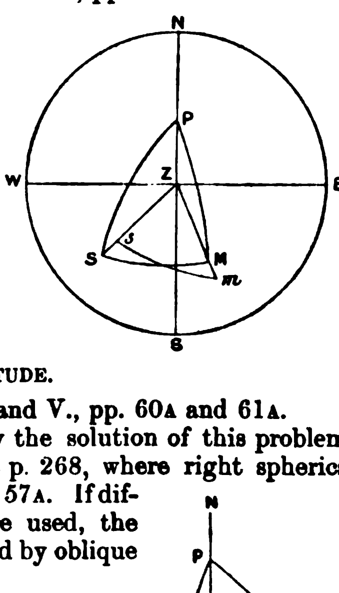




From Oblique Spherics, Case V., p. 61A.

Here are given: P Z the colat., P O the polar distance, and Z O the zenith distance, or the three sides of the triangle Z O P; to find either Z P O the hour angle, or P Z O the azimuth, *see* Nos. 614 and 674.

### Lunars.

From Oblique Spherics, Cases V. and III., pp. 61A and 60A.




The Lunar problem is fully treated upon (*see* Nos. 836 to 863). The figures of 837 show the solution by oblique spherics, where first, in the triangle *s* Z *m*, three sides, the two apparent altitudes Z *m* and Z *s*, and the apparent distance *m s* are given, to find angle *m* Z *s*; and then in the triangle M Z S, two sides, the two true altitudes Z M and Z S and the included angle Z are given, to find the true distance M S.

### Double Altitude.

From Oblique Spherics, Cases III. and V., pp. 60A and 61A.

For two altitudes of the same body the solution of this problem is fully given at No 757, and figure at p. 268, where right spherics are used: *see* p. 57A. If different bodies are used, the problem is solved by oblique spherics.

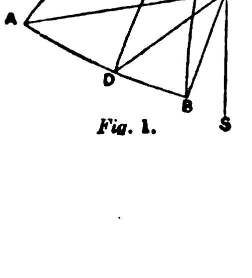



*Fig.* 1.

Fig. 1 illustrates a double altitude where the observations are taken of the same body and right spherics are used. In this case, A and B are the places of the body in the two observations; P A, P B, the polar distances;

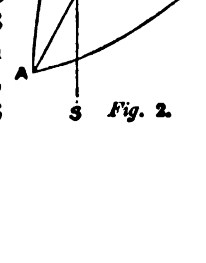


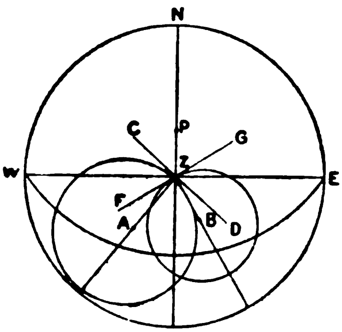

*Fig.* 2.

Z A, Z B the zenith distances; A P B the polar angle or interval. P D is drawn perpendicular to A B, dividing A P B into two equal parts; Z F is drawn perpendicular to P D.

Fig. 2 illustrates the problem where observations of two different bodies are taken, and the problem solved by oblique spherics. *See* No. 770, Note to pages 273, 274, and figure at page 268.

### Sumner's Method.

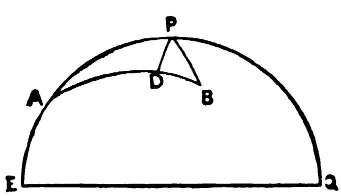
From two altitudes of the same heavenly body taken at a requisite interval apart, or two altitudes of different stars (having the requisite interval in azimuth) taken at the same time, two small circles (circles of position) may be described, the intersection of which * will be the place of the ship, allowing for her run in the interval.

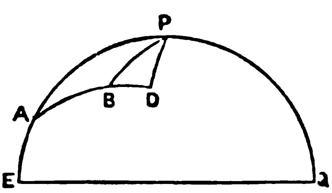



In the figure A and B represent the places of the body or bodies at the time or times of observation. From these points as centres, with the zenith distances, small circles are drawn, the intersection of which will be the zenith of the observer, or place of the ship.

The intersection of these circles will be represented on the chart by the two straight lines C D and F G, drawn at right angles to Z A and Z B, the bearings of the body or bodies at the time of observation. Full explanation of this useful method, with an illustrative chart, will be found under Nos. 1009 to 1014.

### Great Circle Sailing.




From Oblique Spherics, Case III., p. 60A.

Given P A and P B the two colats. and A P B the diff. long., to find A B the distance and A and B the courses from one place to the other; or given two sides P A and P B, and included angle A P B, to find the other parts.

The position of the vertex D will be found from the right-angled triangles A P D or B P D. This problem is fully treated upon in Nos. 336 to 347.

* A chartlet showing this intersection will be found in Lecky's Wrinkles, 9th edit. p. 502.

# NAVIGATION.

## CHAPTER I.

### DEFINITIONS.

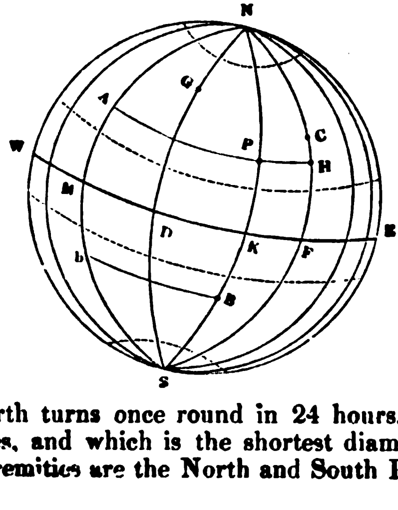
178. BY the general term NAVIGATION is meant that science which relates to the determination of the place of a ship on the sea.

179. The place of a ship is determined by either of two methods, which are independent of each other: 1st, by referring it to some other place, as a fixed point of land, or a former place of the ship herself; 2d, by astronomical observation.

The first of these methods is treated under the head of NAVIGATION; the second, under that of NAUTICAL ASTRONOMY.

180. The earth is nearly a globe or sphere: this is proved in three ways. 1st. When a vessel is seen at a considerable distance on the sea, in any part of the world, the hull is partly or entirely concealed by the water, though the masts are visible. 2d. The shadow of the earth thrown on the moon when the earth is between the sun and the moon is, in all positions of the earth, circular. 3d. The earth has been sailed round.

The earth, however, is not exactly spherical, but of the figure called an oblate spheroid, which resembles an orange, the shortest diameter (that which joins the poles) being 7899 statute miles, and that of the fullest parts (about the equator) being nearly 26 more.




181. The earth turns once round in 24 hours. The line round which it revolves, and which is the shortest diameter, is called the *axis*, and its extremities are the North and South POLES, as N, S.

182. The EQUATOR, called also the Equinoctial Line, or vulgarly the Line, is a circle equidistant from both poles, as W M E, and dividing the globe into two half globes, or hemispheres, N W E and S W E.

At all places on this circle the sun rises at 6 A.M., and sets at 6 P.M., all the year round; the days and nights are thus equal, being 12 hours each.

183. A MERIDIAN is a semicircle joining the two poles, as N A S, N B S. Every portion of the meridian lies north and south; and places lying north and south of each other are said to be on the same meridian.

184. LATITUDE is the distance from the equator, measured on a meridian; thus the latitude of a place A is A M, the latitude of B is B K.

Latitude is named north or south, according as the place is north or south of the equator. Thus A is in north latitude, B is in south latitude.

185. The COLATITUDE is the complement of the latitude to 90°; thus N A, S B, N C, are the colatitudes of the places A, B, C.

The colatitude reckoned from the other pole is the sum of the latitude and 90°; thus the colatitude of A is also S A, which is 90° + M A (the latitude of A): N B is the colatitude of B.

186. Latitude is measured in degrees, minutes, and seconds. A minute, or *nautical mile*, contains about 6082 feet, or 1013 fathoms, and therefore, a second is about 101 feet, or 17 fathoms nearly. *See* p. 104, note, and Spheroidal Tables, p. 724.

187. Circles parallel to the equator, that is, equidistant from it in every point, are *parallels of latitude*; as A P H, b B. Two places in the same latitude are said to lie on the same parallel.

188. The DIFFERENCE OF LATITUDE of two places is the portion of the meridian included between their parallels. Thus, A b is the difference of latitude of the two places A, B; C H is that between A and C.

The difference of latitude of the ship is, therefore, the distance she makes good in a north and south direction.

Difference of latitude is also called *Northing* and *Southing*, and is marked N. or S. It is then said to be one of these *names*.

189. It is evident, that when two places are on the *same* side of the equator, their diff. lat. is found by subtracting the lesser latitude from the greater; and that when they are on *opposite* sides of the equator, that is, when one place is in north latitude, and the other in south latitude, the *sum* of their latitudes is their diff. lat. Thus the diff. lat. of A and B, which is A b, is the sum of the north latitude A M, and the south latitude B K, or M b.

Ex. 1. Find the diff. lat. of Cape Clear and Cape Finisterre.

| | | | |
|---|---|---|---|
| Cape Clear......... | 51° | 26′ | N. |
| Cape Finisterre... | 42 | 54 | N. |
| DIFF. LAT. | 8 | 32 | |

Ex. 2. Find the diff. lat. of Cape Verd and Cape St. Roque.

| | | | |
|---|---|---|---|
| Cape Verd......... | 14° | 43′ | N. |
| Cape St. Roque | 5 | 28 | S. |
| DIFF. LAT. | 20 | 11 | |

Ex. 3. A ship sails from lat. 50° 19′ N. to 48° 12′ N.: find her diff. lat.

| | | |
|---|---|---|
| Lat. left ...... | 50° 19′ N. | |
| Lat. in ...... | 48 12 N. | |
| DIFF. LAT. | 2 7 | or 127 miles. |

Ex. 4. A ship sails from lat. 1° 11 N to 0° 13′ S.: find her diff. lat

| | | |
|---|---|---|
| Lat. left ......... | 1° 11′ N. | |
| Lat. in ......... | 0 13 S. | |
| DIFF. LAT. | 1 24 | or 84 miles. |

*Examples for Exercise.*

Required the diff. lat. between the following places:

1. Between a place A in lat. 42° 21′ N., and another place B in lat. 37° 32′ N. Ans. 289 miles.
2. Between Halifax and the Cape of Good Hope. Ans. 4716 miles.
3. Between Diego Ramirez and Cape Lopatka. Ans. 6447 miles.

190. When a ship in north latitude sails north she evidently increases her latitude; and so, likewise, when in south latitude she sails south; because, in these cases, she increases her distance from the equator, at which the latitude begins.

But if in north latitude she sails south, or in south latitude she sails north, she diminishes her latitude.

Hence, when one latitude and the diff. lat. are given, the other latitude is easily found.

Ex. 1. A ship from 43° 30′ S. sails 219 miles south: required her lat. in.

| | |
|---|---|
| Lat. left ............ | 43° 30′ S. |
| Diff. lat. 219′ ...... | 3 39 S. |
| LAT. IN | 47 9 S. |

Ex. 2. A ship from lat. 43° 11′ N. makes 194 miles southing: required her lat. in.

| | |
|---|---|
| Lat. left ......... | 43° 11′ N. |
| Diff. lat. 194′ ... | 3 14 S. |
| LAT. IN | 39 57 N. |

Ex. 3. A ship from lat. 1° 3′ N. sails 123 miles south: required her lat. in.

| | |
|---|---|
| Lat. left ............ | 1° 3′ N. |
| Diff. lat. 123′...... | 2 3 S. |
| LAT. IN | 1 0 S. |

The ship being in 1° 3′, or 63 miles N. of the equator, must evidently be in S. lat. after making 123 miles southing. Thus, in subtracting one of the quantities from the other, the difference takes the *name* of the greater.

*Examples for Exercise.*

1. A ship from lat. 59° 27′ S. sails southward until her diff. lat. is 374: find her present lat. Ans. 65° 41′ S.
2. Lat. left 48° 2′ S. diff. lat. 149 N.; what is the lat. in? Ans. 45° 33′ S.
3. Lat. left 53° 4′ N. diff. lat. 122′ N.; find the lat. in. Ans. 55° 6′ N.
4. Lat. left 0° 0′, diff. lat. 2° 13′ S.; what is the lat. in? Ans. 2° 13′ S

191. LONGITUDE is the distance measured on the equator between the meridian of a given place and another meridian, called the *first meridian*.* The first meridian with us is the meridian of Greenwich Observatory; thus, if G be Greenwich (fig. in No. 180), the longitude of A is D M, the longitude of B is D K.

The longitude of a place is named East or West, according as it is to the east or west of the first meridian; thus A is in west longitude, H is in east longitude.

* The first meridian is a matter of arbitrary choice amongst different nations; thus, the French refer to Paris. It is therefore necessary, in taking up a chart, to observe what meridian the longitude is reckoned from. See p. 395.

192. We may use either the longitude of one name or the supplement to 360°, with the contrary name; thus, instead of 166° W. we may say 194° E.

193. Longitude is measured either in *space* (or arc), that is, in degrees, minutes, and seconds; or in *time*, that is, in hours, minutes, and seconds, each hour being equal to 15 degrees; for the sun, which regulates the time, returns to the same meridian again, after describing a complete circle, or 360°, in 24 hours, and $15 \times 24$ is 360.

194. The DIFFERENCE OF LONGITUDE of two places is the portion of the equator included between their meridians; thus M F is the diff. long. of A and C, as also of A and H, and of b and C. To measure, therefore, the diff. long. of two places, we must follow down their meridians to the equator, and then take the included portion of the equator itself.*

195. When two places are on the *same* side of the first meridian, their diff. long. is found by *subtracting* the lesser longitude from the greater; thus the diff. long. of C and P, that is, the difference between D F and D K, is K F. But where the places are on *opposite* sides of the first meridian, that is, when one place is in east longitude and the other in west longitude, the *sum* of their longitudes is the diff. long.; thus the diff. long. of A and P, as also of A and B, is M K, which is the sum of M D and K D.

When one longitude being east and the other west, the sum exceeds 180°, take the supplement to 360° for the diff. long.

Ex. 1. Find the diff. long. of Ushant and the east point of Madeira.

| | | |
|---|---|---|
| Ushant | 5° 3′ | W. |
| E. point of Madeira | 16 39 | W. |
| DIFF. LONG. | 11 36 | |

Ex. 2. Find the diff. long. of the Cape of Good Hope and Tristan d'Acunha.

| | | |
|---|---|---|
| Cape of Good Hope | 18° 29′ | E. |
| Tristan d'Acunha | 12 2 | W. |
| DIFF. LONG. | 30 31 | |

Ex. 3. A ship sails from longitude 7° 56 W. to 18° 32′ W.: find her diff. long.

| | | |
|---|---|---|
| Long. left | 7° 56′ | W. |
| Long. in | 18 32 | W. |
| DIFF. LONG. | 10 36 | |

Ex. 4. A ship sails from longitude 1° 20 W. to 2° 17′ E.: find her diff. long.

| | | |
|---|---|---|
| Long. left | 1° 20′ | W. |
| Long. in | 2 17 | E. |
| DIFF. LONG. | 3 37 | |

*Examples for Exercise.*

Required the difference of longitude between the following places:

1. Between Halifax and the Cape of Good Hope. Ans. 4924.
2. Between Ushant and St. Michael's. Ans. 1238′.
3. Between Diego Ramirez and C. Lopatka. Ans. 8071′.
4. Between New York and Manila. Ans. 9899′.

196. When a ship in E. long. sails east, or in W. long. sails west,

* Since the meridians are all parallel at the equator and meet at the poles, the distance between any two meridians, measured east and west, is less as the latitude is greater; that is, the absolute *number of miles*, or of feet, in a degree of longitude, is less as the latitude in which they are measured is greater. Hence, also, a given number of miles between two meridians corresponds to a greater diff. long. as the latitude in which they are measured is greater. For example, two places in lat. 10° and distant 40 miles east and west from each other, have 40′·6 diff. long. In lat. 50° two places similarly situated have 1° 2′·2 diff. long. Questions of this kind are solved by the rules of Parallel Sailing.

she evidently increases her longitude, or the distance from the first meridian. But if in E. long. she sails west, or in W. long. she sails east, she diminishes her longitude. Hence, when one longitude is given, and also the diff. long., the other longitude is easily found.

Ex. 1. A ship from long. $31^\circ$ $40'$ E. sails east $3^\circ$ $9'$: find the long. in.

| | | | |
|---|---|---|---|
| Long. left......... | $31^\circ$ | $40'$ | E. |
| Diff. long. ...... | 3 | 9 | E. |
| LONG. IN | 34 | 49 | E. |

Ex. 2. A ship from long. $97^\circ$ $45'$ W. makes $1^\circ$ $11'$ easting: find the long. in.

| | | | |
|---|---|---|---|
| Long. left ...... | $97^\circ$ | $45'$ | W. |
| Diff. long. ...... | 1 | 11 | E. |
| LONG. IN | 96 | 34 | W. |

Ex. 3. A ship from long. $0^\circ$ $32'$ W makes $2^\circ$ $8'$ easting: find the long. in.

| | | | |
|---|---|---|---|
| Long. left ......... | $0^\circ$ | $32'$ | W. |
| Diff. long. ......... | 2 | 8 | E. |
| LONG. IN | 1 | 36 | E. |

Ex. 4. A ship from long. $178^\circ$ $54'$ W makes $3^\circ$ $4'$ westing: find the long. in.

| | | | |
|---|---|---|---|
| Long. left ...... | $178^\circ$ | $54'$ | W. |
| Diff. long. ...... | 3 | 4 | W. |
| LONG. IN | 181 | 58 | W. |
| Or (by No. 195) | 178 | 2 | E. |

*Examples for Exercise.*

1. Long. left $1^\circ$ $25'$ W. diff. of long. $85'$ E: what is the long. in? Ans. $0^\circ$ $0'$
2. Long. left $0^\circ$ $0'$, diff. of long. $146'$ W: the long. in is required. Ans. $2^\circ$ $26'$ W.
3. Long. left $0^\circ$ $0'$, diff of long. $122'$ E: what is the long. in? Ans. $2^\circ$ $2'$ E.
4. Long. left $160^\circ$ $20'$ W. diff. of long. $41^\circ$ $20'$ W: find the long. in. Ans. $158^\circ$ $20'$ E.
5. Long. left. $179^\circ$ $10'$ E. diff. of long. $84'$ E.: what is the long. in? Ans. $179^\circ$ $26'$ W.

197. The COURSE *steered* is the angle between the meridian and the ship's head. The course *made good* is the angle between the meridian and the ship's real track on the surface of the sphere.

The course is reckoned from the north, towards the east or west, when the ship's head is less than eight points from the north point. The same applies to the south point. The course is measured in *points* of $11^\circ$ $15'$ each, or in degrees and minutes.

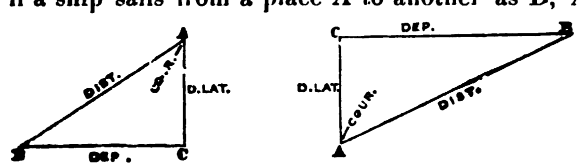
198. The track of the ship while preserving the same angle with all the meridians as she crosses them in succession, is called the RHUMB LINE.

199. The DISTANCE between two places, or the distance run by the ship on a certain course, is measured in *nautical miles* of 60 to the degree of latitude. *See* p. 104, note, and Table 64 A. Three such miles make a *nautical league*.

200. The DEPARTURE is the distance in nautical miles, made good by the ship due east or west; or the distance between two places measured along their parallel.

Departure is marked east or west, according as it is made good towards the east or west, and is accordingly called easting and westing; such easting and westing being, however, expressed in *miles*, and not, like longitude, in *arc*.

Thus, if a ship sails from a place A to another as B, A B is the




*distance*; A C drawn N. and S., or in the meridian, shews the angle

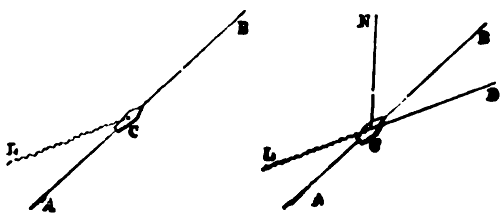
C A B the *course;* B C drawn E. and W., or perpendicular to C A, is the *departure;* and A C is the *diff. lat.*

201. The BEARING of an object or place is the angle contained between the meridian and the direction of the object, and is the same thing as the course towards it.

Taking a bearing of an object is called *setting* it.

The bearings of two objects, taken from the same place, constitute *cross bearings,* the lines of direction of the two objects intersecting or crossing each other at the place of the observer.

202. LEEWAY is the angle included between the direction of the ship's keel and the direction of the wake she leaves on the surface of the water.



Thus the vessel C, while she moves through the water in the direction of her length, in the line C B, is at the same time pressed to leeward of this line by the force of the wind, supposed in the figures to blow on the vessel's left or port side; her wake, or actual path through the water, appears therefore to windward of the line which she endeavours to keep, as is represented by the line C L. The angle A C L is the leeway.

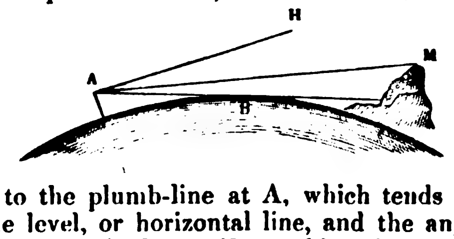
The course steered (No. 197) is the angle N C B, N C being the meridian; the course made good is N C D, the line C D being determined by producing L C.

203. The DEAD RECKONING is the account kept of the ship's place, without reference to astronomical observation. It is written D. R. for shortness.

204. The VISIBLE, or SEA HORIZON, is the apparent boundary of the surface of the water, which appears to the eye the circumference of a circle.

205. The DEPRESSION, or, as it is called by abbreviation, DIP, is the angle through which the sea horizon appears depressed, in consequence of the elevation of the spectator.

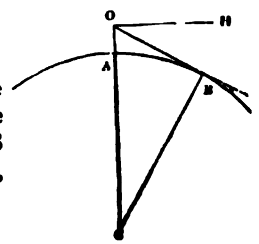
Suppose the spectator at A, above the sea, and A H a line



perpendicular to the plumb-line at A, which tends to the centre; A H is the true level, or horizontal line, and the angle H A B, included between it and the line A B, touching the sea, is the dip.

The dip depends on the distance in nautical miles of the visible horizon. Thus, to the eye 30 feet above the sea the true dip is 6′, or the distance of the horizon itself is about 6 miles. This is easily proved thus,

Let C be the centre of the earth, O the place of the observer; then the line O B drawn touching the surface at B determines B the farthest point visible to him. Draw O H perpendicular to O C, then since O B touches the circle at B, the angle CBO is a right angle (No. 138, Cor.) Hence BCA is the complement of C O B, and H O B is also the complement of COB (C O H = 90°), therefore A C B and H O B are equal.




The depression is given in Table 8.

206. The ALTITUDE of a terrestrial or celestial object above the sea horizon is the angle included between the line drawn from the eye to the object, and the line from the eye to the horizon. Thus, the angle M A B is the altitude of the summit M. The altitude here, in consequence of the great elevation of the spectator at A, about $\frac{1}{12}$ of the radius, or 330 miles. is less than the dip, or the summit M is really below the true horizontal line A H. This may take place when, from the small height of the object with respect to that of the observer, or its great distance, it is seen very little elevated; but in most cases A M will fall above A H.

207. The rays of light which pass from any distant object on the earth suffer a change in their direction, which is called the *terrestrial refraction*, by which the object appears in general higher than its true place. This effect is, on the average, about $\frac{1}{14}$ of the intercepted arc, or distance in miles, which are minutes of a degree very nearly. Thus, an object twenty-eight miles distant is raised about 2′ above its true place. The sea horizon is thus raised by refraction, or the apparent dip (Table 30) is less than the true.

This proportion, however, is subject to great irregularity, and varies between $\frac{1}{4}$ and $\frac{1}{23}$ of the intercepted arc. The apparent elevations of the summits of high land are thus subject to great variations, depending on particular states of the air.

208. The apparent place of the sea horizon differs also in different temperatures of the sea and air. When the sea is *warmer* than the air, the horizon appears *below* its mean place, or that at which it appears when the air and water are of the same temperature, or the apparent dip is too small; when the sea is *colder* than the air, the horizon appears *above* its mean place,* or the apparent dip is too great.

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* Admiral W. F. W. Owen informs me that he found on one occasion, in observing a star's altitude, a change of 4′ in the place of the sea horizon, in the tropics, soon after sunset. Mr. Fisher observed a variation in the place of the horizon of 18′ in the arctic regions. In summer the ice horizon was *elevated*, not depressed; in the winter it was depressed several minutes.—(*Appendix to Captain Parry's Voyage* in 1821–3, p. 187.) These observations, however, do not all follow the rule above. A table for correcting the apparent place of the sea horizon for the difference of temperature of the sea and the air, according to the height of the eye, would

Colonel Sabine gives a table of depressions observed from the gangway of H.M.S. Pheasant, at 15ft. 1in. above the sea, in the Gulf Stream, and after leaving it.* On Dec. 5, 1822, lat. 36°½ N., long. 72°½ W., at 10h A.M., the temperature of the sea being 70°, that of the air 60°, the dip observed by Wollaston's dip sector was 4′ 57″, or 1′ 6″ more than the table. At noon the temperature of the water had changed to 62°·4, the air at 60° as before, the ship having passed from the warmer water of the stream to the colder water of the rest of the ocean, and the dip observed was 3′ 37″. From the result of his observations, Colonel Sabine considers that the navigator will be right nine times in ten in assuming that, when the sea is *warmer* than the air, the tabular dip is *too small*. In only one case, however, did this error ever amount to so much as 1′ 56″, the sea being then at 49°, and the air at 38°, or the difference 11°; and it is important to remark that the error of the table is by no means proportional to the difference of these temperatures, which in one case was no less than 29°.

Numerous instances are on record, in the accounts of modern navigation, of errors of observation arising from variation in the place of the sea horizon.

209. Besides the vertical effect of refraction above described, some instances have been recorded of a sensible change in the *horizontal* direction of objects. Mr. K. B. Martin observed a change in the true direction of a point of land in the Azores, towards sunset. He also mentions an extraordinary change in the direction of C. Grisnez light as seen from Ramsgate at the close of a very hot day; on which occasion, also, distant objects were elongated horizontally till they seemed to separate into parts. ("Naut. Mag." 1847.)

Lieutenant Wilkes observed from the summit of Mowna Roa, the sun's horizontal diameter lengthened out to twice and a half the vertical one. ("Narrative of the United States Exploring Expedition," 1838–42.) In the Survey of the Isthmus of Tehuantepec, under Señor G. Moro, in 1842–3, the refractions at San Mateo on the Pacific, "especially the lateral ones," produced the strangest illusions.†

210. The TROPICS of CANCER and CAPRICORN are the parallels of latitude 23° 28′ N. and S. These are the dotted lines nearest the equator (fig. in p. 55). The sun is vertical at noon twice in the year to every place between the tropics, and never to any place outside of them. The space between the tropics is called the TORRID ZONE, on account of its heat.

211. The ARCTIC CIRCLE, or North Polar Circle, and the ANTARCTIC CIRCLE, or South Polar Circle, are parallels distant 23° 28′ from each pole, and are therefore in latitude 66° 32′. These are the dotted lines nearest the pole. Within these circles the sun does not set during part of the summer, nor rise during part of the winter.

The spaces within these circles are called the FRIGID ZONES, on account of the cold. The spaces between the tropics and the polar circles are called the TEMPERATE ZONES.

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be useful; but there are scarcely any data for the construction of such a table, and the theory itself appears not to be complete.

The above variation of the place of the apparent horizon, with mirage, reflected images, and other optical illusions, were first discussed, generally as questions of unequal temperature alone, by M. Biot, Mém. de l'Institut, 1809.

* Account of Experiments to determine the Figure of the Earth. London, 1825, p. 454.

† It is easy to conceive, that if a mass of air of different density from the rest be interposed between the spectator and the object, and if also the sides or faces which he looks through be not exactly parallel, it will have the effect of a prism, and will seem to throw the object to the right or left of its true direction. If the surfaces are curved, the effect of magnifying or diminishing will occur at the same time.

# CHAPTER II.

## Instruments of Navigation.

### I. The Compass. II. The Log and Glasses.

The necessary instruments of navigation are the Compass, by the aid of which the course of the ship can be directed; and the Log, which, with the help of sand-glasses for measuring small intervals of time, or a watch showing seconds, gives the velocity or rate of the ship, and thence the distance run in any interval of time.

### I. The Compass.

212. Before the invention of the Compass, the course of the ship was directed by reference to the land, or to the position of the heavenly bodies; but when those objects were obscured, the seaman must sometimes have been much perplexed.

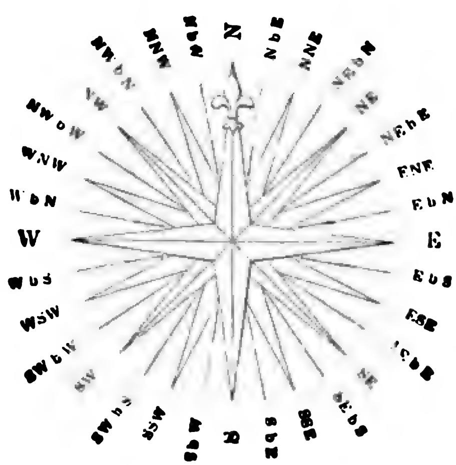
The pointing or directive property of the magnet, on which the efficiency of the compass mainly depends, appears to have been known to the Chinese, and made use of by them in travelling by land and sea, in times of remote antiquity. The ancient Greeks and Romans, though familiar with the magnet, were not apparently aware of its directive property, nor were their descendants till the beginning of the thirteenth century. About that time the seamen of the Mediterranean gradually became acquainted with the fact, that a piece of magnetised steel, shaped like and commonly called a needle, would, if allowed to turn freely about its centre, always come to rest in the same direction, and that, by reference to its pointing, they could roughly check or direct the course of the vessel.

Thus, before the seamen of those days were two problems. First, the best means of giving to the needle freedom, to take up any horizontal direction, and of indicating the direction of the ship's head relative thereto. Second, to find the exact direction of the pointing of the needle, in relation to some known standard of direction. In other words, first the perfecting of the mariner's compass; second, a knowledge of what is now called its variation.

Apparently, the earliest means used to allow the needle to take up any position in azimuth, was by thrusting it through a piece of light wood or pith, forming with it a rectangular cross;

the wood or pith being just sufficiently large to float the needle, when the cross was placed in a vessel of water. Otherwise, the needle was poised at its centre on a sharp pivot, and inclosed in some form of box. Subsequently, the necessity for keeping the box horizontal, in the varying motion of the ship, was met by gimballing the compass-box, and, for convenience, a circular disc of paper, called the fly, having a graduated circumference, was placed on the needle. The fly and the needle together was called the card. The box was generally made of brass, shaped like a basin, and had a glass cover. A mark, called the lubber-line, was placed on the fore part of the compass-box, or bowl as it was commonly called, on the inside, indicating the direction of the ship's fore-and-aft line, from the centre of the card.

The circumference of the card was divided into thirty-two divisions, called points; these were subdivided into half-points and quarter-points. The four principal points, or, as they are called, the *cardinal* points, are the North, South, East, and West; the East being towards the right when facing the North.




All the points of the compass are called by names composed of these four terms.

The points half-way between two cardinal points are called after both of these points: they are the north-east (written N.E.); north-west (N.W.); south-east (S.E.); and south-west (S.W.). These points are sometimes called quadrantal points.

A point half-way between one of these last and a cardinal point is called, in like manner, by a name composed of the nearest cardinal point and the adjacent point, N.E., N.W., S.E., or S.W. Thus the point between N. and N.E. is called north-north-east (written N.N.E.); the point between E. and N.E. is called east-north-east (written E.N.E.); and so of others.

The points *next* the eight principal points (namely, N., S., E., W., and N.E., N.W., S.E., and S.W.) take the word *by* between the name of such point and the next cardinal point. Thus the point *next* to north, on the east side, is called North *by* East; that on the West side is called North *by* West. Thus, on inspecting the compass, it is easy to see the reason of the names E. by N., S.W. by W., &c.

A *half-point*, which is the middle division between two points, is called after that one of its adjacent points which is either a cardinal point, or is the nearest to a cardinal point. Thus the middle division between N. and N. by E. is called north-*half*-east (written N. ½ E.). Half-points near N.E., N.W., S.E., and S.W., take their name from these points. Thus we say N.E. ½ N., and N.E. ½ E., and N.E. by E. ½ E.

The same holds for a quarter and for three-quarters as for a half-point.

In speaking of these divisions of the card, brevity seems to have been the chief end, rather than the habitual reading of the card from left to right, or the reverse. Thus, we may say N.E. by E. ½ E.; but continuing to the right, instead of E.N.E. ½ E. and E. by N. ½ E., it is usual to say E. by N. ½ N. and E. ½ N.

The name of the opposite point to any proposed point is known at once, without referring to the compass, by simply reversing the names or the letters which compose it. Thus the opposite of N. being S., and that of E. being W., the opposite point to S.W. by S. is at once known to be N.E. by N. The opposite of W. ¾ S. is E. ¾ N., and so on.

Dividing the circumference of the card, by successive halving, into points, half-points, and quarter-points, was well adapted to the time, not very distant, when many helmsmen were unable to read. The quarter-point was also considered the smallest division a man, sometimes under the blinding influences of wind, rain, and spray, could well distinguish. Now, however, the cards of steering compasses are frequently divided to degrees, in addition and external to the point divisions. In cards of nine or ten inches in diameter, the degrees are sufficiently large to be distinguished by men of ordinary sight. The degrees are always marked from North or South, towards the East or West; the courses, therefore, are read from left to right, and *vice versâ*, in alternate quadrants. This is apt to cause mistakes in steering. For this reason, and for precision and brevity in speaking, writing, and signalling, there is much to be said in favour of marking the card from zero to 360 degrees, round by the right. Small compasses for shore work are thus marked generally.

Repeating the points in any order is called *boxing the compass*; to do this is, of course, one of the first things a seaman learns.

In becoming familiar with the points of the compass the

learner should bear in mind that their utility is far from being confined exclusively to navigation, and that in finding his way across a new country, or through the streets of a strange city, no impressions will be so distinct or so permanent as those grounded on the points of the compass.

213. As the ship's course, which is sometimes expressed in points and sometimes in degrees, is always reckoned from the north or south point, the seaman has to refer at once, in using the Tables, to the *number of points*, or *degrees*, in any course given by *name*. The following table, which exhibits the degrees, minutes, and seconds, in each quarter-point of the compass, will be convenient for reference :—

| N—E | N—W | S—E | S—W | Pts. | ° ′ ″ |
|---|---|---|---|---|---|
| North. | North. | South. | South. | | |
| N ¼ E | N ¼ W | S ¼ E | S ¼ W | ¼ | 2 48 45 |
| N ½ E | N ½ W | S ½ E | S ½ W | ½ | 5 37 30 |
| N ¾ E | N ¾ W | S ¾ E | S ¾ W | ¾ | 8 26 15 |
| N b E | N b W | S b E | S b W | 1 | 11 15 0 |
| N b E ¼ E | N b W ¼ W | S b E ¼ E | S b W ¼ W | 1¼ | 14 3 45 |
| N b E ½ E | N b W ½ W | S b E ½ E | S b W ½ W | 1½ | 16 52 30 |
| N b E ¾ E | N b W ¾ W | S b E ¾ E | S b W ¾ W | 1¾ | 19 41 15 |
| NNE | NNW | SSE | SSW | 2 | 22 30 0 |
| NNE ¼ E | NNW ¼ W | SSE ¼ E | SSW ¼ W | 2¼ | 25 18 45 |
| NNE ½ E | NNW ½ W | SSE ½ E | SSW ½ W | 2½ | 28 7 30 |
| NNE ¾ E | NNW ¾ W | SSE ¾ E | SSW ¾ W | 2¾ | 30 56 15 |
| NE b N | NW b N | SE b S | SW b S | 3 | 33 45 0 |
| NE ¾ N | NW ¾ N | SE ¾ S | SW ¾ S | 3¼ | 36 33 45 |
| NE ½ N | NW ½ N | SE ½ S | SW ½ S | 3½ | 39 22 30 |
| NE ¼ N | NW ¼ N | SE ¼ S | SW ¼ S | 3¾ | 42 11 15 |
| NE | NW | SE | SW | 4 | 45 0 0 |
| NE ¼ E | NW ¼ W | SE ¼ E | SW ¼ W | 4¼ | 47 48 45 |
| NE ½ E | NW ½ W | SE ½ E | SW ½ W | 4½ | 50 37 30 |
| NE ¾ E | NW ¾ W | SE ¾ E | SW ¾ W | 4¾ | 53 26 15 |
| NE b E | NW b W | SE b E | SW b W | 5 | 56 15 0 |
| NE b E ¼ E | NW b W ¼ W | SE b E ¼ E | SW b W ¼ W | 5¼ | 59 3 45 |
| NE b E ½ E | NW b W ½ W | SE b E ½ E | SW b W ½ W | 5½ | 61 52 30 |
| NE b E ¾ E | NW b W ¾ W | SE b E ¾ E | SW b W ¾ W | 5¾ | 64 41 15 |
| ENE | WNW | ESE | WSW | 6 | 67 30 0 |
| E b N ¾ N | W b N ¾ N | E b S ¾ S | W b S ¾ S | 6¼ | 70 18 45 |
| E b N ½ N | W b N ½ N | E b S ½ S | W b S ½ S | 6½ | 73 7 30 |
| E b N ¼ N | W b N ¼ N | E b S ¼ S | W b S ¼ S | 6¾ | 75 56 15 |
| E b N | W b N | E b S | W b S | 7 | 78 45 0 |
| E ¾ N | W ¾ N | E ¾ S | W ¾ S | 7¼ | 81 33 45 |
| E ½ N | W ½ N | E ½ S | W ½ S | 7½ | 84 22 30 |
| E ¼ N | W ¼ N | E ¼ S | W ¼ S | 7¾ | 87 11 15 |
| East. | West. | East. | West. | 8 | 90 0 0 |

214. The Azimuth Compass is a compass of superior construction, especially adapted for observing bearings. It is fitted with

two vertical vanes. The one near the eye in observing, has a narrow vertical slit, with coloured shades for observing the sun. The other vane has a wider slit or opening, having a vertical thread in the middle of it. In front of this vane is a reflector, for observing objects elevated above the horizon. The line joining the slit in one vane, and the vertical thread in the other, should pass over the centre of the card. The cards of azimuth compasses are always marked to degrees, and frequently to smaller divisions.

In the Prismatic Azimuth Compass, a magnified image of the divisions of the card is read by reflection, in a prism attached to the fore side of the near sight vane. Azimuth compasses being required for taking bearings, are placed on a tripod for shore work, and on an elevated stand on board ship.

215. In the early part of the present century, when ships and instruments for navigation were rapidly improving, the compass was still a rude instrument, and not abreast of the requirements of the seaman. In 1820 Mr. Barlow reported to the Admiralty, that half the compasses he had at their request examined, belonging to the Royal Navy, were useless. It is probable that the compasses of the Mercantile Navy were no better. In 1837 their Lordships appointed a committee to inquire into the matter, and, if possible, to find a remedy for an evil so pregnant, as they said, with mischief. This step was taken for the benefit of the Royal Navy, and the improvement which took place, both in the design and in the workmanship of the compass, in consequence of the recommendations of the Admiralty compass committee, was of immediate and lasting benefit to the public service. The Mercantile Navy was not so immediately benefited, as the proceedings of that committee were not made public. But doubtless the fact of there having been such a committee stimulated compass makers to seek information, and to apply it to the improvement of the mariner's compass.

A great difficulty to be overcome, in a compass intended to be used on board ship, is the disturbance of the card caused by the motion of the ship. The Admiralty compass committee, while insisting on extreme lightness in the fly and fittings of the card, made considerable addition to its weight, by applying more needle power than would otherwise have been desirable, in order to secure steadiness. This was a fairly successful way of meeting the motion of ships at that date. But the violent and continuous motion, subsequently caused by the general adoption of the screw propeller, has been generally met, by suspending the compass bowl by springs or india-rubber.

The difficulty of getting a compass that would be steady in small vessels and boats, led to the introduction of the Liquid Compass; that is, a compass having the bowl filled with liquid instead of air. The first practical liquid compass was patented

by Mr. Crowe in 1813. It was subsequently improved by other makers, and is now, when well made, a very efficient compass for all purposes. It is especially adapted to stand severe vibration, and the shock of gun-firing. For these purposes, and for use in boats, it has not yet been excelled.

**216.** In 1876 Sir Wm. Thomson patented a compass, which is regarded with much favour by navigators. At the circumference of the card is an aluminium ring; the cap is held in the centre by radial silk threads, extending from it to the ring. Attached to the ring and threads is a disc of very light paper, its circumference having the usual compass graduations. All the central part of this disc is removed, still further to lessen the weight. Recognising the fact, that the power of a magnet increases relative to its weight, as the size decreases, the needles are very small. They are suspended under the card from its circumference. The entire card is not more than one-fifth to one-tenth of the weight of compass cards generally, of the same size. The friction on the pivot is, therefore, proportionally diminished.

By giving to the card no more needle power than would certainly overcome this much-diminished friction, it has a very slow period of vibration. The desirability of giving to a compass card a period of vibration that would not be isochronous with the roll of the ship, in order to maintain steadiness in a seaway, had already been pointed out by Mr. A. Smith, and by Mr. Towson. The bowl is protected from disturbance, also, by being suspended on a twisted wire gromet. This compass card, from the little friction on the pivot, is very sensitive at all times. From its slow period of vibration, it is steady when the ship is rolling; and, by reason of the suspension of the bowl, it has considerable immunity from the disturbances caused by vibration, shakes, and sudden shocks.

217. Though a compass, when supplied to a ship, should be accurate and efficient, it is desirable that the seaman should be able to satisfy himself on these points. The following essentials should be looked to, in steering and azimuth compasses, as far as they apply to each kind respectively.

The point of the pivot should always be in the same plane as the centre of the gimbals. The pivot should be sharp, or, when intended to be a little rounded, quite smooth; it should be free from rust. The cap should be sound—that is, not cracked nor perforated—and free from dust or dirt, which sometimes gets into it. Placing the card gently on the pivot, it should be deflected two or three times, through a small angle from its position of rest, to see if it always comes back to rest at the same point. This would show if the needle power is sufficient to overcome the friction on the pivot.

Select a position on shore, free from disturbances, from whence the bearing of some object is known. Measure horizontal angles

from it with a sextant, or other means, to three other objects, so selected that the correct bearing of four objects, about 90° apart, may thus be known. Now turn the compass round horizontally, so that the line from the centre of the card to the lubber-line coincides, in horizontal direction, with the line from the centre of the card to each object in succession. At each position of the compass, observe the bearing of the first object, by the sight vanes. Assuming that the card is regularly divided, these observations would show whether or not a course shaped, or a horizontal bearing taken, by the compass is correct.

Placing the compass on board ship in its binnacle, see that the bowl takes up its proper horizontal position in the gimbals; that the lubber-line is vertical, and that a line from the centre of the card to the lubber-line is exactly in the same horizontal direction as the fore-and-aft line of the ship. See that the thread in the sight vane is vertical, by testing it with a plumb line; and raise and lower the reflector, and see that the reflected image of the thread coincides with the thread itself. This will show that the bearing of an object at any elevation, whether taken by direct bearing or by reflection, is correct.

Metal pivots become blunted by wear, and steel pivots are also very liable to rust; jewelled caps naturally get worn and perforated by use, especially from the long-continued working of the screw propeller. They are also liable to be cracked by sudden concussion. Heavy cards are sometimes fitted with speculum metal caps, and work on jewelled pivots. Defective caps and pivots are a fruitful source of inefficiency in compasses, and require the especial attention of the navigator.

218. At a time when ships had no compass in an elevated position, all bearings had to be taken from the steering compasses. These were low down to the deck, and therefore inconvenient for that purpose. And subsequently, when most ships had an elevated compass, its position was frequently such, that an all-round view could not be obtained therefrom. The difficulty was met by the introduction of an instrument called a dumb card, or bearing-plate. It consists of a circular plate of metal, graduated like a compass card, and so gimballed that it may be revolved round a central pivot, in a horizontal plane. Adjacent to the circumference is a mark, similar to the lubber-line of the compass. It is fitted with sight vanes, shades, and reflector, for taking bearings.

The instrument may be placed in any position from whence the object, or objects, to be observed may be seen. The greatest care must be taken to see that the line from the centre of the bearing-plate to its lubber-mark is in the exact fore-and-aft line of the ship. This may be done by referring it to some mark in the ship, exactly in the fore-and-aft line; or to some mark, such as a bollard, which, from the position chosen for the

bearing-plate, is a known, small, and constant angle from the fore-and-aft line.

If the direction of the ship's head by the bearing-plate, be made to correspond with the direction of the ship's head by any compass, then the bearings taken by the bearing-plate will be the same as if they were taken by that compass. And, conversely, if the bearing-plate be turned round, so that the bearing of an object by it corresponds with its known correct bearing, the direction of the ship's head, as shown by the bearing-plate, is correct. This instrument, sometimes called a Pelorus, is extensively used.

Another instrument, called a Palinurus, is sometimes used for getting true bearings. It is, simply, the mechanical construction of the celestial sphere, with its great circles. By means of time, latitude, and declination of some heavenly body, a line in the instrument may be set to the true direction of that body. All the parts of the instrument, when that line is pointed to the body, will be in the true astronomical direction, and the bearings on the horizontal circle of the instrument will be true bearings round the horizon. A mark placed as the lubber-line will, of course, show the true direction of the ship's head. It will be seen that, with this instrument, no calculations or azimuth tables are required to get a true direction.

With respect to the use of such adjuncts to the compass, as have been briefly described, liability to secondary errors, both personal and instrumental, must be taken into account. To work directly, from a well-placed standard compass, appears by far the safest practice in navigation.

### *Variation of the Compass.*

219. The second problem before the early navigators was, to find the direction in which the needle pointed (No. 214). When the directive property of the magnet was first brought into use by seamen, it is probable that they continued for some time to steer by the sun and stars, as before. It was only when those objects were obscured, that they had recourse to a rude form of compass, to enable them to maintain their course, till their accustomed and more reliable guides appeared again. What the compass needle was to the seamen of those days, it is to the navigator of to-day. By it he can preserve a course, without reference to the heavenly bodies, for a longer or shorter time, and with more or less accuracy, according to the perfection of his compass, and to the degree in which he is acquainted with the laws which govern its pointing.

The natural standard of direction is the meridian. The horizontal angle contained between the direction of the meridian

and the direction of the needle, is called the Variation of the Compass. It is termed easterly or westerly, according to which side of the meridian the north end of the needle points.

The approximate direction of the meridian was easily seen in the northern hemisphere, by the position of the pole star. It must, therefore, have been well known, to all who noted the pointing of the compass needle, with any degree of care, that its direction did not coincide with the direction of the meridian; or, in other words, that it did not, in all places, point to the north. This fact seems to have been brought most prominently into notice by Columbus. He found, on his first voyage, in 1492, when well over towards the West Indies, that the needle pointed to the westward of north. In the seas which Columbus had hitherto navigated, as far as can be now judged, it pointed to the eastward of north. At the port in Europe from which he sailed the variation was, apparently, not less than two points easterly. Probably, therefore, it was the change, and especially its going from easterly to westerly, rather than the existence of variation, which arrested the attention of Columbus.

The first good determination of the variation, in England, was made in 1580, when the direction of the north end of the needle was about one point to the eastward of the meridian. Since that time, the variation has been observed with increasing frequency and accuracy. The following is an outline of the change in the variation in England.

Commencing in 1580 at 11° 15′ easterly, the north point of the needle moved towards the meridian, and crossed it in 1657, moving westward at the rate of 10′ annually. The north end of the needle continued to move westward, with a diminishing rate, till 1818, when it attained the limit of its western range, 24° 38′ westerly. Since that date the north point of the needle has moved to the east with an increasing rate. The variation in London is now 17° 30′ westerly, diminishing at the rate of 8′ annually.

The first attempt to give a comprehensive view of the direction of the compass needle, in all parts of the world, was made by Halley, in a chart published in 1700. This chart embraced the results of a voyage made by Halley himself, and such other information as was at that time available. Joining, by a line, the points on the earth's surface where the variation was the same, he traced, on a Mercator's chart, a series of lines of equal variation, extending over the Atlantic and Indian Oceans, and as far east as the meridian of 150°. Several similar charts, more complete and accurate, as the materials for compiling them increased in quantity and value, have since been published. The latest variation chart published by the Admiralty is all that the seaman can desire. On it the annual change of variation is also shown, enabling the navigator to obtain the variation very closely, at any date subsequent to that of the publication of the

chart. Comparing Halley's chart with those which have since been made, it appears that changes in the variation, analogous to those observed in England, but of greater or lesser extent, have been going on nearly all over the world. The variation of the compass is thus shown to be a variable quantity, changing at a variable rate. Such being the case, the only way in which it is possible to make and maintain an accurate variation chart, is by the co-operation of navigators, in making and recording, for that purpose, observations of the variation of the compass, in all those parts of the world over which they may sail.

220. Besides the change in the variation, which reaches its limits in long intervals of time, and is called the secular change, there are smaller changes, called periodical. Such is the diurnal change, wherein the needle moves through a small angle to the westward during the day, and returns to the eastward during the night, in the northern hemisphere. In the southern hemisphere, a similar change takes place, but in an opposite direction. The needle is also disturbed by the aurora, and by phenomena called magnetic storms. These changes are, in the navigable parts of the globe, too small to be of any importance to the navigator. Neither is the pointing of the compass needle affected by atmospheric phenomena, such as fogs, rain, wind, or thunderstorms. But in cases where a ship has been struck by lightning, the directive property of the compass needle has sometimes been impaired or destroyed.

There is, however, one cause of disturbance of the needle which should interest the navigator. Humboldt, in the beginning of this century, observed that the needle, in certain places on land, was deflected from what may be called its normal direction, by some property in the ground. In previous editions of this work, several places are noted, where the variation was affected by the land, or by the ground in shallow water.* It is probable, from the practice of steering by the land when it is in sight, rather than by compass courses, that this disturbance of the compass needle has escaped notice in some places where it exists. It is, therefore, desirable that this unquestionable source of danger should be pointed out, that the seaman may be on his guard, when navigating near the land, or in shallow water, especially in volcanic regions. Methods of determining the variation of the compass are given in Chapter VIII.

221. To correct compass courses and bearings for variation.

The manner of doing this appears thus. Suppose one compass card to be placed directly over another, and the lower one to be *true*. Now suppose the north point of the upper compass to be drawn two points to the right of the true by easterly variation, then the North point of the upper or *magnetic* compass corresponds

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* Commander W. U. Moore of H.M.S. Penguin reports a large local disturbance of the needle (55°) in 9 fathoms, 2 miles from the shore, off Port Walcott; on the N.W. coast of Australia. *See* Notice to Mariners, No. 43 of 1891.

to N.N.E. of the *true* compass, which point is to the right of N., and the South point corresponds to S.S.W. of the true compass, to the right of S., and so on. The contrary would take place with westerly variation; hence to correct a magnetic course or bearing we have this rule.

Rule. When the variation is *easterly*, apply it to the *right* of the compass course or bearing; when *westerly*, apply it to the *left*, looking from the centre of the card over the point to be corrected.

Ex. 1. Course by compass, S. $\frac{3}{4}$ W.; variation, $2\frac{1}{4}$ points easterly.
True Course, $2\frac{1}{4}$ points to the right of S. $\frac{3}{4}$ W., or S. 3 points W., or S.W. by S.

Ex. 2. Course by compass, N. by E.; variation, 2 point westerly.
True Course, 2 points to the left of N. by E., that is, N. by W.

Ex. 3. Course or bearing by compass, N. 84° E.; variation, 19° W.
True Course, N. 65° E.

Ex. 4. Course by compass, S. 4° E.; variation, 17° E.
True Course, S. 13° W.

To reduce a true course or bearing to the compass course or bearing, apply the variation the *contrary way* to that directed above.

Ex 1. True course, N.E. by E.; variation, 1 point easterly.
Course by Compass, N.E.

Ex. 2. True course, E. $\frac{3}{4}$ N.; variation, $1\frac{3}{4}$ point westerly.
Course by Compass, E. by S.

Ex. 3. True course, North; variation, 18° easterly.
Course by Compass, N. 18° W.

Ex. 4. True course, West; variation, 21° westerly.
Course by Compass, N. 69° W.

*Deviation of the Compass.*

222. From the earliest times it was known that if a magnet, or a piece of ordinary iron, were brought near to a compass, it would deflect the needle in its pointing, and so make the compass indications erroneous. Compasses on board ship, therefore, were not placed near to each other, and iron was rigorously kept away from their vicinity. With these precautions, though accidents sometimes happened from iron in the vicinity of the compass being overlooked, ships were navigated with a fair amount of security. But as iron became increasingly used in the construction of ships, and by the introduction therein of steam engines, with their boilers and funnels, it was no longer possible to navigate, without systematically allowing for the deflection of the compass needle caused thereby.

The horizontal angle, which the needle is deflected by the iron in or of the ship, is called the Deviation of the Compass. It is named easterly or positive (E. or +), when the north end of needle is deflected to the eastward; and westerly or negative (W. or −), when deflected to the westward. The mode of ascertaining and applying the deviation of the compass, is the next problem to engage the attention of the student of navigation.

Within half a century of the present time, many navigators doubted the existence of the deviation of the compass; or, while admitting its existence, denied that it was of any practical importance. And the belief was not uncommon, that it was a constant error--that is, that it was the same in amount with the ship's head in any direction. Those, however, who had studied the subject, or whom circumstances had made familiar therewith, acknowledged its importance, and recognised the necessity of ascertaining the deviation of the compass, with the ship's head in all directions.

223. There are three standards from which to reckon an angle of direction. First, from the meridian, the direction of which can always be ascertained astronomically. A course or bearing thus reckoned, is called a true course, or true bearing. Second, from the direction of the magnetic north; that is, from the direction of a magnetic needle, when uninfluenced by any contiguous iron, or by any such local disturbances as are mentioned in No. 220. A course or bearing thus reckoned, is called a magnetic course or bearing. Third, from the direction of the compass needle, as shown by a compass which is instrumentally correct, placed in any position. A course or bearing thus reckoned, is called a compass course or bearing.

The prefix correct may be placed to either of these quantities. The terms correct true, correct magnetic, correct compass, are used to distinguish the exact angles from those more or less approximate. The student must not confuse correct compass with magnetic. A correct compass course or bearing means a course or bearing accurately observed, with an accurate compass, regardless of any disturbance by which the compass may be influenced.

224. From the fact that compasses, in different parts of a ship, gave different indications, came the necessity for navigating by one especial compass, placed in a selected position. Such a compass is called the Standard Compass. It should be an azimuth compass, that is, one fitted for observing bearings; and one essential of its position is, that from it bearings can be taken all round the horizon, and at any altitude.

Turning a ship round, so as to place her head on all points of the compass in succession, for the purpose of ascertaining the deviation, is called swinging the ship. A ship may be warped or towed round, when lying at anchor or at moorings; or advantage may be taken of her turning with the tide. Wherever there is room, it may be convenient to steer a ship round under steam. It is in all cases desirable that the ship should be checked in her swinging, and steadied on the point on which it is desired to obtain the deviation.

As the variation of the compass is determined by comparing the true bearing of an object with its magnetic bearing,

so the deviation of the compass is ascertained by comparing the magnetic bearing with the compass bearing—the compass, at the time, being deflected by the iron in and of the ship only. Any other disturbance, such as from the proximity of other ships or masses of iron, or the irregular influence of the land, is not deviation according to the definition already given.

The first problem is, therefore, to determine the magnetic bearing of some object external to the ship. The sun is very commonly used; the true bearing is easily found, and the variation being applied thereto, gives its magnetic bearing. A distant mark on the land may also be used; its true bearing may be found by the chart, or by measuring and applying the horizontal angle or difference of bearing between it and the sun, and the magnetic bearing by further applying the variation. A third method is to have a correct compass in a convenient position on shore, where it is free from magnetic disturbances. Then the bearing of that compass being taken from the standard compass, and the bearing of the standard compass being simultaneously taken from the shore compass, the deviation of the standard compass is found by comparison.

These methods are spoken of as, swinging by the sun, swinging by distant mark, and swinging by shore compass. When using a distant mark, it should be so far away that the radius of the circle, along the circumference of which the standard compass moves as the ship goes round, subtends a smaller angle than is of practical consequence in navigating. Otherwise the bearings must be corrected for parallax.

There are many places where the true direction of lines, on which two known and conspicuous marks appear in one, are known. These lines, called transit lines, offer especial facilities for ascertaining the deviation.

Looking from the centre of the card, if the bearing shown by the compass is to the left of the magnetic bearing, the needle is obviously deflected to the right, and the deviation consequently called easterly. If the bearing shown by the compass is to the right of the magnetic bearing, the needle must be deflected to the left, and the deviation westerly.

225. Though the deviation of other compasses is not of so much importance as that of the standard, it is usual to note the direction of the ship's head, as shown by them, when it is on each point by the standard. The deviation is usually tabulated for reference, in some form similar to the following, which is commonly called a Deviation Table.

| Head by Standard Compass | Deviation of Standard Compass | Direction of Head by other Compasses | | |
|---|---|---|---|---|
| | | Port Steering | Starboard Steering | Bridge Compass |
| | | | | |

The bearing-plate is frequently used in swinging. The vanes on the bearing-plate, being set to the known magnetic bearing of the sun, distant mark, or shore compass, the magnetic direction of head is shown by the lubber mark, when the plate is turned round so that the vanes point to the object. Thus, the deviation of the compasses on the magnetic points is shown, and may be tabulated as follows :—

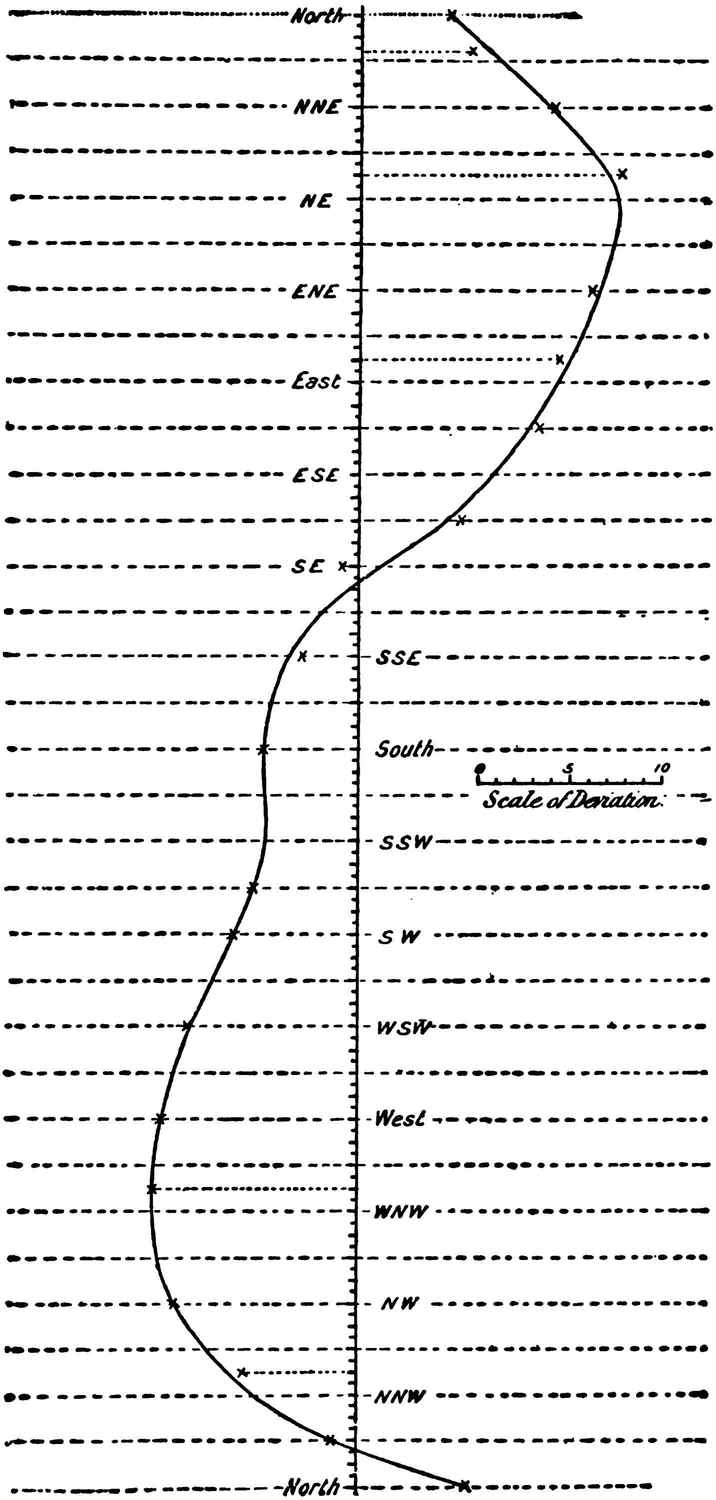
| Head Magnetic | Direction of Head by Compasses | | | |
|---|---|---|---|---|
| | Standard | Port Steering | Starboard Steering | Bridge Compass |
| | | | | |

226. It is customary to form a deviation table from observations made on each point. But it may be convenient, or necessary, to form such a table with fewer observations, such as on every second or third point. Further, it may not be possible to get the observations exactly on the points. The problem, therefore, is to form a deviation table with few observations, irregularly distributed round the compass.

This is done by drawing a curve of deviations in the following manner. Draw a vertical line on paper, and divide it as a compass card is divided. The vertical line will thus represent the circumference of the card unrolled, and formed into a straight line. Through each compass point draw a line at right angles to the vertical line. On these lines, with any convenient scale, lay off the deviation found on each point. On parallel lines, passing through any intermediate degree or division of the point, lay off the deviation found thereon. Easterly deviation to be measured from the vertical line to the right, and westerly deviation to the left, marking, by a cross or otherwise, the positions thus determined. Now draw a line which, without being irregular in direction, passes most nearly through the several marks. This line, in practice, will always be a curve. The distance of the point of intersection of this curve with any point line, from the vertical line, will give the deviation on that point, using the same scale as before.

*Example.*—The following deviations having been observed, find the deviation on each compass point.

| | ° | ′ | | | ° | ′ | |
|---|---|---|---|---|---|---|---|
| North | 5 | 0 | E | South | 5 | 0 | W |
| N $\frac{3}{4}$ E | 6 | 0 | E | SW b S | 5 | 0 | W |
| NNE | 10 | 0 | E | SW | 5 | 30 | W |
| NE $\frac{1}{2}$ N | 14 | 0 | E | WSW | 8 | 0 | W |
| ENE | 12 | 0 | E | West | 10 | 0 | W |
| E $\frac{1}{2}$ N | 10 | 0 | E | W b N $\frac{1}{2}$ N | 11 | 0 | W |
| E b S | 9 | 30 | E | NW | 10 | 0 | W |
| SE b E | 6 | 0 | E | NNW $\frac{1}{2}$ W | 6 | 30 | W |
| SE | 1 | 0 | W | N b W | 1 | 0 | W |
| SSE | 2 | 30 | W | North | 5 | 0 | E |


North
NNE
NE
ENE
East
ESE
SE
SSE
South
0 5 10
Scale of Deviation.
SSW
SW
WSW
West
WNW
NW
NNW
North

227. Plotting these observations in the manner directed, and as shown in the foregoing diagram, the following table of deviations is obtained.

| | ° ′ | | | | ° ′ | |
|---|---|---|---|---|---|---|
| North | 5 0 | E | | South | 5 0 | W |
| N b E | 7 45 | E | | S b W | 5 0 | W |
| NNE | 10 0 | E | | SSW | 5 0 | W |
| NE b N | 12 15 | E | | SW b S | 5 0 | W |
| NE | 13 30 | E | | SW | 5 30 | W |
| NE b E | 13 30 | E | | SW b W | 6 30 | W |
| ENE | 12 45 | E | | WSW | 7 45 | W |
| E b N | 11 45 | E | | W b S | 8 45 | W |
| East | 10 30 | E | | West | 9 45 | W |
| E b S | 8 45 | E | | W b N | 10 30 | W |
| E b E | 7 15 | E | | WNW | 10 45 | W |
| SE b E | 4 30 | E | | NW b W | 10 30 | W |
| SE | 0 45 | E | | NW | 9 45 | W |
| SE b S | 2 0 | W | | NW b N | 8 0 | W |
| SSE | 3 30 | W | | NNW | 5 15 | W |
| S b E | 4 30 | W | | N b W | 1 0 | W |

In the diagram shown, the vertical scale is made small as compared with the horizontal scale, in order to get it within the limits of the page. A sheet of ordinary ruled foolscap will be found very convenient for plotting deviations to form the curve.

228. The methods of ascertaining the deviation having been explained, the following are directions for applying the same to a compass course or bearing, so as to obtain the magnetic course or bearing.

The ship's head being on any compass point, and the deviation on that point being easterly, that deviation must be allowed to the right, to find the magnetic direction of the ship's head; and also to the right of any bearing taken by compass, to find the magnetic bearing. If the deviation on the compass course is westerly, it must be allowed to the left, to find the magnetic course or bearing.

*Example.*—Ship's head E.N.E. by compass, a point of land bore N. 10° W. What is the magnetic direction of the ship's head, and the magnetic bearing of the point, the deviation being as given in table 227?

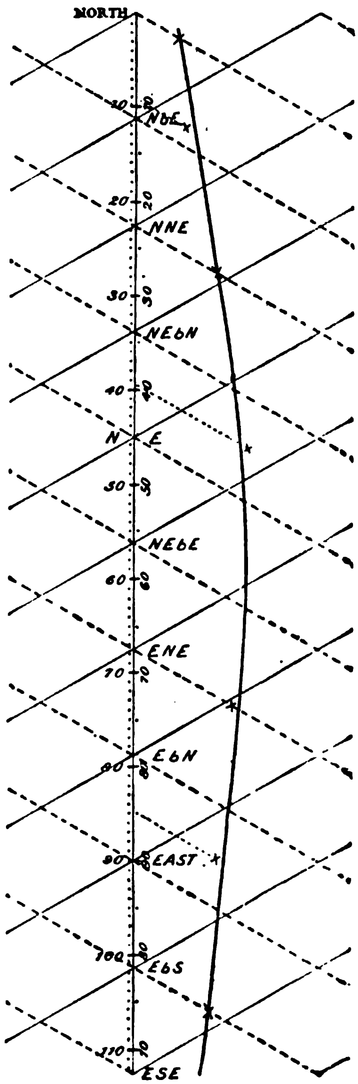
The deviation on E.N.E. is 12.45 E., which allowed to the right of N. 67.30 E., gives N. 80.15 E. as the magnetic direction of the ship's head; and allowed to the right of N. 10.0 W., gives N. 2.45 E. as the magnetic bearing of the point. In the same way, head being N.W. and bearing S. 40 E., the deviation on N.W. is 9.45 W., which allowed to the left, gives N. 54.45 W. as magnetic direction of ship's head, and S. 49.45 E. as magnetic bearing of point.

To turn magnetic courses or bearings into compass courses or

bearings, it is obvious that the deviation should be allowed the opposite way. That is, easterly deviation to the left, and westerly deviation to the right.

229. To facilitate turning compass courses or bearings into magnetic courses or bearings, and the reverse, certain graphic methods are sometimes used. The most common is one called, from its inventor, Napier's diagram. The example given, wherein are plotted, through a quadrant, the observations given in No. 226, shows the use of this diagram for the purpose named, as well as for forming a curve of deviations from few observations.

NAPIER'S DIAGRAM.



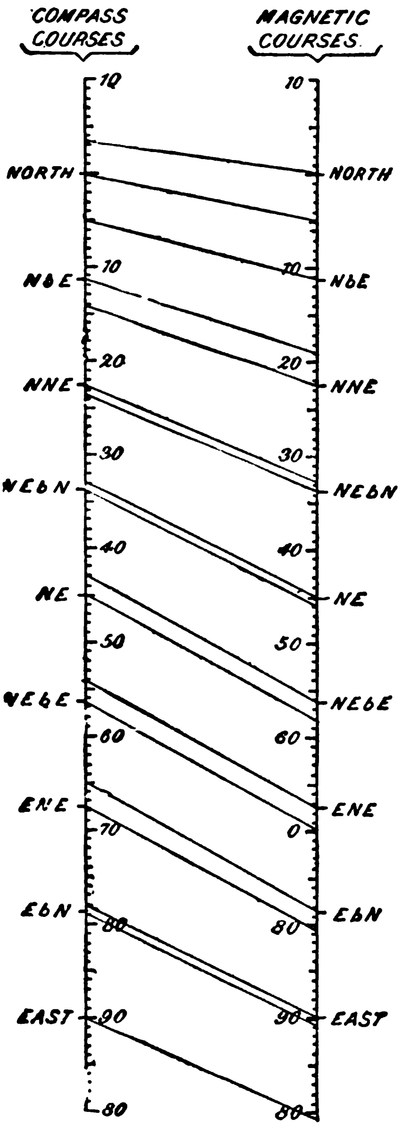

The dotted compass point lines intersect the vertical line, at an angle of 60°, and the vertical scale and deviation scale are equal. Therefore, if the deviation found on any compass point be laid off on one of the dotted lines, or on a line parallel thereto, and, from the point reached, a line be drawn making an angle of 60° with the compass point line, it will intersect the vertical line at the magnetic point. And, *vice versâ*, if the deviation on a magnetic point be laid off on one of the plain lines, or on a line parallel thereto, the return line, drawn as before, will reach the vertical line at the compass point. The three lines form an equilateral triangle, of which the difference between compass and magnetic forms the base, the other sides being equal thereto, and to the deviation due to the direction of head, whether given by compass or magnetic.

230. Another method, called the straight line method, is due to Mr. Archibald Smith. It is only useful for showing, at a glance, the magnetic course equivalent to any given compass course, and *vice versâ*, when the deviation is known. It consists merely of two parallel vertical lines, each divided as the circumference of a compass card is divided. Straight lines are

drawn, from the compass points on one line to the magnetic points on the other.

In the annexed example, the deviation table through one quadrant, given in No. 227, is thus treated.

STRAIGHT LINE DIAGRAM.




If a ship be steering any compass course, shown on the left-hand column, the corresponding magnetic course is shown on the right-hand column. And if it is desired to steer any magnetic course, shown on the right-hand column, the required compass course is shown on the left-hand column.

231. A third method is to have two prints of compass cards, one laid on the other. The upper card somewhat smaller than the lower, and capable of being rotated about the common centre. The lower card, being fixed, may be considered as representing either true, or magnetic, courses or bearings.

Consider the lower card to represent true courses and bearings, and the north points of the two cards together. Conceive the north point of the upper card, moved through an arc equal to the variation, away from the north point on the lower card, to the right when the variation is easterly, and to the left when the variation is westerly. Magnetic courses and bearings on the upper card, and true courses and bearings on the lower card, will now be coincident.

Similarly, if the lower card be considered as showing magnetic courses or bearings, and the north points of the cards be separated by an arc equal to the deviation, then the compass courses and bearings on the upper card, will coincide with magnetic courses or bearings on the lower card.

Diagrams on which curves of deviation can be drawn, so as to show indifferent observations, and thus eliminate their effects, or to form the curve from few observations, are of undoubted value to the seaman. But it is a question, whether any means such as have been described, for turning magnetic courses into compass courses, or the reverse, are of ultimate benefit. The habit of considering the effect on courses and bearings, of the north point, and consequently the whole circumference of the card, being turned right or left, from what may be considered its proper position, so as to have a clear conception thereof in the mind, will make the seaman independent of rules, and of all such semi-mechanical methods.

*Adjustment of the Compass.*

232. If the increase of iron put into ships had been limited to engines and boilers, it is possible that a compass might have been so placed, in most ships, that the deviation would have been comparatively small. Seamen might have continued to navigate with confidence, by ascertaining and applying the deviation. But when ships were built with iron beams, iron frames, or wholly of iron, it was no longer possible to evade a deviation so large as to be unmanageable; and steps had to be taken to correct, or, as it is now called, adjust, the compass.

This operation is generally performed by practised compass adjusters; but many rightly think this is essentially the duty of a seaman, and that he should also have sufficient knowledge of magnetism to enable him to select the best position for the compasses of a ship. In a book in which teaching navigation is the main object, magnetism can only be treated with brevity; but it is hoped that the navigator will find herein all that is required for his guidance.

The horizontal pointing of the compass needle has been shown to be of the utmost importance to the navigator. For the right understanding of the magnetism of iron ships, however, and its effect on the compass, some further knowledge of the pointing of the magnetised needle, and the cause thereof, is necessary.

In the year 1576, Robert Norman, a mathematical instrument maker, of London, discovered that a needle, however nicely balanced, would, after being magnetised, depart from the horizontal, and assume a position within 20° of vertical. By careful observations he found that the needle in London, at that date, pointed, with its north end downward, 71°·50′ from the horizontal. Since that time, observations have been made nearly all over the world. It is found that the needle is horizontal only on a line round the earth, not far from the equator. Going from this line to the northward, the needle points with its north end downwards; and going to the southward, with its south end downwards. The angle of inclination, in both cases, increases, till in a position in

each hemisphere, about 18° from the earth's poles, the needle becomes vertical. These positions are called Magnetic Poles.

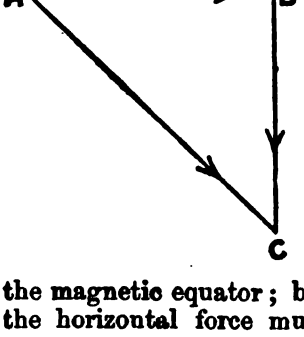
This angle of inclination to the horizontal is called the Dip. It is named positive, or +, when the end towards the north magnetic pole is the lower, and negative, or −, when the end towards the south magnetic pole is the lower. Like the variation, the dip is found to change with time, and other circumstances.

In the adjacent maps, lines of equal dip are drawn. The line whereon the dip = 0, is called the magnetic equator; and the lines of equal dip may be considered as parallels of magnetic latitude. The lines running nearly north and south show the horizontal direction the needle lies in, and may be considered as magnetic meridians. These lines converge to the magnetic pole in each hemisphere. For the use of seamen, there is no better way of giving the variation of the compass, than by lines of equal variation, as drawn on the variation chart (No. 238); but the lines here shown give a more direct representation of the pointing of the compass needle.

233. In the beginning of the present century it became known, chiefly through the researches of Humboldt, that the strength, or force, with which the needle points is not the same in all parts of the earth. It may be stated, generally, that this force is least about the equator, and, like the dip, increases towards the poles. Also, like the variation and dip, it is not constant in value at the same place.

The line whereon the magnetic force is least, coincides nearly with the magnetic equator; but there are apparently, in each hemisphere, two points where the force is greater than in the surrounding regions, neither of which coincides with the magnetic pole.

As the earth's force is not horizontal, except at the magnetic equator, it is convenient to reckon, or resolve, as it is called, that force in the horizontal and vertical directions. If the length of the line A C represents the earth's force, and the angle A be equal to the dip, then the horizontal line A B, and the vertical line B C, will in length represent, respectively, the horizontal and vertical components of the earth's force. These quantities are usually called the Horizontal Force, the Vertical Force, and the Total Force. Of these quantities and the dip, if any two are known, the other two may be found by the ordinary processes of trigonometry.




As previously stated, the dip and total force increase, going away from the magnetic equator; but it is evident that when the dip is 90° the horizontal force must vanish, whatever the total force may

## Hemisphere from 60° W. to 120° E. Longitude.


Maps showing the **Magnetic Equator,** lines of **Equal Dip,** and **Horizontal Direction** of the **Compass Needle.** The parallels of latitude and the meridians are drawn at every fifteen degrees of latitude and longitude; the figures at the circumference denote the dip in degrees along the respective magnetic parallels; and the direction of the magnetic meridians, compared with the direction of the geographical meridians, shows the variation.

*Between pp 82 & 83.*

# Hemisphere from 120° E. to 60° W. Longitude.


**The points (⊙) to which the magnetic meridians converge are the magnetic poles, sometimes called, from the dip thereat being 90°, the poles of Verticity. The points (✱) show the approximate position of the foci of maximum force. It is remarkable that these six points are within 160° of longitude.**

**These maps, and the following table of horizontal force, are based on the good work on this subject done by the late Sir F. Evans, R.N.**

be. The dip and total force, therefore, increase together in such a manner that the horizontal force continually diminishes.

The horizontal force is the only part of the earth's force by which the compass card maintains its due position. The seaman is generally satisfied if this condition is fairly answered; but he must be sometimes painfully aware, from what is called the sluggishness of his compass, that this force is, at best, very feeble.

The following table gives the comparative value of the horizontal force, in different positions; the maximum value being considered as unity.

COMPARATIVE VALUE OF HORIZONTAL FORCE
Maximum Value equal Unity

| Latitude | East Longitude | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0° | 15° | 30° | 45° | 60° | 75° | 90° | 105° | 120° | 135° | 150° | 165° | 180° |
| N 60° | 0·40 | 0·41 | 0·43 | 0·44 | 0·44 | 0·43 | 0·42 | 0·43 | 0·44 | 0·45 | 0·47 | 0·49 | 0·48 |
| 50 | 0·49 | 0·52 | 0·55 | 0·57 | 0·58 | 0·58 | 0·58 | 0·57 | 0·57 | 0·59 | 0·60 | 0·60 | 0·59 |
| 40 | 0·60 | 0·64 | 0·68 | 0·70 | 0·73 | 0·75 | 0·75 | 0·75 | 0·74 | 0·73 | 0·71 | 0·70 | 0·68 |
| 30 | 0·71 | 0·75 | 0·79 | 0·83 | 0·87 | 0·89 | 0·90 | 0·89 | 0·87 | 0·84 | 0·82 | 0·80 | 0·76 |
| 20 | 0·78 | 0·81 | 0·86 | 0·90 | 0·94 | 0·97 | 0·97 | 0·96 | 0·94 | 0·92 | 0·89 | 0·86 | 0·84 |
| 10 | 0·82 | 0·85 | 0·88 | 0·90 | 0·93 | 0·97 | 1·00 | 1·00 | 0·99 | 0·97 | 0·94 | 0·92 | 0·90 |
| 0 | 0·79 | 0·79 | 0·80 | 0·83 | 0·87 | 0·90 | 0·96 | 1·00 | 1·00 | 1·00 | 0·98 | 0·97 | 0·95 |
| S 10 | 0·70 | 0·70 | 0·70 | 0·72 | 0·76 | 0·82 | 0·88 | 0·92 | 0·96 | 0·98 | 0·98 | 0·97 | 0·96 |
| 20 | 0·61 | 0·59 | 0·59 | 0·60 | 0·64 | 0·71 | 0·77 | 0·82 | 0·87 | 0·90 | 0·91 | 0·91 | 0·90 |
| 30 | 0·56 | 0·54 | 0·52 | 0·53 | 0·54 | 0·58 | 0·62 | 0·68 | 0·71 | 0·75 | 0·78 | 0·81 | 0·82 |
| 40 | 0·55 | 0·51 | 0·49 | 0·48 | 0·49 | 0·50 | 0·51 | 0·54 | 0·55 | 0·57 | 0·62 | 0·65 | 0·68 |
| 50 | 0·54 | 0·50 | 0·47 | 0·44 | 0·43 | 0·42 | 0·41 | 0·39 | 0·38 | 0·39 | 0·43 | 0·47 | 0·52 |
| 60 | 0·53 | 0·49 | 0·46 | 0·42 | 0·39 | 0·36 | 0·32 | 0·27 | 0·20 | 0·20 | 0·24 | 0·30 | 0·37 |

| Latitude | West Longitude | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0° | 15° | 30° | 45° | 60° | 75° | 90° | 105° | 120° | 135° | 150° | 165° | 180° |
| N 60° | 0·40 | 0·37 | 0·33 | 0·29 | 0·22 | 0·12 | 0·10 | 0·20 | 0·29 | 0·38 | 0·43 | 0·46 | 0·48 |
| 50 | 0·49 | 0·45 | 0·41 | 0·37 | 0·34 | 0·32 | 0·36 | 0·43 | 0·49 | 0·54 | 0·55 | 0·57 | 0·59 |
| 40 | 0·60 | 0·55 | 0·50 | 0·48 | 0·47 | 0·50 | 0·56 | 0·60 | 0·64 | 0·65 | 0·65 | 0·66 | 0·68 |
| 30 | 0·71 | 0·66 | 0·62 | 0·61 | 0·65 | 0·71 | 0·77 | 0·80 | 0·80 | 0·77 | 0·74 | 0·74 | 0·76 |
| 20 | 0·78 | 0·74 | 0·72 | 0·72 | 0·77 | 0·85 | 0·90 | 0·90 | 0·88 | 0·85 | 0·82 | 0·82 | 0·84 |
| 10 | 0·82 | 0·79 | 0·77 | 0·79 | 0·84 | 0·89 | 0·94 | 0·95 | 0·92 | 0·89 | 0·89 | 0·90 | 0·90 |
| 0 | 0·79 | 0·78 | 0·77 | 0·80 | 0·83 | 0·89 | 0·92 | 0·93 | 0·92 | 0·90 | 0·92 | 0·93 | 0·95 |
| S 10 | 0·70 | 0·71 | 0·73 | 0·76 | 0·80 | 0·84 | 0·87 | 0·88 | 0·89 | 0·88 | 0·91 | 0·93 | 0·96 |
| 20 | 0·61 | 0·65 | 0·68 | 0·70 | 0·74 | 0·79 | 0·82 | 0·84 | 0·85 | 0·87 | 0·88 | 0·90 | 0·90 |
| 30 | 0·56 | 0·60 | 0·63 | 0·67 | 0·70 | 0·76 | 0·77 | 0·78 | 0·78 | 0·80 | 0·81 | 0·82 | 0·82 |
| 40 | 0·55 | 0·59 | 0·63 | 0·67 | 0·71 | 0·74 | 0·75 | 0·73 | 0·71 | 0·70 | 0·70 | 0·70 | 0·68 |
| 50 | 0·54 | 0·59 | 0·63 | 0·69 | 0·72 | 0·73 | 0·72 | 0·68 | 0·63 | 0·61 | 0·59 | 0·56 | 0·52 |
| 60 | 0·53 | 0·58 | 0·63 | 0·68 | 0·71 | 0·71 | 0·67 | 0·60 | 0·55 | 0·50 | 0·46 | 0·42 | 0·37 |

**234.** In dealing with the subject of compass adjustment, it will sometimes be useful for the seaman to know the value of the force with which the needle points on board ship, compared with the force with which it points on shore; or the force with which

it points when the ship's head is in one direction, compared with the force with which it points when the head is in other directions. It is necessary, therefore, to show how comparative magnetic force is measured. If a magnetised needle, balanced on its centre, be disturbed from its position of rest, it will, like a pendulum, vibrate through diminishing arcs, till it again comes to rest. The speed of the needle is increased when the magnetic force is increased; the force being proportional to the square of the speed of the needle. That is, if the needle in one position makes 10 vibrations in any given time, and in another position makes 12 vibrations in the same time, the magnetic force in the first position is to the magnetic force in the second position as $10^2$ is to $12^2$.

It is convenient to measure the horizontal force and the vertical force separately. The horizontal force is measured by means of a flat and pointed needle, about three inches long. It has a jewelled cap at its centre, which works on a sharp pivot. It must be used in a covered box, or compass bowl, to protect it from the motion of the air. It is brought horizontal by a small weight, counterbalancing the dip, and so vibrated in the horizontal plane.

Horizontal force may also be measured by deflection. If a magnet be placed at right angles to the direction of the needle, the magnet will deflect the needle through a certain angle, depending upon the strength of the magnet, compared with the horizontal force. The smaller the force, the larger the angle of deflection of the needle, the force being as the cosine of the angle of deflection. Or the deflecting magnet may be moved round, and kept at right angles to the compass needle, and the horizontal force measured by the maximum deflection the magnet is capable of producing, when thus applied.

Vertical force is measured by means of a Dip Circle. This is an instrument having a flat pointed needle, with an axle passing through its centre of gravity, about which it can rotate in a vertical plane; the axle being supported at the centre of a graduated circle. If the circle is placed in the vertical plane of the magnetic force, the needle will stand in the direction of that force, showing the dip, if it be acted on by the earth's force only. A small weight placed on the upper arm of the needle, bringing it horizontal, will be a measure of the vertical force.

If the circle is placed at right angles to the plane of the magnetic force, the needle will hang vertically, where there is any vertical force, and in this position may be vibrated, so as to measure that force.

Measuring either horizontal or vertical force by vibration, the initial arc should be the same, in any positions wherein it is desired to compare those forces. The effects of friction, and the resistance of the air, are to cause the needle to take a little more

time, in going through the larger arcs than the smaller, and ultimately to bring it to rest. The smallest arcs which can be conveniently used give the best results.

235. Studying the phenomena of the pointing of the magnetised needle on the earth's surface, and comparing them with the effects of one magnetised needle, or steel bar, on another magnetised needle, or steel bar, the conviction gradually gained ground, that the earth is, or has the properties of, a large magnet. Those properties are two. First, Attraction and Repulsion: the property by which one magnet will attract and repel another, according to definite laws. Second, Induction: the property by which a magnet can impart magnetism, and so convert into a magnet any piece of iron or steel, either by contact or mere proximity.

The property of attraction and repulsion may be shown, by bringing two compass cards near to each other. The north part of one card will push away or repel the north part, and attract or draw towards it the south part, of the other. The ends of magnets are called poles, and we express the law of attraction and repulsion by saying, like poles repel, and unlike poles attract, each other.

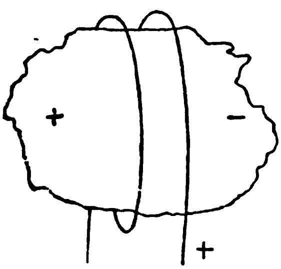
This attraction and repulsion may be due to two different kinds of magnetism in the poles, or to an excess of magnetism in one pole as compared with the other, or it may be a magnetic state, depending upon neither one cause nor the other. It will be convenient to speak of the magnetic state of the north pole of the compass needle as positive, indicating it by the sign +, and of that of the south pole as negative, indicating it by the sign −.

The pointing of the magnetised needle appears to be, the direction it takes up in obedience to the law of attraction and repulsion existing between it and the larger magnet, the earth. Also, the increasing strength, with which the needle is found to point as the latitude increases, appears due to the approach to the magnetic poles of the earth.

By the law of induction, a magnet when brought near to any piece of unmagnetised iron, induces magnetism therein; the near pole of the magnet, and the proximate part of the iron, having magnetism of opposite kinds. The similar magnetism to that of the near pole of the magnet is found in a remote part of the iron. Applying this law to the earth as a large magnet, the magnetism of iron and iron structures is apparently due to induction from the earth, and the end or part of iron which is towards the north will have positive magnetism.

In dealing with the magnetism of iron ships, this property of induction, hitherto little thought about by seamen, becomes of great importance. The earth's magnetic force, by inducing magnetism in the iron of a ship, is the source of all magnetic disturbances of the compass.

236. The question as to how the earth became magnetised will perhaps come into the mind—possibly it is, or was, magnetised by induction, from some far distant cause. But magnetism may be induced by electricity. If an insulated wire is passed round a piece of iron, and the wire be considered as conveying an electric current flowing from positive to negative, the iron will become magnetised, and have positive and negative powers, as shown in the figure.




If the trade winds flowing round the earth from the eastward, be considered as acting as a positive electric current, the earth would be magnetised with a negative pole to the north, and a positive pole to the south. Whether it is thus magnetised or not, the idea will aid the memory as to the magnetic state of the earth, show how magnetic forces may be generated by electricity, and suggest the possibility of compass disturbance, by the increasing use of electricity on board ship.

237. All iron is capable of receiving magnetism by induction from the earth. If the iron remain a long time in the same position, or if it be hammered or subjected to mechanical violence, part of the induced magnetism will remain. That is, the iron will show polarity in the same parts, after it has been moved into another position, relatively to the line of the earth's force.

All magnetism, therefore, may be called induced magnetism. That which instantly passes away, when the inducing cause no longer acts, is called transient magnetism. That which remains for a longer or shorter time, is generally called permanent magnetism. The term permanent, in this extended sense, means all magnetism that is not transient. The terms trans-permanent, sub-permanent, and permanent, may be used to indicate increasing degrees of permanency, if desired. It is, however, a question whether anything is gained by thus multiplying terms, as no definite line of separation can exist.

Speaking generally, iron will receive or part with magnetism more or less readily, according as it is soft or hard. Hard iron or steel, when magnetised, will retain its polarity for a very long time.

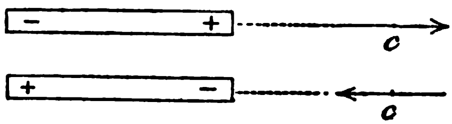
238. The disturbing effects of iron on a compass, being caused by magnetism induced in the iron by the earth's magnetism, the possibility of so placing iron about a compass on board ship as to counteract the effect of the iron of the ship, is the problem of compass adjustment.

Professor Barlow was the first to deal practically with compass adjustment, and the problem was subsequently completely solved by Professor Airy in 1839. That gentleman gave the results of his researches and experiments in the following words: 'By

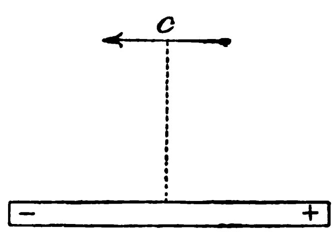
placing a magnet so that its action will take place in a direction opposite to that which the investigations show to be the direction of the ship's independent magnetic action, and at such a distance that its effect is equal to that of the ship's independent magnetism, and by counteracting the effect of the induced magnetism by means of the induced magnetism of another mass [according to rules which are given], the compass may be made to point exactly as if it were free from disturbance.' Briefly, this statement is to the effect, that the permanent magnetism of the ship may be counteracted by the permanent magnetism of steel magnets, and the transient magnetism of the ship by the transient magnetism of iron; the magnets and iron being placed near the compass, according to definite rules.

In order to be able to consider together, the disturbing effects of the iron of the ship on the compass, and the action of magnets and iron in counteracting the same, a brief explanation of the latter is necessary.

239. Magnets, when used to adjust a compass, are applied, generally, either end on, or, as it has been termed, broadside on. If a magnet be placed near a compass, so that the centre of the needle is in the line of the magnet, the effect of the magnet is to cause a force pushing away the north point of the needle, if the positive end of the magnet is presented, and drawing the north point of the needle towards the magnet, if the negative end is presented. In the figure, if *c* represent the centre of the compass needle, the arrows represent the direction of the force on its north end. This is called the end-on position of the magnet.




If a magnet be placed near a compass, so that the centre of the needle is in the same plane as the magnet, and on a line drawn from the middle of the magnet, perpendicular to its direction, the effect of the magnet is to cause a force parallel to itself, pushing the north end of the needle away from the positive end of the magnet. In the figure, if *c* be the centre of the compass needle, the arrow shows the direction of the force on its north end. This is sometimes called the broadside position of the magnet.



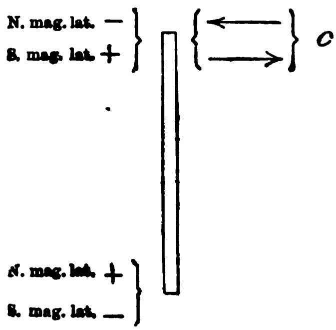

Magnets used for compass adjustment are made of hard steel, and well magnetised. Their magnetism may be considered as permanent. Thus, by means of a magnet, a permanent magnetic force can be produced, pushing the north end of the compass needle in any desired direction.

240. The iron used in adjusting compasses should be soft malle-

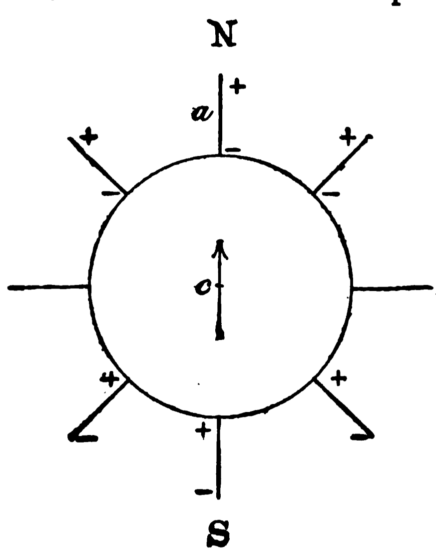
able iron, so that magnetism is readily induced therein by the earth's force, and readily parted with; that is, it does not become permanent.

It is used for two purposes. For one purpose, it is in the form of an upright bar, placed, generally, before or abaft the compass. For another purpose, masses of chain or scrap iron in boxes, cylinders, or spheres, are used. These are placed beside the compass, on the same level as the needle.

241. The action of the upright bar depends upon the earth's vertical force. In north magnetic latitude, the lower end has positive magnetism, and the upper end negative magnetism. On the magnetic equator the bar may be considered as unmagnetised. In south magnetic latitude, the lower end has negative magnetism, and the upper end positive magnetism. Therefore a magnetic force in any direction can be produced, acting on the north end of the compass needle, varying in strength with the earth's vertical force, by placing the upper end of the bar in a suitable position. It is generally desired to make this force horizontal, as shown in the figure, where *c* is the centre of the compass needle. After Captain Flinders, R.N., who was the first to propose this, or, indeed, any mode of counteracting the effect of the ship's iron on the compass, iron thus used is called a Flinders bar.




242. The action of iron placed beside a compass, is not quite so simple as that of the Flinders bar. In the fig. let *c* be the centre of the compass needle, and the circle the outer circumference of the binnacle. Let *a* represent a horizontal iron rod, placed radially north of the centre of the compass. In this position it will be magnetised by induction from the earth—the north end of the rod with positive magnetism, and the south end with negative magnetism. It will cause no deflection of the needle, because the force is in the line of the needle. It will, however, increase the force with which the needle points.



Conceiving the rod to be moved round the needle to the right, as the spokes of a wheel move round its centre, it will be seen that the amount of magnetism in the rod will diminish as it goes round, till in the east position it may be considered as without magnetism. But as the rod leaves the north position, so the magnetic force of the rod, by being inclined to the needle at a greater angle, has a greater proportional effect in deflecting it. From the combined action of these two causes, the maximum deflection of the needle occurs when the rod is in the N.E. position.

Following the rod round, and noting the magnetism induced therein by the earth's magnetism, and the effect of the magnetic force, thus generated in the rod, in deflecting the needle, the following results will appear:—

Rod North or South of the centre of the needle. Increase of force, no deflection of the needle.

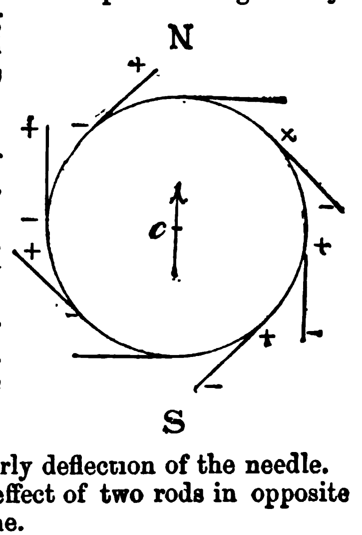
Rod N.E. or S.W. Increase of force, maximum easterly deflection of the needle.

Rod East or West. No effect on the needle.

Rod S.E. or N.W. Increase of force, maximum westerly deflection of the needle.

Thus it will be seen, that the effect of the rod is to cause a deflection of the needle, easterly and westerly in alternate quadrants, and to increase the mean magnetic force. It will also be seen, that the effect of two rods opposite to each other, is to double the effect of one.

243. Another instructive example of the effects of iron moving round a compass is that of a similar rod placed tangentially. Following the rod round, and noting the magnetism induced therein, and the effect thereof on the compass needle, as in the figure, the following results will be seen:—




Near end of the rod North or South of the centre of the needle. No effect.

Near end of the rod N.E. or S.W. of the centre of the needle. Westerly deflection of the needle.

Near end of the rod East or West of the centre of the needle. Maximum westerly deflection of the needle.

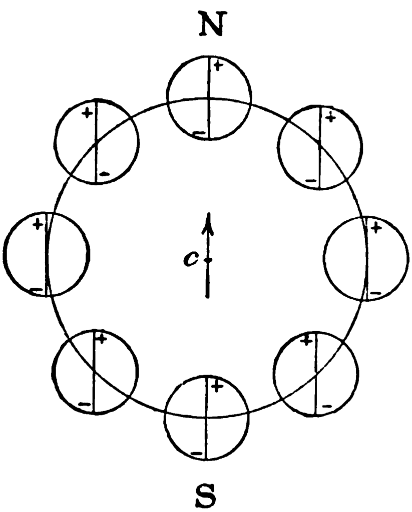
Near end of the rod S.E. or N.W. of the centre of the needle. Westerly deflection of the needle.

In this example, as in 242, the effect of two rods in opposite positions is to double the effect of one.

When two rods thus placed tangentially, having their near

ends at North and East, or in any positions 90° apart, revolve about the compass together, one rod will cause a maximum deflection of the needle, when the other rod has no effect thereon. As the effect of one rod increases, the effect of the other decreases; and the combined effect of the two rods, thus revolving together, is a constant westerly deflection of the needle. If the rods are placed in the opposite direction from their point of contact with the circle, similar easterly deflections will be produced.

The iron rod has been here used as an example, because the effects can be most simply shown thereby; but other forms of iron (240) are generally used in adjusting compasses, to produce the same effects. Hollow iron spheres are used with Sir William Thomson's compass. Their action is that of a rod of the length of the diameter of the sphere, always standing in the line of the earth's magnetic force, and magnetised thereby. In the figure, where *c* is the centre of the compass needle, it will be seen that the horizontal force of the spheres deflects it, and affects its pointing force, in the same manner as the iron rod in 242. When east and west of the centre, however, spheres diminish the directive force on the needle, more than the forms of iron commonly used.




Having briefly examined the means employed to counteract the ship's magnetic forces, the origin and effect of those forces, and the mode of applying the counteracting means, may now be considered.

244. An iron ship, in the course of construction, stands in the influence, or field as it is termed, of the earth's magnetism, and is consequently magnetised by induction. In north magnetic latitude, all upright iron structures, such as stern-post and frames, have positive magnetism in their lower ends, and negative magnetism in their upper ends. In south magnetic latitude, these conditions are reversed. In all latitudes, horizontal iron structures, such as beams and keel, have positive magnetism in their northern ends, and negative magnetism in their southern ends. The ship throughout is, in course of building, permeated with magnetism in the direction of the inducing force. Part of the magnetism thus acquired in building remains after the ship has been launched, causing a permanent magnetic force, in some direction in the ship.

This force tends to draw the north point of the compass towards that part of the ship which was south in building.

Besides this permanent magnetism, the ship, as she subsequently turns about with her head in different directions, takes up magnetism according to her varying positions. The amount of magnetism iron will thus receive by induction, within the limits of the change in the earth's force, varies as that force; the ends of beams, and other parts of the ship's structure, which are towards the north having positive magnetism, which changes and becomes negative when the direction of the ship's head is reversed. It is evident, however, that vertical iron will have magnetism which does not depend on the direction of the ship's head, but which will vary, in character and value, with the earth's vertical force only.

245. From these premises it will be seen, that there must be always a Constant force, and a Variable force, acting on the compass needle as the ship goes round. Therefore, if the direction and value of these forces are known, together with the law which governs the change in the variable force, the deviation of the compass could be found without swinging the ship. Generally, it is easier to deal with the deviation than with the forces which cause it; but a knowledge of the manner in which these forces act, facilitates very much the construction of a deviation table. Considering the commercial value of time, in all matters relating to shipping, this is a subject of no small importance.

246. It has been stated, that part of the magnetism acquired in building causes a constant force, in some direction, in the ship. The amount of deviation any force is capable of producing must decrease, as the force with which the needle points increases. Therefore, the deviation caused by the ship's permanent magnetism varies inversely as the earth's horizontal force.

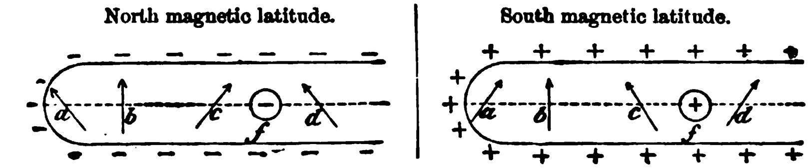
It is also clear, that, if the direction of the ship's permanent magnetic force is known, a permanent force by means of magnets (239) might be produced to counteract it; and if this magnetism of the ship, and of the magnets, were equally permanent, the adjustment would be perfect for all time and places.

The transient magnetism of vertical iron also causes a force which is constant in direction and value, as the ship goes round. This force, however, changes with change of place, as it depends on the earth's vertical force for its value. The liability of the needle to be deflected thereby varies inversely as the horizontal force. Therefore, the deviation caused by the transient magnetism of vertical iron will vary as,

$$\text{ver. force} \times \frac{1}{\text{hor. force}} = \text{tan. dip}$$

247. The following diagram will show how the compass is affected by the transient magnetism of vertical iron, and the manner in which Flinders' bar (241) counteracts that effect.

AFTER PART OF SHIP'S UPPER DECK. HEAD EAST.




In north magnetic latitude, the upper part of the ship's frames having negative magnetism, a compass in the position (*a*) would have its north point drawn to the westward. In south magnetic latitude, it would be drawn to the eastward. It is certain that no fixed magnet would meet this change. A Flinders bar, however, might be placed before the compass, so that its magnetism would exactly counteract that of the stern frames. The magnetism of the bar would change, exactly as that of the stern frames, when the ship went into south magnetic magnitude.

At a position (*b*), generally rather more than one-third of the distance between the stern and the funnel (*f*), the magnetism of the upper part of the boilers and funnel counteracts that of the stern frames, so that no bar is required.

At the position (*c*), the bar would be required abaft the compass; at the position (*d*), before the compass.

The position (*b*), when not otherwise objectionable, is chosen for the position of the standard compass in the Royal Navy. The position (*d*), being more convenient, is commonly used in the Mercantile Navy.

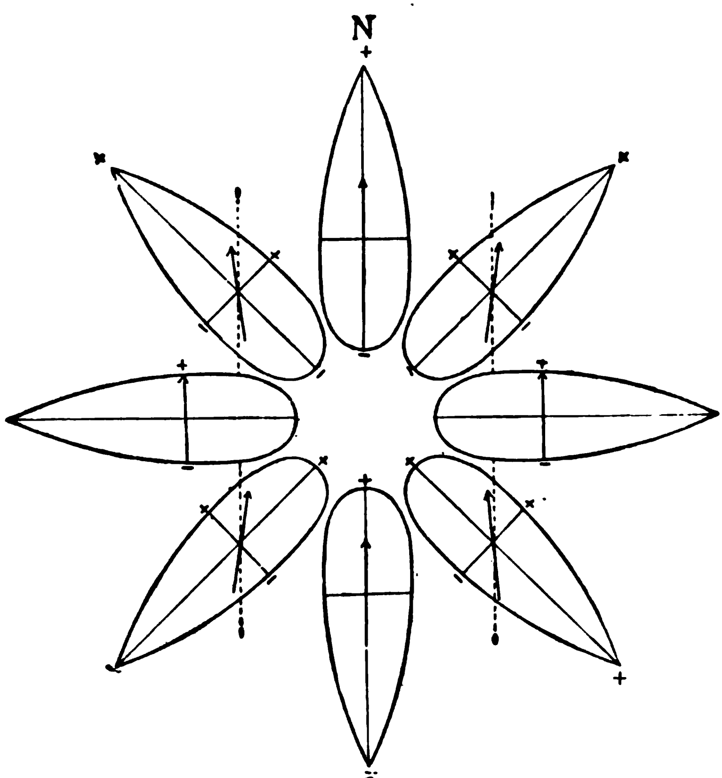
If a compass were placed out of the middle line, its north point would be drawn to the near side of the ship in north magnetic latitude, and repelled therefrom in south magnetic latitude. This effect would have its maximum value when the ship's head is north or south; and the Flinders bar must be towards the middle line, to counteract it.

248. The horizontal forces, from permanent magnetism and the transient magnetism of vertical iron, cause a deviation which is zero when the direction of the ship's head is such that the resultant of these forces is in the north and south line; and a maximum deviation when that resultant is in the east and west line. This deviation, from being easterly through one semicircle, and westerly through the other, is called the Semicircular Deviation.

In correcting the semicircular deviation, such magnets as are commonly used should not be brought nearer than twice their length to the compass needles. And Flinders' bar should not be so near to the compass needles, or correcting magnets, as to receive magnetism by induction from them.

249. When the semicircular deviation has been got rid of, by

the means shown, there remains the deviation caused by the variable force. This force comes from the transient magnetism of horizontal iron; or, from the transient magnetism induced by the earth's horizontal force, in iron in any position. It causes a deviation which has four equidistant zero points, and is alternately easterly and westerly, in the intervening quadrants. It is for this reason called Quadrantal Deviation. The following diagram will show how it is caused, and why it takes that form.




Let the figures in the diagram represent the upper deck of a ship, in the several positions, and the fore-and-aft and thwartship lines thereon represent the horizontal magnetic axes of the ship, passing through the centre of the compass. Considering the magnetism of these axes to be positive in the ends presented to the north, it will be seen that, with the ship's head north, there will be no deviation; with the head N.E., the thwartship magnetism tends to deflect the needle to the right, while the fore-and-aft

magnetism tends to deflect it to the left. From the proximity of the poles of the thwartship magnetism, as compared with the poles of the fore-and-aft magnetism, the deviation is always easterly.

It is as well, however, for the student to recognise the possibility of its being westerly, as in the case of a very flat vessel, where the compass might be placed not much above the screw-shaft, or keel.

Following the vessel round in the several positions, it will be seen that there is a deviation, alternately easterly and westerly, having its zero points when the ship's head is on the cardinal points; and that there is always a diminution of the pointing force of the needle. No. 242 shows, that a quadrantal deviation of this kind could be corrected, and the pointing force of the needle increased, by placing iron on each side of the compass, directly athwartships.

The compass might be so placed, with reference to the iron about it, especially if it were out of the middle line of the ship, that the magnetic axes would be oblique in the ship. In that case, the zero points of the quadrantal deviation would not be at the cardinal points. No. 242 shows that any quadrantal deviation can be corrected, by placing iron beside the compass, at the same angle from the ship's head, as the zero points which have easterly quadrantal deviation on their left, are from the north point of the compass.

250. Besides the semicircular and quadrantal deviations, there is sometimes a residual deviation, which has the same value in whatever direction the ship's head may be, and is therefore called the Constant Deviation. No. 243 shows that if a compass were placed near iron, such as bulkheads, in somewhat the relative position of the corrector there shown, a positive or negative constant deviation might be caused, and that either one or the other can be corrected, by correctors placed tangentially.

251. Reverting to the force which is in some fixed direction in the ship, the deviation caused thereby must be the same in amount, but contrary in sign, when the ship's head is in opposite directions; or, when the deviation is small, in opposite directions by compass.

Looking at the cause of the variable force, whatever may be the position of iron about a compass, that force will be the same when the ship's head is in opposite directions. The deviation caused thereby will also be the same in amount, and have the same sign, when the semicircular deviation has been corrected, or is small.

These facts show how the deviation caused by the variable force may be separated from that caused by the constant force. Let the deviation on each point of the compass be tabulated in the following form:

| Head | Deviation | Head | Deviation | Column I. | Column II. | Column III. |
|---|---|---|---|---|---|---|
| | ° ′ | | ° ′ | ° ′ | ° ′ | ° ′ |
| North | 0 0 | South | 8 0 E. | 4 0 E. | 0 05 W. | 1 57 E. |
| N. b E. | 4 20 E. | S. b W. | 8 30 E. | 6 25 E. | 2 0 W. | 2 12 E. |
| N.N.E. | 6 40 E. | S.S.W. | 8 30 E. | 7 35 E. | 3 35 W. | 2 0 E. |
| N.E. b N. | 8 50 E. | S.W. b S. | 7 40 E. | 8 15 E. | 4 25 W. | 1 55 E. |
| N.E. | 10 0 E. | S.W. | 6 0 E. | 8 0 E. | 4 05 W. | 1 57 E. |
| N.E. b E. | 10 20 E. | S.W. b W. | 3 10 E. | 6 45 E. | 2 50 W. | 1 57 E. |
| E.N.E. | 9 50 E. | W.S.W. | 0 20 W. | 4 45 E. | 0 40 W. | 2 02 E. |
| E. b N. | 8 10 E. | W. b S. | 3 50 W. | 2 10 E. | 1 40 E. | 1 55 E. |
| East | 7 0 E. | West | 7 10 W. | 0 05 W. | | 8)15 55 E. |
| E. b S. | 5 40 E. | W. b W. | 9 40 W. | 2 0 W. | | |
| E.S.E. | 4 30 E. | W.N.W. | 11 40 W. | 3 35 W. | Constant deviation | 2 0 E. |
| S.E.E. | 3 40 E. | N.W. b W. | 12 30 W. | 4 25 W. | | |
| S.E. | 3 40 E. | N.W. | 11 50 W. | 4 05 W. | | |
| S.E. b S. | 4 0 E. | N.W. b N. | 9 40 W. | 2 50 W. | | |
| S.S.E. | 5 30 E. | N.N.W. | 6 50 W. | 0 40 W. | | |
| S. b E. | 6 50 E. | N. b W. | 3 30 W. | 1 40 E. | | |

Take half the sum of the deviations, on each pair of opposite points, and insert it, with its proper sign, in column I. From what has gone before, this must be the deviation caused by the variable force, on each of the two points. That is, on the north and south points, there is 4° easterly deviation, on N. b E. and S. b W., 6° 25′ E., on N.N.E. and S.S.W., 7° 35′ E., from that force. So the deviation caused thereby can be ascertained on every point of the compass.

To find how much of column I. has the same value on every point, bring up its lower half into column II. Insert half the sum of the values in columns I. and II., with its proper sign, in column III. Each value in this column will be that of the mean of the deviation on four points 90° apart, and should be equal to each other, and to the mean constant deviation 2° 0′ E.

The deviation in column I., made up of the quadrantal and the constant deviations, has the same value in all parts of the world. Because, the disturbing force and the pointing force of the needle vary together, both depending on the earth's horizontal force. It also changes but little with time, losing about ·05 of its value in a year, owing to the fact that iron slowly loses its capacity for receiving magnetism by induction. It may be worth noting here, that this quantity has nearly the same value, at compasses similarly placed, in ships nearly alike.

The correction by soft iron is also perfect for all time and places, if the magnetism of the correctors is derived from the earth's force only; but when the correctors are placed so near to compass needles, as to receive magnetism by induction from them, though it adds to their power as correctors, the correction is to that extent imperfect, the correctors having less effect when the horizontal force is increased. The soft iron correctors should on no account be less than the length of the needles, from their ends.

252. When a compass is placed on the upper deck, in the middle line of the ship, with the iron in about the same relative position on each side of it, and the usual height for taking bearings, the maximum quadrantal deviation is about 6° in a new iron ship. Its zero points are at the cardinal points, and there is no constant deviation. In compasses placed in very unfavourable positions, the constant deviation has amounted to 12°, and the quadrantal deviation to 24°, and possibly more.

It is not customary to correct the constant deviation by soft iron, as it occurs generally only in compasses not required for taking bearings. To meet it, the binnacle, or the compass in the binnacle, or the lubber-line itself, is so placed, that it points the value of the constant deviation, on the starboard bow, when positive, and on the port bow when negative. Thus, a course steered by a compass, having the lubber-line so placed, is unaffected by the constant deviation.

If the quadrantal and constant deviations were not corrected, or were only partially corrected, column I. (251), the sum of their values might be tabulated on each point of the compass, whenever opportunities occur of swinging the ship completely round. Bearing in mind what has been said (No. 251), this quantity should soon become very exactly known, leaving only the semicircular deviation to be ascertained.

253. The horizontal forces causing the semicircular deviation, are best considered as resolved in the fore-and-aft and in the athwartship directions. The fore-and-aft force causes a maximum deviation, when the ship's head is east or west. The athwartship force causes a maximum deviation, when the head is north or south. Looking at the deviation table (No. 251), and allowing for the value in column I., it is evident that in this case there is a force towards the ship's head, capable of producing a maximum deviation of 7° 5′, and that there is a force towards the ship's port side, capable of producing a deviation of 4°. Therefore, to adjust this compass, a force must be produced by magnets, or Flinders' bar, or both, towards the stern, leaving 5′ westerly deviation on the east and west points; and towards the starboard side, leaving 4° easterly deviation on the north and south points. These residual quantities must be corrected by the means already explained, Nos. 249, 250.

Hence the law for correcting the semicircular deviation. Make the deviation zero on any two adjacent cardinal points. If it is known, or, from the position of the iron about the compass, suspected, that there is deviation on those points from the variable force, then the ship's head must be placed on the opposite cardinal points also, and half the deviation found thereon taken out.

254. The question naturally arises, as to how much of the semicircular deviation should be taken out by magnets, and how

much by Flinders' bar. At first, there is no other guide than the position of the compass (No. 247); but when a ship has gone into positions where there is much change in dip and horizontal force, a better judgment can be formed. At the magnetic equator, there can be no transient magnetism in vertical iron; all the semicircular deviation there found, must be caused by the ship's permanent force. Hence if, near the magnetic equator, the semicircular deviation be corrected by magnets, any deviation subsequently found, arising from change of place, should be corrected by Flinders' bar.

From the fact (No. 246) that one part of the semicircular deviation varies inversely as the horizontal force, and the other part as the tangent of the dip, the value of each of these parts can by ascertained, if the deviation is observed in two magnetic latitudes.

*Example.*—The steamship *Scotia*, having a standard compass in position *d* (No. 247), corrected by magnets in the Thames, soon after, in latitude 30° S., longitude 16° E., found 12° easterly deviation on the east point, and 10° westerly on the west point. How much of the deviation on those points should be corrected by Flinders' bar?

From map 232, and table 233:—

Thames, dip $67\frac{1}{2}°$; Nat. tan. of dip 2·42; Hor. force ·48.

$\left.\begin{array}{l}\text{Lat. } 30° \text{ S.}\\ \text{Lon. } 16° \text{ E.}\end{array}\right\}$ dip − 51°, Nat. tan. of dip − 1·24; Hor. force ·54.

Let P = the deviation from permanent magnetism,
and T = the deviation from transient magnetism of vertical iron.

(1) Thames . $\dfrac{P}{\cdot 48} + T \times 2\cdot 42 = 0.$

(2) $\left.\begin{array}{l}\text{Lat. } 30° \text{ S.}\\ \text{Lon. } 16° \text{ E.}\end{array}\right\}$ $\dfrac{P}{54} + T \times -1\cdot 24 = 11°$ semicircular on east point.

From (1) $P = -1\cdot 16\,T$,
substituting in (2) $-3\cdot 39\,T = 11°$ semicircular on east point.

Therefore $T = -\dfrac{11°}{3\cdot 39} = -3\cdot 25°$ on east point.

In the Thames . $-3\cdot 25° \times 2\cdot 42$ (the tan. of dip) $= -7\frac{3}{4}°$.
Lat. 30° S., Lon. 16° E. $-3\cdot 25° \times -1\cdot 24$ (the tan. of dip) $= 4°$.

Therefore, a Flinders bar should be placed before the compass, capable of deflecting the needle $7\frac{3}{4}°$ in the Thames, and 4° at the southern position. These deflections, from the magnetism of the bar, will be in opposite directions, and will exactly correct the deviation caused by the transient magnetism of vertical iron. Clearly, the magnetism of the funnel, in this case, draws the north point of the needle aft, in north magnetic latitude; and forward, in south magnetic latitude. A convenient form of Flinders' bar is fitted to the binnacle of Sir Wm. Thomson's compass.

255. The value of the semicircular deviation, on the east or west point, is a key to the value of the deviation caused by the

force in the fore-and-aft line, on every point of the compass. Similarly, the value of the semicircular deviation, on the north or south point, is a key to the value of the deviation caused by the force in the thwartship line, on every point of the compass. As the deviation on any point is made up of that caused by the forces in these two directions, added to that caused by the variable force, it is evident, that if the latter be known (No. 252), and the semicircular deviation be ascertained on two adjacent cardinal points, the deviation table can be completed.

When the semicircular deviation is small, the following table will be useful for that purpose:—

| Semicircular deviation on any cardinal point | Semicircular deviation caused by the same force, on each point, reckoned right and left from that cardinal point, through the adjacent quadrants | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1st | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th |
| ° | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ |
| 1 | 0 59 | 0 55 | 0 50 | 0 42 | 0 33 | 0 23 | 0 12 | 0 0 |
| 2 | 1 58 | 1 51 | 1 40 | 1 25 | 1 7 | 0 46 | 0 23 | 0 0 |
| 3 | 2 57 | 2 46 | 2 30 | 2 7 | 1 40 | 1 9 | 0 35 | 0 0 |
| 4 | 3 55 | 3 42 | 3 20 | 2 50 | 2 13 | 1 32 | 0 47 | 0 0 |
| 5 | 4 54 | 4 37 | 4 9 | 3 32 | 2 47 | 1 55 | 0 59 | 0 0 |
| 6 | 5 53 | 5 33 | 4 59 | 4 15 | 3 20 | 2 18 | 1 10 | 0 0 |
| 7 | 6 52 | 6 28 | 5 49 | 4 57 | 3 53 | 2 41 | 1 22 | 0 0 |
| 8 | 7 51 | 7 24 | 6 39 | 5 39 | 4 27 | 3 4 | 1 34 | 0 0 |
| 9 | 8 50 | 8 19 | 7 29 | 6 22 | 5 00 | 3 27 | 1 45 | 0 0 |
| 10 | 9 48 | 9 14 | 8 19 | 7 4 | 5 33 | 3 50 | 1 57 | 0 0 |

*Example.*—The deviation (table 251) having been observed to be 8° 0′ E. on the south point, and 7° 10′ W. on the west point, what is the deviation on the N.W. b W. point?

The semicircular deviation on the south point, allowing for the value in column I., must be 4° E. It is therefore 4° W. on the north point, and, from the above table, 2° 13′ W. on N.W. b W., five points from north.

The semicircular deviation on the west point must be 7° 5′ W., it is therefore 5° 53′ W. on N.W. b W., three points from west. Therefore the whole deviation on N.W. b W. must be

2° 13′ W. + 5° 53′ W. + 4° 25′ W. (the value in col. I.) = 12° 31′ W.

The semicircular deviation being the same in amount, with contrary signs, on opposite points, the deviation on S.E. b E. is 8° 6′ E. + 4° 25′ W. = 3° 41′ E. In the same manner, the deviation on every point of the compass can be estimated.

There may be circumstances where it would be convenient to ascertain the position of the correctors necessary to apply to a compass, by measuring hor. force (234). The most simple way of looking at the problem is, to consider a ship lying with her head in any known magnetic direction. By placing a horizontal magnet at right angles to the compass needle, and so keeping it, the needle may be made to stand in the direction of the magnetic

meridian. By placing another horizontal magnet in the line of the magnetic meridian, the force with which the needle points may be made equal to the force on shore. Thus, all the forces due to the ship's magnetism, may be counteracted with the ship's head in the one direction. But when the ship's head is moved round, the needle will move away from the magnetic meridian, by reason of the change in the variable force. When the head is in the opposite direction, the deviation will be nearly equal to twice that caused by the variable force, and the needle will point with a force which will differ from the horizontal force on shore, by twice the value of the component of the variable force in the direction of the needle, nearly.

Therefore, to counteract the force which causes the semicircular deviation, the distance of the magnets from the card must be so adjusted, that the needle points with the mean value of the force found with the ship's head in the two directions, and with half the deviation found in the second position.

Another way of dealing with the problem is suggested by considering the following facts. If the force with which the needle points is the same when the ship's head is east and west, there can be no constant force in the athwartship line. If it is the same when the ship's head is north and south, there can be no constant force in the fore-and-aft line. Therefore, when these conditions are fulfilled, there can be no semicircular deviation. Further, if the force is the same on the four cardinal points, there can be no quadrantal deviation.

Working by force is a more delicate operation than working by bearings, and, under the circumstances in which the seaman has generally to work, is scarcely capable of the same degree of accuracy. If advantage be taken of the known direction of docks, wharves, transit and other lines, there will be few occasions where it will be necessary to have recourse to measuring force. But with the two methods available, there should be no detention of ships in port for the purpose of compass adjustment.

256. Hitherto the effects of the vertical component of the ship's forces have not been considered, because a vertical force cannot deflect the compass-needle, right or left. But when a ship heels, a force previously vertical may be no longer so, and the position of the iron about a compass may be so changed, as to introduce a new magnetic force. The deviation, caused by this change in a ship's magnetic forces, is called the Heeling Error. To estimate or correct the heeling error with theoretical accuracy is not an easy problem; especially in certain positions in a ship, and with the semicircular deviation uncorrected. The following remarks must be considered as applying to a compass, in such a position as is usually selected for a standard compass, and having the semicircular deviation corrected. At a compass so situated, there will be a force upwards or downwards in the ship, caused by per-

manent magnetism. The value of this force will depend, mainly, upon the direction in which the ship was built, and the position of the compass in the fore-and-aft line. It may be counteracted by a magnet placed end on (239), and vertically below the centre of the compass. If it is not counteracted, it will, by coming partly on one side when the ship heels, draw the north point of the compass to one side or the other.

There will also be a force upwards or downwards in the ship, from the transient magnetism of vertical iron, depending for its value on the earth's vertical force, of which it is a constant fraction. This force, in north magnetic latitude, is that of a negative pole under the compass, changing to positive in south magnetic latitude, drawing the north point of the needle to the high side of the ship in the former case, and to the low side in the latter. This force evidently should not be counteracted by a fixed magnet, but by a bar of soft iron, having, in north magnetic latitude, negative magnetism in the end nearest to, and above, the compass. ·05 of the earth's vertical force is about a mean value of the vertical force caused by induction therefrom; therefore, in correcting the heeling error by a vertical magnet, the vertical force of the earth and ship should be brought to about 1·05 of the earth's vertical force, wherever the ship may be.

Sometimes the position of the funnel, or an iron mast, may be such, that its vertical transient magnetism counteracts that of the ship; this will probably be the case in a compass in such a position as *d* (247). Or it may be counteracted by putting the upper end of the Flinders bar, where one is used, above the level of the compass.

Looking at the magnetic condition of athwartship iron, such as beams, passing under the compass, when, from the ship heeling, it departs from the horizontal position, it is evident that the higher ends will have negative magnetism, drawing the north point of the compass-needle to the high side of the ship in north magnetic latitude. The reverse of this takes place in south magnetic latitude, therefore this force should not be counteracted by a fixed magnet.

If a soft iron bar were placed horizontally athwartship, on each side of the compass, the magnetism induced therein would, if they were of suitable size and distance from the compass needle, exactly counteract the magnetism induced in the athwartship iron of the ship. This condition is nearly fulfilled by soft iron so placed as to correct the quadrantal deviation, so that no separate corrector is required for this part of the heeling error.

Because the transient magnetism of horizontal fore-and-aft iron, below the compass, causes a vertical force which is zero when the ship's head is east or west, it is desirable to correct the heeling error when the ship's head is nearly on those points. Then, if the quadrantal deviation is corrected, and the vertical

force brought by a magnet to the same value as, or a little more than, the vertical force on shore, the heeling error will be practically corrected.

The forces which cause the heeling error, by drawing the north end of the needle to one side or the other, must have their maximum effect when the ship's head is north or south. When the ship is rolling, the north end of the needle being drawn to each side alternately, causes the card to be unsteady. This disturbance of the compass-card has probably been more trouble to the navigator, than the error produced by heel.

Thus, in dealing with compass deviation, there are two distinct problems: one, to ascertain its amount; the other, to get rid of it altogether. At first sight, one or the other of these processes appears unnecessary, and in the early days of iron ships some thought that, with a table of deviation, there was no need for correctors; others that, if the compass were corrected, there was no need for a table of deviation. Experience has long since shown that neither of these views was correct. Many iron ships could not be navigated unless the compass was, at least, partly corrected. On the other hand, though compasses are frequently so well adjusted as to be without deviation, there are small changes subsequently which cannot be safely disregarded, rendering a deviation table necessary.

Changes which are gradual can be met by the ordinary daily observations, which should never be omitted; but there are some changes which are sudden, against which the seaman must be on his guard. If a ship has been steering for some time on one course, she will acquire negative magnetism in the part of the ship towards the south. On first altering course, the north point of the compass is likely to be drawn, for a short time, towards that part of the ship which was previously south. This is especially the case in changing from courses near east or west to those near north or south. Of course, the same effects follow when a ship has been some time in dock.

Thin iron structures, such as funnels, funnel casing, or ventilating cowls, are liable to change their magnetic state from strains or concussion, and so affect the deviation of a compass placed near. Any shock or strain which causes iron to vibrate or bend, and so cause movement in its particles, facilitates magnetic change.

With the introduction of electric lighting on board ship, came a new form of compass disturbance. The magnetism of the large electro-magnets, in the dynamos at present used, may disturb a compass at the distance of sixty feet. Also, circling round the wires conducting electricity, and at right angles to their direction, is a magnetic force, going in one direction round the wire conducting the direct current, and in the opposite direction round the wire conducting the return current. Thus these forces counteract each other when the conducting wires

are together, but when they are separated cause a proportional disturbance to the compass.

The maximum value of this disturbance, for any speed of the dynamo, is apparent directly the dynamo is started at that speed. So, by starting and stopping the dynamo, with the ship's head on two adjacent cardinal points, and noting the effects, the value of the disturbance on every point of the compass can be ascertained. Table 255 will be useful for this purpose.

257. A method of measuring the effects of a ship's magnetic forces, in causing deviation, was introduced by the late Mr. Archibald Smith. He found that the deviation could be expressed, as in the following equation :—

$$\left.\begin{array}{l}\text{Deviation with ship's head on}\\ \text{any point} \quad . \quad . \quad . \quad .\end{array}\right\} = A + B\,.\,\sin\zeta' + C\,.\,\cos\zeta' + D\,.\,\sin 2\zeta' + E\,.\,\cos 2\zeta'.$$

The factors A, B, C, D, E, are called coefficients, and $\zeta'$ is the direction of the ship's head by compass, reckoned round the circle to the right. Therefore, in dealing with the equation, the seaman, who generally has to deal only with angles not greater than a right angle, must consider the sign of the direction of the head, as well as that of the coefficient, in each term.

A, the first term in the expression, is the value of the constant deviation (250). It may be found by taking the sum of the deviation on the four cardinal points, and dividing it by four.

B is the maximum value of the deviation caused by the force in the fore-and-aft line (253). It is + when the force is towards the ship's head, and − when towards the stern. It may be found by adding to the deviation on the east point, the deviation on the west point with its sign changed, and taking half that sum. Any constant force in the fore-and-aft line, which causes this deviation, must cause a deviation $= B\,.\,\sin\zeta'$, the second term of the expression, on every point of the compass.

C is the maximum value of the deviation caused by the force in the athwartship line (253). It is + when the force is towards the ship's starboard side, and − when towards the port side. It may be found by adding to the deviation on the north point, the deviation on the south point with its sign changed, and taking half that sum. Any constant force in the athwartship line, which causes this deviation, must cause a deviation $= C\,.\,\cos\zeta'$, the third term in the expression, on every point of the compass.

D is the mean value of the deviation on the inter-cardinal points, caused by the variable force (249). It may be found by adding to the deviation on the N.E. and S.W. points, the deviation on the S.E. and N.W. points with the sign changed, and taking the fourth part of that sum. A force varying regularly, and causing this deviation, must cause a deviation $= D\,.\,\sin 2\zeta'$, the fourth term of the expression, on every point of the compass.

E is the mean value of the deviation on the cardinal points,

caused by the variable force (249). It may be found by adding to the deviation on the north and south points, the deviation on the east and west points with the sign changed, and taking the fourth part of that sum. A force varying regularly, and causing this deviation, must cause a deviation $=$ E . cos $2\zeta'$, the fifth term of the expression, on every point of the compass. The existence of the E shows that the axes are oblique (249).

It is obvious that the foregoing statement of the effect of the forces in causing deviation is true only when each force is the only disturbing force on the needle; it is true enough when those forces are small: in that case the resulting deviation is also small, and the sum of the five terms is equal thereto; when the deviation is large, the coefficients must be determined with more exactness. With such deviations as are usually found, since the general adoption of compass adjustment, the method here given is sufficiently exact.

The student must not consider the coefficients as forces, or as in any way causing the deviation; they merely measure it, with more or less exactness. And by their means the parts of the deviation can be particularised, in speaking and in writing, and a record of its value kept in five terms, of which two are generally zero. Excepting for this purpose, the treatment of the subject by coefficients, especially laborious methods of determining their exact values, and of deriving the ship's magnetic forces therefrom, has never been greatly esteemed by navigators.

258. Professor Airy made use of the terms Red and Blue, to indicate the two kinds or states of magnetism, of the north and south ends of the compass needle respectively. These terms have been of great use, especially in making clear, by coloured diagrams, the distribution of magnetism in iron ships. The terms positive and negative have been used in this chapter, being in accord with the terms used in the kindred science of electricity, which is daily becoming of more importance to seamen.*

The subject of compass deviation and adjustment was thoroughly investigated by a body of scientific men, shipowners, and others, interested in the subject, called the Liverpool Compass Committee. The results of their labours were published, in language intelligible to seamen, in three most valuable reports to the Board of Trade, 1856, 1857, 1861.

* Professor (now Sir) George Biddell Airy, K.C.B., has lived to see his accurate and thoroughly practical method of adjusting compasses, devised half a century ago, overcome all opposition, and be now, and for many years past, universally adopted. He has in other ways furthered the science of navigation, but in facilitating the navigation of iron ships he is pre-eminent.

*The following Notes are the result of recent theory and experience. The numbers refer to Articles in the present edition.*

Art. 215. The method of suspension by india-rubber has been discontinued, owing to its rapid deterioration when exposed to heat and wet.

216. In Lord Kelvin's (Thomson) compasses the outer graduation of the numerals is inverted in the Navigational or Standard Compass to enable the card to be read direct with the azimuth mirror. The average period of a Thomson's card varies from thirty seconds for a ten-inch card to thirteen and a half seconds for a four-inch one.

219. The Variation at Greenwich was (1899) 16° 34′ westerly, decreasing 7′ annually.

220. The simultaneous appearance of auroras and disturbances of the magnetic needle (magnetic storms) are manifestations of the same cause. The late Father Secchi held that thunderstorms exercised a perceptible influence on the magnetic needle. The disturbing element of land on the compass needle is recognised to be submarine. Theory confirmed by experience show that if the rocks are the upper extremities of a ridge in north magnetic latitudes they would attract and in southern repel, the red (paragraph 239) end of a compass needle.

223. The prefix correct to true, magnetic and compass courses is being discontinued, a true course is a compass one corrected for variation and deviation; a magnetic course, the same corrected for deviation, and a compass course, one uncorrected for variation and deviation.

232. The Dip of the needle at Greenwich was (1899) 67° 10′, decreasing 1′·7 annually.

237. The expression, "magnetism by induction from the earth" is seldom used; the magnetism of both earth and soft iron are produced by the same lines of magnetic force.

239. To avoid ambiguity, the pole of a magnet that attracts the north-seeking end of the needle is called blue and the repelling one red, bearing in mind the pole in the north end of a compass needle is a true south pole, and that in the south end of a compass needle is a true north pole.

244. Read paragraph at 237. Gaussin error is often developed by magnetic induction in a ship's iron beams, more especially when proceeding east and west; in fast Atlantic liners a Gaussin error of 8° to 10° is not unusual during a voyage across the Atlantic.

249. A compass is usually corrected in the following order: the quadrantal error, the heeling error, and lastly the semi-circular error.

256. In merchant vessels arrangements are usually made to place

the navigational compass beyond the magnetic field of the dynamo, but the necessary arrangements in a man-of-war may prevent this being carried out. A compass if within the magnetic field of a dynamo will be disturbed, the error altering with change of azimuth.*

In the general type of dynamo supplied to H.M. ships, designed for 80 volts at the terminals, the minimum distance of a compass should be 60 feet from a 300-ampère machine, increased to 70 feet from a 400-ampère one. A 600-ampère machine being armour-clad and multipolar produces no disturbance on a compass 15 feet away. In the "Destroyers" the correction is made by an electro-magnet at the foot of the compass pedestal, with its poles reversed to those of the dynamo; in second class cruisers (*Apollo* class) by exciting the shunt coils of both dynamos, when only one is in use, the resulting disturbances are neutralised, provided the poles of the dynamos are symmetrical to the middle line.

In the electric lighting of a compass, the current is usually conveyed to a 16 c.p. lamp by a twin cable, protected by phosphor-bronze braiding. The best position is to place the lamp vertically above the axis of the compass needle; occasionally a disturbance arises from the inductive effect due to the current in the filament of the lamp itself.

A small electric light (half-candle power) is found useful for star azimuths at night or if fitted to a sextant for stellar observations.

* For detailed information see *The Mariner's Compass in an Iron Ship*, by Captain J. Whitly Dixon, R.N., sold by J. D. Potter, 145 Minories, London, E.

## II. The Log and Glasses.

### 1. *The Log.*

259. The log consists of the *log-ship* and *line*. The log-ship is a thin wooden quadrant, of about five inches radius; the circular edge is loaded with lead, to make it float upright, and at each end is a hole. The inner end of the log-line is fastened to a reel, the other is rove through the log-ship and knotted; and a piece of about eight inches of the same line is spliced into it at this distance from the log-ship, having at the other end a peg of wood, or bone, which, when the log is hove, is pressed firmly into the unoccupied hole.

At ten or twelve fathoms from the log-ship a bit of buntin rag is placed, to mark off a sufficient quantity of line, called *stray-line*, to let the log go clear of the ship before the time is counted.

260. The log-line is divided into equal portions, called *knots*, at each of which a bit of string, with the number of knots upon it, is put through the strands.

The length of a knot depends on the number of seconds which the glasses measure, and is thus determined:

The No. of feet in 1 knot : No. of feet in 1 mile :: No. of seconds of the glass : 3600 (the No. of seconds in an hour).

The nautical mile being about 6080 feet,* we have, for the glass of 30 seconds, the knot $= \frac{6080 \times 30}{3600} = 50 \cdot 7$ feet, or 50 feet 8 inches, for the glass of 28 seconds, the knot $= \frac{6080 \times 28}{3600} = 47 \cdot 3$ inches, or 47 feet 4 inches; and so for any other glass.

261. The knot is supposed to be divided into eight equal parts, or fathoms (which they are very nearly). In the Royal Navy the knot is divided into tenths and the even fathoms only are reckoned, for the convenience of adding up the distance on the log-board.†

262. The log-line should be repeatedly examined, by comparing each knot with the distance between the nails, which are (or should be) placed on the deck for this purpose, at the proper distance. The line should be wet whenever it is required thus to remeasure it, or to verify the marks.

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* The Geographical Mile is generally defined to be the length of a minute of arc in the earth's equator; but the Nautical Mile as defined by hydrographers is the length of a minute of the meridian, and is slightly different for every different latitude. (*See* Table 64A.) It is equal to a minute of arc in a circle, whose radius is the radius of the curvature of the meridian, at the latitude of the place.

† It is, of course, more systematic to divide the knot or mile into tenths, as in the Traverse Table, instead of eighths; but single tenths and fathoms may be used for each other without sensible error.

263. As the manner of heaving the log must be learned at sea, it is only necessary to remark, for reference, that the line is to be faked in the hand, not coiled; that the log-ship is to be thrown out well to leeward to clear the eddies near the wake, and in such a manner that it may enter the water perpendicularly, and not fall flat upon it; and that before a heavy sea the line should be paid out rapidly when the stern is rising, but when the stern is falling, as this motion slacks the line, the reel should be retarded.

264. (2) *Massey's Log* shews the distance actually gone by the ship through the water, by means of the revolutions of a fly towed astern, which are registered on a dial-plate. This log is highly approved in practice.*

265. When the water is shoal, and the set of the tides or current much affected by the irregularity of the channel, or other causes; and when, at the same time, either the ship is altogether out of sight of land, or the shore presents no distinct objects by which to fix her position, recourse may be had to the *ground log*. This is a small lead, with a line divided like the log-line; the lead remaining fixed at the bottom, the line exhibits the effect of the combined motion of the ship through the water, and that of the water itself, or the current; and therefore the course (by compass) and distance made good are obtained at once.†

*Caution.*—Logs, whether patent or common, are unsatisfactory instruments in these days of high speed. No patent log yet invented will stand the wear and tear of a fast ship for any length of time. To avoid this wear and tear they should be used only when coasting or in with the land. They will tell a different story in a head sea to what they do in a following sea. In slow steamers and sailing ships they are naturally more reliable. Still, logs must be used; but it must be remembered they are beset with *impediments*, and their indications must not be *implicitly* trusted in critical times.

By practice, seamen learn to estimate the rate of progress of the ship closely by the number of revolutions in a given time made by the engines; but this is only speed through the *water*; the sailor has to consider carefully what that *unstable* element has *also* been doing.‡

Further, though ships may now better preserve a given course, and the distance run may be estimated more accurately than formerly, there are in modern iron ships elements of uncertainty about D.R. which still makes it perilous to close the land unless there are means of knowing with some certainty the ship's proximity thereto, especially where land has a bad reputation, as Ushant, C. Finisterre, C. Guardafui, Mocha I. in South America, &c.

* Other logs on this principle have since been invented and are in common use: notably, Walker's taffrail log. They should be well oiled, and stowed away clean.

† In numerous passages up and down the river Plate, where the above circumstances concur, Captain Gordon T. Falcon, in 1818–19–20, made constant use of this log.

‡ *See* Admiralty Current Charts, Tide Tables, and Sailing Directions, Nos. 951, 952.

266. (3) *The Glasses.*—The long glass runs out in 30$^s$ or in 28$^s$; the short glass runs out in half the time of the long one.

When the ship goes more than five knots, the short glass is used, and the number of knots shewn is doubled.

267. The sand-glasses should frequently be examined by a seconds watch, as in damp weather they are often retarded, and sometimes hang altogether. One end is stopped with a cork, which is taken out to dry the sand, or to change its quantity.

268. When either the line or the glass is faulty, or when a line and glass not duly proportioned to each other are employed, the distance run is found as follows:—The number of feet in 1$^h$ is to the number of feet run out in an observed number of seconds, as 3600 (seconds in an hour) are to the observed number of seconds.

Ex. Suppose 190 feet of line are run out in 22$^s$: required the rate.

The number of feet run out in 1$^h$ : 190 :: 3600$^s$ : 22$^s$; hence the number of feet $= \frac{190 \times 3600}{22} = 31090$ feet; which, divided by 6000 (as near enough), gives 5·2 miles.

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# CHAPTER III.

## The Sailings.

I. Plane Sailing, with Traverse, Current, and Windward Sailings. II. Parallel Sailing, with Middle Latitude, and Mercator's Sailings. III. Great Circle Sailing.

269. In considering the place of a ship at sea, with reference to any other place which she has left, or to which she is bound, these five things are involved: the Course, Distance, Difference of Latitude, Departure, and Difference of Longitude.

270. In practice these two general questions occur.

1st. The course and distance from one place in given latitude and longitude to another are given, and it is required to find the latitude and longitude of the other place.

2d. The latitudes and longitudes of two places are given, and it is required to find the course and distance from one to the other.

The methods of solution, that is, the rules of calculation, by which the answers to such questions are obtained, are commonly termed Sailings.

## I. Plane Sailing.

271. In Plane Sailing, as the term implies, the path of the ship is supposed to be described on a plane surface.

If the ship sails 1 mile on a given course, she makes a certain D. lat. and Dep.; in sailing a second mile, on the same course, she

makes good the same D. lat. and Dep. as before. Thus the D. lat. and Dep. for 2 miles of Dist. are twice those for 1 mile; for 3 miles of Dist. they are three times those for 1 mile, and so on; that is, the total D. lat. and Dep. made good are proportional to the Dist. on the sphere as they would be on a plane. Plane Sailing, accordingly, treats of the relations of the Course, Dist., D. lat., and Dep., and applies to right-angled triangles generally.

But each mile of Dep. which the ship makes good corresponds to a Diff. of Long. which is different according to the latitude in which the ship moves (Note, p. 58), that is, there is no *constant proportion* between the Dep. and Diff. Long. in two different latitudes, and therefore a question in which Diff. Long. is concerned is not within the province of Plane Sailing, except the case in which the ship is on or near the equator, where Dep. and D. Long. are the same thing.

272. (1.) The proportions, No. 162, p. 46, as adapted to the figures, No. 200, p. 59 (or to the third figure of No. 163, where the course is the angle ABC), give the proportions or *canons*, as they are called, of Plane Sailing. We employ the following:

| | | | | | |
|---|---|---|---|---|---|
| Dist. : Dep. | :: rad. (= 1) : sin. Co., | whence, | Dep. | = Dist. × sin. Co. | (1.) |
| Dist. : D. Lat. | :: 1 : cos. Co., | | D. Lat. | = Dist. × cos. Co. | (2.) |
| D. Lat. : Dep. | :: 1 : tan. Co., | | Dep. | = D. Lat. × tan. Co. | (3.) |
| | | | and tan. Co. | $= \dfrac{\text{Dep.}}{\text{D. Lat.}}$ | (4.) |
| D. Lat. : Dist. | :: 1 : sec. Co., | | Dist. | = D. Lat. × sec. Co. | (5.) |
| | | | and sec. Co. | $= \dfrac{\text{Dist.}}{\text{D. Lat.}}$ | (6.) |

(2.) These equations put into logarithms by the rules Nos. 64 and 65, p. 20, become

| | | | |
|---|---|---|---|
| Log. Dep. | = log. Dist. | + log. sin. Co. − 10 | (1.) |
| Log. D. Lat. | = log. Dist. | + log. cos. Co. − 10 | (2.) |
| Log. Dep. | = log. D. Lat. | + log. tan. Co. − 10 | (3.) |
| Log. tan. Co. | = log. Dep. + 10 − log. D. Lat. | | (4.) |
| Log. Dist. | = log. D. Lat. | + log. sec. Co. − 10 | (5.) |
| Log. sec. Co. | = log. Dist. + 10 − log. D. Lat. | | (6.) |

Which logarithmic equations contain the rules employed.

On ordinary occasions four places are enough.

Case I. Given the course and distance, to find the difference of latitude and departure.

Ex. 1. A ship sails N.W. by N. 103 miles from lat. 49° 30′ N.; find the D. Lat. and Dep. and also the Lat. in.

273. *By Inspection*. Open Table 2 at 3 Points,* and against the Dist. 103 stand D. Lat. 85·6 and Dep. 57·2.

Then 85·6 or 1° 25′·6 added to 49° 30′ gives Lat. in 50° 55′·6 N.

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* Whenever the course is given in points or divisions of a point, it must be turned into degrees (213) before entering Traverse Table 1.

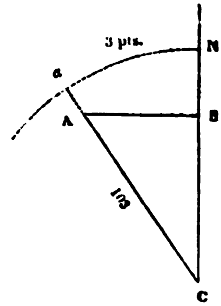
274. *By Computation.* (1.) For the D. Lat. To the log. cos. of the Course (Table 68) add the log. of the Dist. (Table 64); the sum (rejecting 10 from the index) is the log. of the D. Lat.

(2.) For the Dep. To the log. sine of the Course add the log. of the Dist.; the sum (rejecting 10) is the log. of the Dep.

Ex. above. Course 3 points, Dist. 103.

| | | | | | |
|---|---|---|---|---|---|
| 3 points, or 33° 45′ | log. cos. 9·9198 | | Course 33° 45 | log. sin. 9·7447 |
| Dist. 103 | log. 2·0128 | | Dist. 103 | log. 2·0128 |
| D. Lat. 85·6 | log. 1·9326 | | Dep. 57·2 | log. 1·7575 |
| (This is the Canon (2.) in No. 272.) | | | (This is the Canon (1.) in No. 272) | |

275. *By Construction.* Draw a line C N towards the north for the meridian. From the centre C, with the chord of 60° as radius, describe an arc on the west side of C N, and lay off the chord of three points, or 33°¾ to *a* (No. 107). Through *a* draw C *a*, this gives the angle N C *a* equal to the Course, or three points; lay off from a scale of equal parts C A equal to the Dist. 103; draw A B perpendicular to C N, then C B will shew on the same scale the D. Lat. 85·6, and A B the Dep. 57·2.



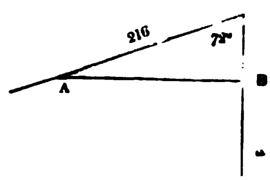

Ex. 2 A ship sails S. 72° W. 216 miles from lat. 14° 11′ N.: required the D. Lat. and Dep., and also the Lat. in.

*By Inspection.* The Course 72° and Dist. 216 give D. Lat. 66·7 and Dep. 205·4. Then 66·7, or 1° 6′·7, subtracted from 14° 11′ N. leaves Lat. in 13° 4′·3 N.

*By Computation.*

| | | | | |
|---|---|---|---|---|
| Course 72° | log. cos. 9·4900 | | Course 72° | log. sin. 9·9782 |
| Dist. 216 | log. 2·3345 | | Dist. 216 | log. 2·3345 |
| D. Lat. 66·7 | log. 1·8245 | | Dep. 205·4 | log. 2·3127 |

*By Construction.* Draw a line C S to the southward for the meridian. By the chord of 60° lay off the arc 72° to the westward, and draw C A equal to 216; draw A B perpendicular to C S, then C B is the D. Lat. 66·7, and A B the Dep. 205·4.




These two examples of construction are sufficient for all varieties of Case I. When the course is to the eastward, C A is drawn on the right side of the meridian C N or C S instead of the left side.

Case II. Given the course and difference of latitude, to find the distance and the departure.

Ex. 1. A ship sailing W.S.W. makes 47 miles D. Lat.: find the Dist. run and the Dep.

276. *By Inspection.* Enter Table 1 with the Course 6 points: look in the D. Lat. column for 47; the nearest to 47 is 47·1, against which stand the Dist. 123 and Dep. 113·6.

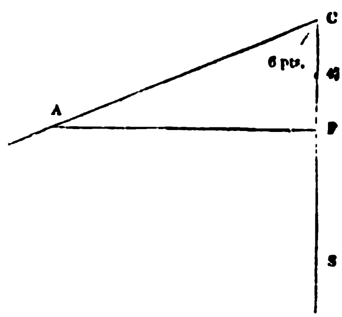
The Lat. of the ship is, from the nature of the case, already given.

277. *By Computation.* (1.) For the Dist. To the log. sec. of the Course add the log. of the D. Lat.; the sum (rejecting 10) is the log. of the Dist.

(2.) For the Dep. To the log. tan. of the Course add the log. of the D. Lat.; the sum (rejecting 10) is the log. of the Dep.

| | | | |
|---|---|---|---|
| 6 points, or 67° 30′ | log. sec. 0·4172 | Course 67° 30′ | log. tan. 0·3828 |
| D. Lat. 47 | log. 1·6721 | D. Lat. 47 | log. 1·6721 |
| Dist. 122·8 | log. 2·0893 | Dep. 113·5 | log. 2·0549 |
| (This is the Canon (5.) in No. 272.) | | (This is the Canon (3.) in No. 272.) | |

278. *By Construction.* Draw the meridian line C S; lay off the course, or angle S C A, 6 points (No. 107); from C lay off C B the D. Lat. 47; draw B A perpendicular to C S, then C A is the Dist. and A B the Dep.




This example will suffice for all varieties of Case II. When the course is to the northward, C N is drawn upwards instead of C S downwards; and when the course is to the eastward, C A is to be drawn on the right side of the meridian instead of the left side.

Ex. 2. A ship sails N. 54° E. and makes 119 miles D. Lat.: required the Distance run and the Departure.

*By Inspection.* Course 54° in Table 1, and D. Lat. 119·3, give the Dist. 203 and Dep. 164·2, nearly enough in practice.

Case III. Given the difference of latitude and departure, to find the course and distance.

Ex. A ship makes 91 miles northing and 34·7 Dep. (easting): find her Course and Distance.

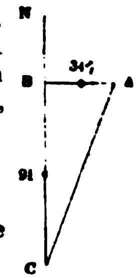
279. *By Inspection.* Look in Table 1 for 91 in the D. Lat. column, and 34·7 in the Dep. column; the nearest are 90·6 and 34·8, which give the Course 21° (N. 21° E. in this example) and Dist. 97 miles.

280. *By Computation.* (1.) For the Course. From the log. of the Dep. (adding 10 to its index if necessary) subtract the log. of the D. Lat.; the remainder is the log. tan of the Course.

(2.) For the Dist. Find the Course; then to the log. sec. of the Course add the log. of the D. Lat.; the sum is the log. of the Dist.

| | | | |
|---|---|---|---|
| Ex. Dep. 34·7 | log. 1·5403 | Course 20° 52′ | log. sec. 0·0295 |
| D. Lat. 91 | log. 1·9590 | D. Lat. 91 | log. 1·9590 |
| Course 20° 52′ | log tan. 9·5813 | Dist. 97·4 | log. 1·9885 |
| (This is the Canon (4.) No. 272.) | | (This is the Canon (5.) No. 272.) | |

281. *By Construction.* Draw the meridian C N. Take C B, the D. Lat. 91, and through B draw B A perpendicular to C N, and equal to 34·7; join C A; then B C A, the Course, measures 21° (No. 106, 2), and C A, the Dist. measures 98.




This example will suffice for all varieties of the case.

Case IV. Given the distance run and the difference of latitude, to find the course and departure.

Ex. A ship sails 101 miles between south and east, and makes 52 miles D. Lat.: find the Course and Dep.

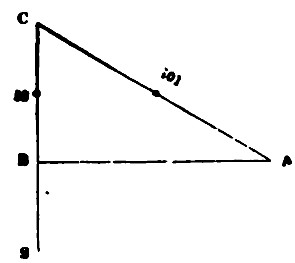
282. *By Inspection.* In Table 1, 101 in the Dist. column, and 52 in the D. Lat. column, occur over Course 59° (S. 59° E. in this example), and against the Dep. 86·6.

283. *By Computation.* (1.) For the Course. From the log. of the Dist. subtract the log. of the D. Lat.; the remainder is the log. sec. of the Course.

(2.) For the Dep. Find the Course; then to the log. sine of the Course add the log. of the Dist.; the sum is the log of the Dep.

| | | | | | |
|---|---|---|---|---|---|
| Ex. Dist. 101 | log. 2·0043 | | Course 59° 1′ | log. sin. 9·9331 |
| D. Lat. 52 | log. 1·7160 | | Dist. 101 | log. 2·0043 |
| Course 59° 1 | log. sec. 0·2883 | | Dep. 86·6 | log. 1·9374 |
| (This is the Canon (6.) No. 272.) | | | (This is the Canon (1.) No. 272.) | |

284. *By Construction.* Draw the meridian C S. Take C B, the D. Lat. 52, and through B draw B A perpendicular to C S. From C as centre, with the Dist. 101 as radius, describe an arc cutting B A in A; then the Course, S C A, measures 59°, and B A, the Dep., measures 86·6.




This one example of construction will be sufficient.

*Examples for Exercise.*

Ex. 1. A ship sails from Flamborough Head, in 54° 7′ N., E. by N. ½ N. 264 miles: required her Lat. in, and Dep.
Ans. D. Lat. 76·6 N., Lat. in, 55° 24′ N.; Dep. 252·6.

Ex. 2. A ship from Lat. 49° 57′ N. sails S.W. by W. 244 miles: required her Lat. in, and Dep.
Ans. Lat. in 47° 41′ N.; Dep. 202·9.

Ex. 3. A ship sails S.E. by E. from Lat. 1° 45′ N., until she arrives in Lat. 0° 31′ S.: required her Dist. and Dep.
Ans. Dist. 244·8; Dep. 203·5.

Ex. 4. A ship from St. Helena in Lat 15° 55′ S. sails N.W. ½ W. till she is in Lat. 13° 1′ S.: find the distance she has run, and the Dep.
Ans. Dist. 274·3; Dep. 212.

Ex. 5. A ship makes 135 miles northing, and 87·7 miles of Dep. westing: required her Course and Dist. made good.
Ans. Course N. 33° W.; Dist. 161 miles.

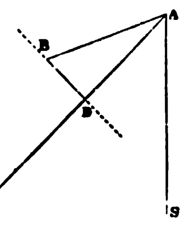
Ex. 6. A ship sails 210 miles between N. and E., and makes 160'·9 D. Lat: find the Course and Dep. Ans. Course N. 40° E.; Dep. 135 miles.

Ex. 7. A ship sails 244 miles between S. and W., and makes 136' D. Lat.: find the Course and Dep. Ans. Course S. 56° 8' W.; Dep. 202·6.

## 1. *Resolution of one Course upon another.*

285. It is sometimes required to resolve the distance run upon a given course into the distance upon a proposed course.

Ex. A ship is making good S. 70° W. 5¼ miles an hour: at what rate is she nearing a port bearing S.W.?




Draw the meridian, A S, of the ship at A. Lay off the bearing of the port, S.W., and the Course S. 70° W., and take A B to represent the rate per hour (or for a smaller interval), as 5¼ knots. B then is the place of the ship at the end of this interval.

The distance, A P of the port, being very great, as compared with A B, a circle B D, described from P as a centre, is nearly a right line, and perp. to A P, and cuts off A D, the dist. by which the ship has neared P in an hour. Now A D is the D. Lat. to the Dist. A B, and the angle B A D as Course. B A D equal to 70° − 45°, or 25°, and Dist. 5¼, give A D equal to 5 knots, the rate required, and A D is A B resolved in the direction AP.

When the number of degrees between the given and proposed courses exceeds 90, the ship is increasing her distance from the port instead of closing it.

It is proper to observe, that the change in the distance of the port, made by the ship when not steering directly for it, is true only for its present bearing, and therefore holds only for a short time.

## 2. *Traverse Sailing.*

286. This is a variety of plane sailing in which the ship makes two or more courses in succession.

The process of reducing several courses, with the distances run on each, to the single course and distance which the ship would have made good if she had sailed at once from the place she first left, to the place at which she last arrived, is called *working a traverse.*

287. To work a Traverse. (1.) Draw six vertical lines. Head the space to the left Courses, the first column Distances, the next two columns D. Lat.; marking the first N. and the second S.; head the last two columns Dep., marking one E. and the other W. This forms a skeleton Traverse Table.

(2.) Set down the Courses, and the Distances against them, in order; look out in Table 1, the D. Lat. and Dep. to each Course and Distance. When the ship makes northing (that is, when the Course has an N. in it), set the D. Lat. in the N. column, otherwise in the S. column. When the ship makes easting (that is, when the Course has an E. in it), set the Dep. in the E. column, otherwise in the W. column.

(3.) Add the D. Lats. in each column; write the lesser of the two sums under the greater, and take their difference. Do the same with the Departures.

(4.) Those differences are the D. Lat. and Dep. made good on the whole, and each takes the name of the column it stands in.

The course and distance are then found by No. 279.

It may be advisable for a beginner, before he proceeds to take out the quantities from the Traverse Table, to write a *dash* in all places *not* to be occupied by a D. Lat. or a Dep., in order to avoid writing a quantity in the wrong column. The first example only is thus marked, because such helps are useless to an expert computer.

Ex. A ship sails S.W. by S. 24 miles; N.N.W. 57 miles; S.E. by E. ½ E. 84 miles; and South 35 miles: find the Course and Distance made good.

| Courses | Dist. | D. Lat. N. | D. Lat. S. | Dep. E. | Dep. W. |
|---|---|---|---|---|---|
| S.W. by S. | 24 | — | 20·0 | — | 13·3 |
| N.N.W. | 57 | 52·7 | — | — | 21·8 |
| S.E. by E. ½ E. | 84 | — | 39·6 | 74·1 | — |
| South. | 35 | — | 35·0 | — | — |
| | | 52·7 | 94·6 | 74·1 | 35·1 |
| | | | 52·7 | 35·1 | |
| | | | 41·9 | 39·0 | |

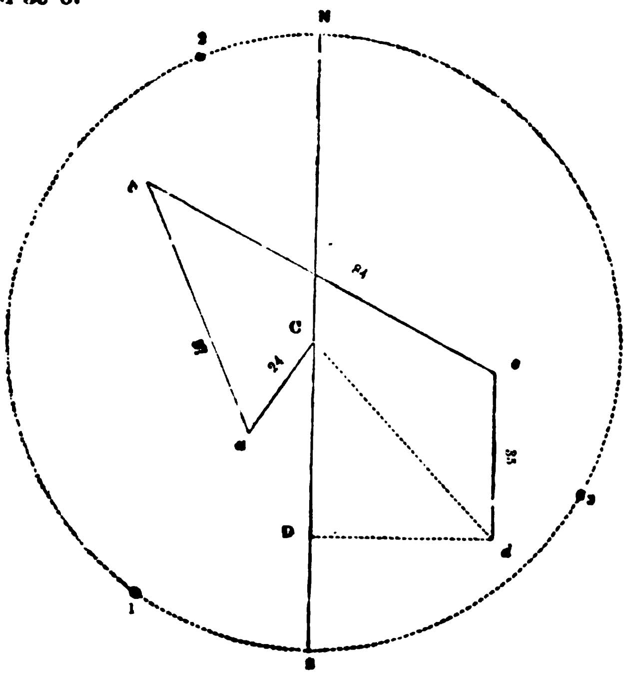
The D. Lat. 41·9 and Dep. 39·0, are found at 43° against the Dist. 57. Hence, since the ship has by the Traverse Table made southing and easting upon the whole, the Course is S. 43° E., and Dist. 57 miles.

*By Computation.* Each portion of the process having already been separately considered in plane sailing, nothing remains to be added here.

288. *By Construction.* With the chord of 60 describe a circle; draw the meridian N S, and mark the centre C. By means of the scale of chords lay off S 1, equal to 3 points, or S.W. by S., for the first course. Lay off N 2, equal to 2 points, or N.N.W., for the second course. Lay off S 3, equal to 5½ points, or S.E. by E. ½ E., for the third course. The fourth course, or south, is already laid off, being on the meridian.

Now lay the edge of the ruler on C and on the point 1, and lay off by the compasses, or a scale of equal parts, the first distance, C *a*, 24. Place the edge of the ruler on *a*, laying it parallel to the line joining C and the point 2, and lay off the second distance, *a b*, 57. Place the ruler on the point *b*, laying it parallel to the line joining C and the point 3, and lay off the third distance, *b c*, 84. Lay the ruler on *c*, parallel to the meridian, and lay off *c d*, the fourth distance, 35. The point *d* is therefore the place at which the ship has arrived. Join C*d*, then S C *d* is the course, 43°, and C *d* the distance, 57. Also, drawing D *d* perpendicular to C S, gives

D C the D. Lat., and D $d$ the Dep. which will be found to measure 41·9 and 39·0.




The circle is here drawn outside the traverses altogether, without regard to the dimensions of the scale of chords, merely to shew the process more clearly.

This example, after the practice which the learner will have already had in drawing the figures in the preceding articles, will be sufficient for any case that may occur.

Ex. 2. A ship sails N.N.E. 11 miles; N.E. ¾ E. 39 miles; E. ½ N. 14 miles; West, 19 miles; N.N.W. 4 miles: required the Course and Distance made good.

| Courses | Dist. | N. | S. | E. | W. |
|---|---|---|---|---|---|
| N.N.E. | 11 | 10·2 | | 4·2 | |
| N.E. ¾ E. | 39 | 23·2 | | 31·3 | |
| E. ½ N. | 14 | 1·4 | | 13·9 | |
| West. | 19 | | | | 19 |
| N.N.W. | 4 | 3·7 | | | 1·5 |
| | | 38·5 | 0 | 49·4 | 20·5 |
| | | | | 20·5 | |
| | | | | 28·9 | |

The D. Lat. 38·5 in the N. col., and Dep. 28·9 in the E. col give Course N. 37° E., Dist. 48 miles.

289. The D. Lat. made good on the whole, as thus found, being applied to the Lat. left, gives the Lat. in. Thus, suppose in the above example the ship left Lat. 38° 40′ S.; then 38′·5 northing places her in Lat. 38° 1′·5 S.*

*Examples for Exercise.*

Ex. 1. A ship from Cape St. Vincent, in lat. 37° 3′ N., sailed E.S.E. 45 miles, S.W. by W. 43 miles, S.E. by S. 64 miles, and N.N.E. 22 miles: find the Course and Distance made good, and also her Latitude in.
Ans. Course S. 34° E.; Dist. 89 miles; Lat. in 35° 49′ N.

Ex. 2. A ship from Cape Amber (N.E. extremity of Madagascar), in lat. 11° 57′ S., sailed as follows: — S.S.E ½ E. 33 miles, S.W. by W. 40 miles, S.E. by S 44 miles; N. 36 miles, S.W. by S. 44 miles, S.E. by E. 40 miles, S.S.W. ½ W. 33 miles: required the Course and Distance made good, and also what Latitude she is in.
Ans. Course due South; Dist 140 miles; the Lat. in is 14° 17′ S.

Ex. 3. Yesterday, at noon, we were in lat. 28° 34′ N., and since then we have sailed N.E. ¾ E. 62 miles, N. by E. 16 miles, E. ½ N. 40 miles, N.E. ¾ E. 29 miles N. by W. 30 miles, and N. ¾ W. 14 miles: what Course and Distance have we made good, and what is our present Lat.?
Ans. Course N. 43° E. or N.E. ½ N.; Dist. 158 miles; Lat. in 30° 29′ N.

Ex. 4. Yesterday, at noon, we were in lat. 44° 10′ N., and since then we sailed the following courses (all true): S. 69° W. 4 miles, S. 58° E. 15 miles, S. 66° E. 8 miles, S. 65° W. 12 miles, S. 1° E. 6 miles, S. 55° W. 2 miles, N. 21° E. 2 miles, S. 55° W. 28 miles, S. 32° E. 14 miles, S. 55° W. 4 miles: find what Course and Distance the ship has made good, and what is her present Lat.
Ans. Course S. 15° W.; Dist. 55·0 miles; Lat. in 43° 17′ N.

## 3. *Current Sailing.*

290. A current is named after the point *towards* which it runs or *sets:* thus, a current setting towards S.E. is called a south-east current. The mode adopted in speaking of the wind, which is named according to the point *from* which it blows, is thus reversed in speaking of a current.†

The term *set*, which is used to describe the direction of the current, is employed in the same way as in taking a bearing (No. 201); but it is necessary for the complete description of the current to state also its *drift*, that is, the distance through which the ship is carried or driven by its action.‡

291. When the rate of a current per hour is known, the drift for any number of hours is found by multiplying the rate by the number of hours.

In like manner, when the drift in a number of hours has been

* The beginner will proceed now to parallel sailing, because, though current sailing is strictly a branch of plane sailing, yet some of the examples, for the convenience of arrangement, involve the consideration of longitude.

† It is easy to conceive that people would name a wind according to the quarter it blows from, as bringing heat or cold, rain, &c., and a current according to the quarter to which it carries them.

‡ These terms have not in general been employed with sufficient precision. The term "drift" has been defined as the distance run per hour, or rate of the current. But as a second term for rate is superfluous, and as it is convenient to have a term expressive of the distance through which the ship has been carried by the current in any interval of time, we have used the word drift in the latter sense only. Thus the terms *set* and *drift* are used in speaking of the current as *course* and *distance* are in speaking of the ship.

ascertained, the rate is found by dividing the number of miles of the drift by the number of hours.

Ex. 1. A current runs 2·2 knots: required its drift in 13 hours.

Ans. $2·2 \times 13 = 28·6$ miles, the Drift.

Ex. 2. A ship is found to have drifted by the current 42 miles in 21 hours: required its rate.

Ans. $\frac{42}{21} = 2$ miles per hour, the Rate.

292. Since the current sets the ship in a certain direction and at a certain rate, while the ship herself is going through the water in another direction and at another rate, the course of a ship affected by a current becomes in general a case of traverse sailing, in which there are two courses and distances.

Thus current sailing is analogous to traverse sailing, the two courses, instead of following in succession, being here considered as taking place at the same time.

The subjects for consideration in this section are, finding the place of a ship affected by a current; determining the course under a particular condition; and, lastly, finding the motion of the current itself.

Case I. Given the course steered, and dist. run by the log, with the set and rate of the current, to find the course and distance made good.

Ex. A ship runs N.E. by N. 18 miles in three hours, in a current setting W. by S. two miles an hour: required the Course and Dist. made good.

| | | | | |
|---|---|---|---|---|
| N.E. by N. 18 m. gives | D. Lat. | 15·0 N. | Dep. | 10·0 E. |
| W. by S. 6 m. | D. Lat. | 1·2 S. | Dep. | 5·9 W |
| | | 13·8 N. | | 4·1 E |

The Course is, therefore, N. by E. ¼ E.; Dist. 14 miles.

The Construction of this example is the same as that of a case of traverse sailing, in which the courses and distances to be laid off are N.E. by N. 18 miles, and W. by S. 6 miles.

293. When a ship steering for a port is drifted by a current, it is evident that, unless it be exactly with her or exactly against her, it will throw her out of her intended course. Since the course to be shaped in any case depends on the rate of sailing of the ship, and as this cannot be foreseen for any future hour, the course must, when it is proposed to take into consideration the effect of the current, be determined by the present rate of sailing, and independently of the distance of the port.

Case II. Given the bearing of the port, and the set and rate of the current: it is required to shape the course so as to keep the port on the same bearing.

294. *By Inspection.* When the bearing of the port and the set of the current are in *adjacent* quarters of the compass, take their *sum*; when in the *same* or *opposite* quarters, take the *difference*.

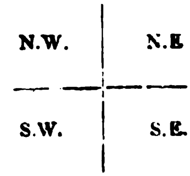
With this sum (or its supplement to 16 points, or 180°, if it exceeds 90°), or difference, as a course, and the rate of the current as a distance, find the Dep.

With this Dep. as Dep. and the rate of the ship as Dist. find the Course.

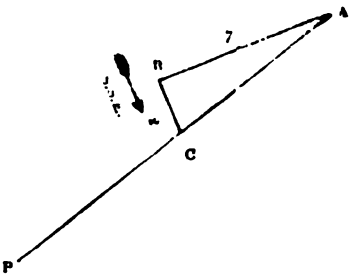
This course being applied to the bearing of the port on the *opposite* side to that towards which the current is drifting the ship, gives the course to be steered.

Ex. 1. The port bears S. 52° W , the current sets S.S.E. two miles an hour; the present rate of sailing 7 knots: shape the course so as to keep the port on the same bearing.

*By Inspection.* S. 52° W. and S.S.E. are in *adjacent* quarters; the *sum*, therefore, of 52° and 22°½ is 74°½. This course, with the dist. 2, gives dep. 1·9. The dist. 7 and dep. 1·9 give the course 16°. This 16° applied to the *right* (because, in facing towards S. 52° W. S.S.E. lies to the *left*), gives the Course 52° + 16°, or S. 68° W.




295. *By Construction.* Take a point B, any where, and from it lay off the set and rate of the current, as BC, S.S.E. two miles; through C draw a line AP, S. 52° W., for the direction of the port; from B lay off BA, 7, the rate of sailing, meeting PA in A; then CAB is the angle 16°, which the ship is to steer to the right of the port.




It is evident, in the present case, that while the ship is running along AB, looking to windward of the port, the current is setting her to the left towards the proposed line, AP. Attention to this point will ensure marking A on the proper side of BC; for if a line were drawn from B towards a point between C and P, to represent the ship's course, it is evident that while on it she would be looking to leeward of the port, while the current was also drifting her to leeward.

This example will serve for all cases. Thus, while the port bears as above, suppose the current sets N.N.W. 2 miles; then the point B and the line AB would lie on the S.E. side of AP instead of the N.W. side, the angle A would be 16° as before, but the distance AC made good by the ship in the direction of the port, would be different.

Ex. 2. The port bears N. 42° W., the current runs south 3 knots; rate of sailing, 5: shape the Course as required by the condition.

*By Inspection.* South giving no angle, the first course is 42° at once, which, with Dist. 3, gives Dep. 2. The Dist 5 and Dep. 2 give Course 24°, to be applied to the *right*, because in facing towards N. 42° W., south is to the *left*.

Ex. 3. The port bears E., the current sets S.W. by S. 3 knots; rate of sailing, 4.

East is 8 points, or 90°, which is one of the *opposite* quarters to S.W.; the diff. of 8 points and 3 points, or 5 points as Course, and Dist. 3, give Dep. 2·5. The Dep. 2·5, and Dist 4 give Course 39°, which, applied to the left of E., gives the Course to be steered N. 51° E.

Ex. 4. The port bears S. 82° E., the current sets N. 5° W. 4 knots; rate of sailing, 2.

S.E and N.W. being opposite quarters, the diff. of 82° and 5°, or 77°, is the Course; which, with the Dist. 4, gives Dep. 3·9. This Dep. 3·9 being greater than the Dist. 2 (the ship's rate) which is impossible, shews that the ship cannot maintain the bearing of the port.

296. When the current sets at right angles across the line of direction of the port, the ship's velocity must evidently be equal, at least, to that of the current, that she may be able to stem it, and to preserve both the bearing and distance of the port unchanged.

Hence, if the current tend in any degree to set the ship away from her port, she will not be able to preserve the required position unless her velocity exceed that of the current.

Case III. Given the Course and Distance run by account from a well-determined place, and the true position of the ship, to find the Current.

297. *By Inspection.* Having the D. Lat. and Dep., both by account and as deduced from observation, take the difference between the two D. Lats. and the two Deps.; if the D. Lats. are of different names, take their sum, and the same of the Deps.

When the true lat. of the ship is to the north of the account, mark the diff. or sum of the D. Lats. N., otherwise S.; and when the true longitude of the ship is to the E. of the account, mark the diff. or sum of the Deps. E., otherwise W. Find in the Traverse Table the course and distance corresponding to the said differences, as D. Lat. and Dep. these are the set and drift of the current.

Ex. 1. A ship in lat. 37° N., sails S. 57° E., 48 miles, by account, and is found to have made good 31′·6 D. Lat. (S.), and 44·7 Dep. (E.): find the current.

| | | | |
|---|---|---|---|
| D. Lat. by account | 26·1 | Dep. by account | 40·3 |
| Do. true | 31·6 | Do. true | 44·7 |
| Diff. of D. Lats. | 5·5 S. | Diff. of Deps. | 4·4 E. |

The D. Lat. 5·5 S., and Dep. 4·4 E., give Course S. 39° E., Dist. 7·1, the Set and Drift of the current in the time. Suppose the time eight hours and a half, then the Rate is 0·8 of a mile per hour.

Ex. 2. A ship from lat. 38° 20′ S., and long. 31° 15′ W., sails S. 40° E., 170 miles, by account, when she is found by observation to be in lat. 40° 54′·5 S., and long. 30° 44′·8 W.: find the current.

The lat. by account is 40° 30′ S.; the long. by account, 28° 55′ W.

| | | | |
|---|---|---|---|
| Lat. left | 38° 20′ | Long. left | 31° 15′ |
| Lat. in | 40 54·5 | Long. in | 30 44·8 |
| True D. Lat. | 2 34·5 = 154·5 | True D. Long. | 30·2 |

The mid. lat. 40° as Course, and Dist. 30·2, give D. Lat. 23·0. (See No. 318.)

| | | | |
|---|---|---|---|
| D. Lat. by account | 130·2 | Dep. by account | 109·3 |
| Do. true | 154·5 | Do. true | 23·0 |
| Diff. of D. Lats. | 24·3 S. | Diff. of Deps. | 86·3 W. |

The D. Lat. 24·3 S., and Dep. 86·3 W. give Course S. 74° W., Dist. 90 miles, the Set and Drift of the current in the given time.

Ex. 3. (By bearings and dist. of land.) A ship at sunset sets a point of land, N. 58° E., 11 miles. Next morning having, as supposed, made good S. 40° E. 14 miles, the point bears N. 76° E. 20 miles: required the current.

The Bearing at sunset, considered as a Course from the land or S. 58° W., Dist. 11, and S. 40° E. 14, give whole D. Lat. by account, between the ship and the point, 16·5 S. and Dep. 0 3 W. The Bearing and Dist. in the morning give the D. Lat. 4·8 S., and Dep. 19·4 W.

| | | | |
|---|---|---|---|
| D. Lat. by account | 16·5 | Dep. by account | 0·3 |
| Do. true | 4·8 | Do. true | 19·4 |
| | 11·7 | | 19·1 |

The D. Lat. 11·7, and Dep. 19·1, give Course or Set 58° and Dist. or Drift 22; the set is evidently (from the two bearings) between N. and W.

The complete construction of this last case, in which longitude is involved, requires the use of Mercator's Chart. No further directions are, however, necessary than to lay off the place of the ship by D.R. and her true position; the line joining these two points shews the set of the current, and its drift.

298. The last example leads to the remark that, unless the ship's head be the same way at the taking of each bearing, as well as during the whole interval between the observations, the resulting set of the current will be mixed up with local deviation; and the current accordingly cannot be truly determined, unless the effect of local deviation be removed.

In this subdivision* rules have been laid down for working certain questions in current sailing. Other matters relative to the current, which present themselves for consideration in shaping the course, and also in determining the current itself by experiment, are treated in the division of the work entitled "Navigating the Ship."

### 4. *Windward Sailing.*

299. In windward sailing the vessel bound to a port has a foul wind. As she is thus compelled to make more courses than one, the case is one of Traverse Sailing; but as the course on either tack is determined by the circumstances, the inquiry is limited to the consideration of the time at which it is proper to tack.

The general principle, supposing the wind to remain unchanged, is to near the port as much as possible from instant to instant. Now the ship nears the port fastest on that tack on which she looks the best up for it; if, therefore, she looks up for the port better on her present tack than she would on the other, she should stand on; if not, she should go about. Hence it follows, that the ship should constantly keep the port in the wind's eye; but, as working up on this line would require the vessel to be continually tacking, which is practically impossible, the limits within which the rule should be followed must be determined by circumstances.

The advantage of working up nearly in the stream of the wind towards any object, whether fixed or moving, is, that the wind cannot be worse, and, therefore, every change must be for the better.†

300. The distance run, or the ground actually gone over, is the same whether the ship makes two boards or a greater number, pro-

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* As it is convenient occasionally thus to refer by name to the several parts into which, from the classification adopted, the contents of this volume are divided, it may be stated briefly that the principal portions, as the Introduction, Navigation, &c., are here termed *divisions*, which, when necessary, are divided into *chapters*. The parts of a division or of a chapter, distinguished by capital letters, are termed *sections*; the parts of a section in large italics, *subdivisions*, and the further division of these, in small italics with figures in brackets, *subsections*, the prefix *sub* being thus applied to the smallest divisions.

† The question of closing another vessel belongs to tactics, and not to our present subject, which relates solely to the place of the ship on the sea. It may not be useless, however, to notice here, that in working up to a vessel to windward, it is proper to keep as near the stream of the wind as circumstances permit; because from the time that the chase has dropt to the weather beam of the chaser, the latter, however great her superiority of sailing, ceases to near the chase. See Naut. Mag. 1838, Art. "Chasing," p. 446.

vided that no ground or time is lost in stays: the application of the above rule, therefore, depends entirely on the probability of a change of wind.

In this subdivision we consider merely the general principle of sailing with a foul wind. Other points involved in Shaping the Course, as the combination of a current with a foul wind, the selection of such a course as may, in certain cases, convert a foul wind into a fair one, the effects of local deviation which have been observed while sailing on different tacks, will be treated in the Chapter on Navigating the Ship, under the heads "Shaping the Course," "Error of the Course."

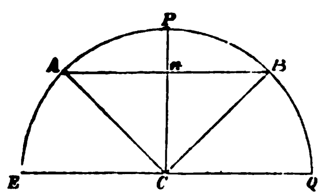
## II. Parallel Sailing.

**301.** When two places lie on the same parallel of latitude, or due east and west of each other, the distance between them, estimated along a parallel, or E. and W. (which is all departure), is converted into difference of longitude; or, on the other hand, their difference of longitude is converted into distance,—by the rules of Parallel Sailing.

The principles of Parallel Sailing are contained in the two following propositions.

302. Prop. A parallel of latitude is a circle of which the radius is proportional to the cosine of the latitude.

Let E P Q be part of a meridian, P the pole, E Q a diameter of the equator, A a place whose latitude is the arc A E.




Take B Q equal to A E; then B is the opposite point to A on the same parallel. Join A B crossing C P in $n$.

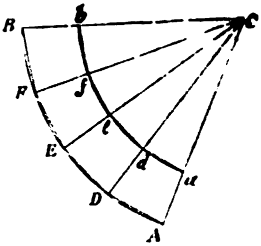
Suppose now a ship to move from A round the polar axis C P, preserving the same lat., or the angle P C A constant; then at the end of half a revolution she will be at B, and PCB will be equal to PCA.

Then C A and C B being equal, each being a radius, and the angles P C A, P C B, equal, and C $n$ common to the two triangles A C $n$, B C $n$, these are equal (No. 117). Hence A $n$ is equal to B $n$; and this holds for every point of the parallel.

Hence A and B are on the circumference of a circle whose centre is $n$, in the line or diameter joining any two opposite points.

Now A $n$ (see fig. p. 44) is equal to the cosine of the arc A E, C E being radius; hence C E : A $n$ :: rad. (= 1) : cos lat., which was to be proved.

303. Prop. The length of a circular arc is proportional to its radius. Or, the length of A B : the length of $ab$ :: C A : C $a$.




C is the common centre of the arcs A B, $ab$. Divide the angle C into any number of equal parts, as for ex. four, by the lines C D, C E, C F; join the points A and D, &c. by the chords A D, D E, &c. Then the sides C A, C D, &c. being equal, and the angles A C D, D C E, &c. being equal, the bases A D, D E, &c. are all equal. (No. 117.)

In like manner the chords $ad$, $de$, &c. are all equal.

Now the triangles C A D, C $ad$, being isosceles, and having one angle A C D common, have the remaining angles equal; they are thus equiangular, and therefore similar (148 cor.), and their sides are proportional (146); hence A D : $ad$ :: C A : C$a$.

We may multiply both terms of the ratio A D : $ad$ by any number without altering its value (Nos. 37 and 7), whence 4 A D : 4 $ad$ :: C A : C $a$. Now 4 A D is the sum of the four equal chords A D, D E, &c., and 4 $ad$ is that of the chords $ad$, $de$, &c. Hence,

The sum of the equal chords of A B : sum of the same number of equal chords of $ab$ :: C A : C$a$.

This proportion is evidently true, whatever be the number of equal parts into which the angle C is divided. It would therefore hold equally for an immensely increased number of diminished chords, as for ex. of 1′, or 1″, or a millionth of 1″, or infinitely less; it therefore holds of the arc itself, which we may conceive to be composed of an indefinitely great number of indefinitely small portions, each of which is arc or chord indifferently,* or arc A B : arc $ab$ :: C A : C$a$.

(1). If A B be the equator, and $ab$ a parallel, then C A : C$a$ :: 1 : cos lat. Whence A B : $ab$ :: 1 : cos lat.

And since Diff. Long. is an arc of the equator, and an arc measured parallel to it in any other latitude is called Dep., we have,

D. Long. : Dep. :: 1 : cos. lat., whence Dep. = D. Long. × cos. lat. . . . (1)
Dep. : D. Long. :: 1 : sec. lat., (162 (2) (4)) D. Long. = Dep. × sec. lat. . . . . . . (2)

These are the equations for Parallel Sailing.

(2). These equations, in logarithms, become

Log. Dep. = log. D. Long. + log. cos. lat. . . . . . . (1)
Log. D. Long. = log. Dep. + log. sec. lat. − 10 . . . (2)

Case I. Given the distance run on a given parallel of latitude, to find the difference of longitude.

304. *By Inspection.* (1.) Enter the Traverse Table with the latitude as a course, and look in the D. Lat. column for the given distance; the Dist. against this is the Diff. Long. required.

* As, from the nature of the case, the sum of all the chords can never surpass the arc, though it may approach indefinitely near it, the arc is said to be the *limit* of the sum of the chords increased indefinitely.

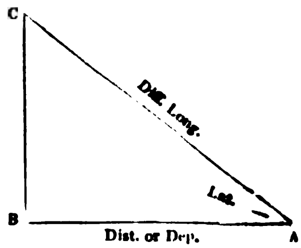
Ex. A ship runs 143 miles due W. in Lat. 38° 11′: required the diff. long. she makes good.

The lat. 38° as course, and 143 in the D. Lat. column, give the Dist. 181, or 3° 1′: the Diff. Long. required.

(2.) Or employ Table 3, as directed in the Explanation of the Tables.

305. *By Computation.* To the log. sec. of the Lat. add the log. of the Dist.; the sum (rejecting 10) is the log. of the Diff. Long.

| | | | | |
|---|---|---|---|---|
| Ex. above. | Lat. | 38° 11′ | log. sec. | 0·1046 |
| | Dist. | 143 | log. | 2·1553 |
| | Diff. Long. | 181·9 | log. | 2·2599 |




306. *By Construction.* Draw a line A B east and west, and lay off 143 on it; lay off the angle B A C equal to the Lat. or 38° in this case; draw B C perpendicular to A B, and meeting A C in C. Then A C is the Diff. Long. required.

Case II. Given the Diff. Long. of two places on the same parallel, to find their distance as measured along the parallel.

307. *By Inspection.* (1.) Enter the Traverse Table with the Lat. as course and the Diff. Long. as distance; the D. Lat. is the distance required.

Ex. The diff. long. of two places in the parallel of 53° 20′ is 12° 14′: required their distance as measured along their parallel.

The lat. 53° as Course, and Dist. 734, give in the D. Lat. column 442 nearly: the distance required.

(2). Or employ Tab. 4, as directed in the Explanation of the Tables.

308. *By Computation.* To the log. cos. of the Lat. add the log. of the Diff. Long.; the sum (rejecting 10) is the log. of the distance required.

| | | | | |
|---|---|---|---|---|
| Ex. above. | Lat. | 53° 20′ | log. cos. | 9·7761 |
| | D. Long. | 12 14 or 734 | log. | 2·8657 |
| | Dist. | 438·3 | log. | 2·6418 |

309. *By Construction.* Draw a line A B (fig. No. 306) of any length; lay off at A the angle B A C equal to the latitude 53°; take A C equal to the Diff. Long. 734; from C draw C B perpendicular to A B; then A B is the Dist. required, and measures 442.

310. In parallel sailing the Distance and Departure are identical. When the course is nearly, though not exactly, on a parallel, the distance run and the departure are very nearly equal; hence it is evident that parallel sailing will apply, nearly enough for common purposes, to cases in which the course is not exactly east or west.

311. In lats. below 5°, when the distance does not exceed 300 miles, the Dep. may at once be taken as the Diff. Long., as the greatest error will scarcely exceed 1′.

### 1. *Middle Latitude Sailing.*

312. This is a method (founded on the principle of parallel sailing) of converting the Departure into Difference of Longitude, and the Difference of Longitude into Departure, when the ship's course lies obliquely across the meridian; that is when, besides Departure, she makes Difference of Latitude.

Suppose a ship make 100 miles departure in going, on the same course, from lat. 38° to lat. 41°; this departure, if made good altogether in lat. 38°, would give 127 Diff. Long. by No. 304; and again, if made good in lat. 41°, it would give 132·5 Diff. Long. Now, since the ship has sailed between these two parallels, and not on either of them exclusively, her real Diff. Long. must be between 127 and 132·5; and therefore we may conclude it to be not far from that which would result from a departure made good altogether in the *middle parallel*; hence the name of the sailing.

313. Middle latitude sailing has thus the same two cases as parallel sailing; and, accordingly, the rules for inspection, computation, and construction, already given, Nos. 304, &c., apply equally to this sailing, observing merely to read *middle latitude* for *latitude*.

314. When the latitudes of the two places are of the *same* name, the middle lat. is half their *sum*.*

In using the Traverse Tables, it is enough to take the latitudes to the nearest degree.

Ex. 1. A ship sails from lat. 51° 33′ N. to 49° 9′ N.: find the Mid. Lat.

| | |
|---|---|
| Lat. left | 52° |
| Lat. in | 49 |
| | 101 |
| Mid. Lat. | 50 |

Ex. 2. A ship sails from lat. 2° N. to lat. 1° S.

The ship moving near the equator, the consideration of middle latitude is omitted, and the Dep. taken as the Diff. Long.

When the latitudes are of *contrary* names, no sensible error can arise from taking the Dep. itself, made good from day to day, as the Diff. Long. But in greater distances between places in opposite latitudes it is proper to convert the Dep. made good in N. lat. into Diff. Long. by means of the north mid. lat., that is, half the N. latitude, and that made good in S. lat. by half the S. lat.

When, on the other hand, the Diff. Long. is to be converted into Dep., this rule does not apply. It will be near enough for common purposes, when the latitudes are either very nearly equal or very unequal, to employ, as the mid. lat., half the greater latitude. In

* The rule which directs half the difference of the latitudes of two places on opposite sides of the equator to be employed as their middle latitude, is erroneous. The error will be readily perceived in considering a case. Suppose a ship sails S.E. from lat. 10° N. to 10° S.; it is evident that her diff. long. will be exactly the same as if, on reaching the equator, she returned to the same N. lat., steering N.E., since her course is the same, and she moves in the same lats. in both cases. Thus the mid. lat., which is the average of all the latitudes passed through, or the half sum of the first and last, and is here 5°, is independent of the distinctions of N. and S. The common rule gives 0 for the mid. lat.; whence it would follow that the diff. long. made good by a ship in ranging through all the latitudes between 10° N. and 10° S., or any other equal latitudes, however great, would be the same as if she made good her departure altogether on the equator — a conclusion manifestly erroneous.

an intermediate case we may combine the two mid. lats., giving the greater weight to that which corresponds to the greater latitude.

Ex. 1. Find the mid. lat. between 30° N. and 29° S.
The lats. being nearly equal, half of 30°, or 15°, may be taken as the MID. LAT

Ex. 2. Find the mid. lat. between 30° N. and 2° S.
Half of 30°, or 15°, may be taken as the MID. LAT.

Ex. 3. Find the mid. lat. between 30° N. and 15° S.
The N. mid. lat. is 15°, the S. mid. lat. is 7° nearly; now the mid. lat. 15° corresponds to 30° of lat., and the other, or 7°, to only half as much. Instead, therefore, of dividing the sum of the two by 2, we give to the first double the weight of the other, and divide by 3; thus, 15 + 15 + 7, or 37 divided by 3, gives 12°, the MID. LAT. required, nearly.

Case I. Given the departure, to find the difference of longitude.

Ex. 1. A ship from lat. 51° 9′ N. sails S.W. by W. 216 miles: required her Lat. in and Diff. Long.

315. *By Inspection.* Find the D. Lat. and Dep., and the Lat. in. Find the Mid. Lat.; then, with the Mid. Lat. as Course, look for the Dep. in the *D. Lat. column*, the corresponding Dist. is the D. Long. required.

By Case I. of Plane Sailing, S. 5 points, Dist. 216, give D. Lat. 120 and Dep. 179·6; hence the Lat. in is 49° 9′ N.

| | | |
|---|---|---|
| Lat. left | 51 9 N. | |
| | 100 18 | Mid. Lat. 50° |

Then Course 50° and Dep. 179·6 in the D. Lat. column give Dist. 279 or 4° 39′, the DIFF. LONG. required.

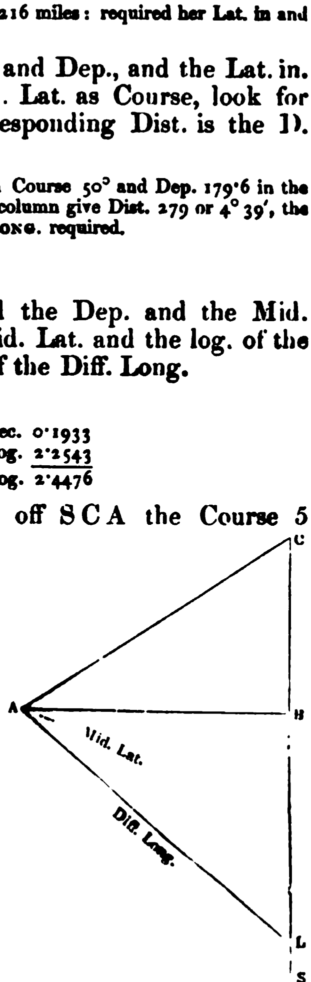
316. *By Computation.* Having found the Dep. and the Mid. Lat., add together the log. sec. of the Mid. Lat. and the log. of the Dep.; the sum (rejecting 10) is the log. of the Diff. Long.

Ex. above. Dep. 179·6 Mid. Lat. 50° 9′

| | | | |
|---|---|---|---|
| Mid. Lat. | 50° 9′ | log. sec. | 0·1933 |
| Dep. | 179·6 | log. | 2·2543 |
| DIFF. LONG. | 280·3 (4° 40′·3) | log. | 2·4476 |

317. *By Construction.* (Ex. 1.) Lay off S C A the Course 5 points, and take C A the Dist. 216; draw A B perpendicular to C S. The figure is thus far complete for plane sailing, Case I.

Lay off the angle B A L equal to the Mid. Lat. 50°, and A L meeting C S is the Diff. Long. 280.



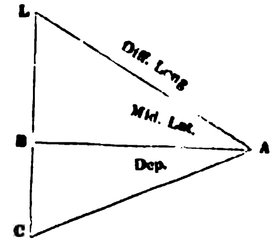

Ex. 2. A ship from Lat. 29° 40′ N. sails E.N.E. till she makes 72 miles D. lat.: required the Dist. run and Diff. Long.

*By Inspection.* By No. 276, Course 6 points and D. Lat. 71·9 give Dep. 173·7; and 72 miles northing give lat. in 30° 52′ N.

| | |
|---|---|
| Lat. left | 29° 40′ N. |
| Lat. in | 30 52 N. |
| | 60 32 |
| Mid. Lat. | 30 16 |

Course 30° (Mid. Lat.) and Dep. 173·7 as D. Lat. give Dist. 201 or 3° 21′, the DIFF LONG. required.

*By Construction.* C B A represents the fig. for plane sailing.




Lay off B A L equal to the mid. lat. 30°; and A L is the Diff. Long. and measures 201.

These two examples of construction are sufficient for the case.

Ex. 3. A ship from lat. 44° 58′ N. runs 230 miles, and makes 56 miles southing: find the Course and Diff. Long.

By Case IV. of Plane Sailing, p. 86, the Dist. 230 and D. Lat. 56 stand together over the Course 76° and against the Dep. 223·2; then 56′ southing gives Lat. in 44° 2′ N.

The Lat. left 44° and Lat. in 45° give the Mid. Lat. 44°½ or 44°.

Course 44° (Mid. Lat.) and Dep. 22·3 in D. Lat. column give Dist. 31: hence the DIFF. LONG. is 310, or 5° 10′.

Case II. Given the latitudes and longitudes of two places, to find the departure, and thence the course and distance between them.

Ex. Find the Course and Dist. between C. Sierra Leone, in lat. 8° 30′ N., long. 13° 8′ W., and C. St. Roque, lat. 5° 28′ S., long. 35° 17′ W.

318. *By Inspection.* Find the Mid. Lat. and the Diff. Long. of the places; open the Traverse Table at the Mid. Lat. as a course, look for the Diff. Long. in the Dist. column, and take out the D. Lat.: this is the Dep. required.

The Dep. and given Diff. Lat. between the places give the Course and Dist. by Case III. Plane Sailing, p. 109.

| | | | | |
|---|---|---|---|---|
| C. Sierra Leone, lat. | 8° 30′ N. | | Long. | 13° 18′ W. |
| C. St. Roque | 5 28 S. | | | 35 17 W. |
| D. Lat. | 13 58 | | Diff. Long. | 21 59 |
| Or | 838 miles | | Or | 1319 miles. |

The Mid. Lat. of 8° 30′ is 4° 15′, that of 5° 28′ is 2° 44′, or 4° and 3° nearly. As 4° corresponds to the greater lat., we may adopt it as the Mid. Lat. (Assigning the relative weights with some further precision gives 3° 40′ as the Mid. Lat.)

Course 4° (Mid. Lat.) and Dist. 132 give 131·7 in the D. Lat. col.; this as Dep., and D. Lat. 83·8, give COURSE 57°½, DIST. 1570 miles.

319. *By Computation.* Find the Diff. Long. and the Mid. Lat., to the log. cos. of the Mid. Lat. add the log. of the Diff. Long.: the sum is the log. of the Dep.

Ex. above. D. Lat. 838, D. Long. 1319, Mid. Lat. 3° 40′.

| | | | |
|---|---|---|---|
| Mid. Lat. | 3° 40′ | log. cos. | 9·9991 |
| Diff. Long. | 1319 | log. | 3·1202 |
| | DEP. 1316 | log. | 3·1193 |

The Dep. being now found and the D. Lat. given, the Course and Dist. may be found. (No. 279.)

*Construction.* Construct the triangle for turning the Diff. Long. into Dep., as in No. 306 (reading Mid. Lat. for Lat.). Then having the D. Lat. and Dep. the process is completed by drawing the figure as for Case III. of Plane Sailing, p. 109.

320. When the Mid. Lat. is below 5°, and Dist. under 300 miles, see No. 311.

*Examples for Exercise.*

Ex. 1. If a ship from Tynemouth Castle, in Lat. 55° 1′ N. and Long. 1° 25′ W., sails S.E. by S. 296 miles: what is her present latitude and longitude?

Ans. Lat. in 50° 55′ N.; Diff. Long. 273m.; Long in, 3° 8′ E.

Ex. 2. A ship from Cape Clear, in Lat. 51° 26′ N. and Long. 9° 29′ W., sails S.W. 263 miles: required her Lat. and Long.

Ans. Lat. 48° 20′; Diff. Long. 288·7; whence the Long. in is 14° 18′ W.

Ex. 3. Find the Course and Distance between Tynemouth and the Naze of Norway.

Ans. Course N. 57° 42′ E.; Distance, 331·3 miles

Ex. 4. Required the Course and Distance from a place A, in Lat. 51° 25′ N. and Long 9° 29′ W., to a place B, in Lat. 36° 57′ N. and Long 25° 6′ W.

Ans. Course S. 37° 45′ W.; Distance, 1098 miles.

Ex. 5. Required the Course and Distance from a place A, in Lat. 56° 12′ N. and Long. 2° 36′ W. to a place B, in Lat. 57° 58′ N. and Long. 7° 3′ E.

Ans. Course N. 71° 23′ E.; Distance, 332 miles.

Ex. 6. Required the Course and Distance from A to B; Lat. of A 53° 18′ N.; Long. of A 0° 55′ E.; Lat. of B, 57° 58′ N.; Long. B 7° 3′ E.

Ans. Course N. 36° 34′ E.; Distance, 349 miles.

## 2. *Mercator's Sailing.*

321. This sailing is employed for exactly the same purposes as middle latitude sailing; but it is a perfect method, which the other is not.

The calculations are performed by the help of a table of Meridional Parts, Table 6.

322. To find the *Meridional Difference of Latitude.* When the latitudes are of the *same* name, take the *difference* of the meridional parts for the two latitudes; when of *contrary* names, take the *sum.*

Case I. Given the course between two places, and their latitudes, to find their difference of longitude.

Ex. 1. (Lats. *same* name.) A ship from lat. 51° 9′ N. sails S.W. by W. 216 miles: required the Lat. in and Diff. Long.

323. *By Inspection.* Having found the Lat. in, take out the meridional parts (Table 6) for it, and for the Lat. left; find the Meridional Diff. Lat. (No. 322).

With the Course, and Mer. D. Lat. in the D. Lat. column, find the Dep.; this is the Diff. Long.

By Case I. No. 273, the Course 5 points and Dist. 216 give D. Lat. 120 and Dep. 179·6; this D. Lat. subtracted from 51° 9′ gives Lat. in, 49° 9′ N.

| | | | |
|---|---|---|---|
| Lat. in | 49° 9′ N. | Mer. parts | 3396 |
| Lat. left | 51 9 | —— | 3583 |
| | | Mer. D. Lat. | 187 |

The Course 5 points and D. Lat. 187 give Dep. 280, or 4° 40′ the Diff. Long

324. *By Computation.* Find the Lat. in, and the Mer. D. Lat. To the log. tan. of the Course add the log. of the Mer. D. Lat.; the sum (rejecting 10) is the log. of the D. Long.

Ex. above. Lats. 49° 9′ and 51° 9′, Course 5 points.

| | | | |
|---|---|---|---|
| | 5 points | log. tan. | 10·1751 |
| Mer. D. Lat. | 187 | log. | 2·2718 |
| Diff. Long. | 279·8, or 4° 39′·8 | log. | 2·4469 |

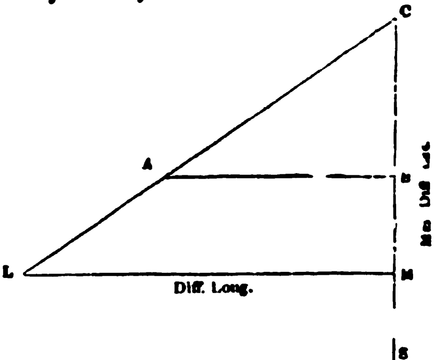
(This is the canon (3) No. 272. It will be sufficiently understood by observing that, in the fig. below, C M is the Mer. D. Lat., and M L the Diff. Long., and C M : M L :: rad. : tan. M C L the course.

This example is sufficient for any variety of the Case I.

325. *By Construction.* Lay off the course M C A, S 5 points W.; take C A 216 the Dist.; draw A B perp. to C S: the fig. C A B is, thus far, the case for plane sailing.

Now lay off C M the Mer. D. Lat. 187, and draw M L parallel to A B meeting C A produced: M L is the Diff. Long. and measures 280.

This example of construction is sufficient for Case I.




Ex. 2. A ship from lat. 29° 40′ N. sails E.N.E. till she makes 72 miles D. Lat.: find her Diff. Long.

*By Inspection.* Course 6 points and D. Lat. 72 give Dist. 188 miles: the Lat. in is 30° 52′.

| | | | |
|---|---|---|---|
| Lat. left | 29° 40′ | Mer. parts | 1865 |
| Lat. in | 30 52 | — | 1949 |
| | | Mer. D. Lat. | 84 |

Course 6 points and D. Lat. 84, give Dep. 203, or 3° 23′, the Diff. Long.

Case II. Given the latitudes and longitudes of two places to find the course and distance between them.

Ex. Find the Course and Distance between Ushant, in lat. 48° 28′ N. long. 5° 3′ W., and St. Michael's, lat. 37° 44′ N. long. 25° 40′ W.

326. *By Inspection.* Take out the mer. parts for the two lats.: find the Mer. D. Lat. and the Diff. Long.

Enter the Traverse Table with the Mer. D. Lat. as D. Lat. and the D. Long. as Dep.: this gives the Course.

Then with this Course and the *true* D. Lat. find the Dist., which is the distance required.

| | | | | | |
|---|---|---|---|---|---|
| Ushant, lat. | 48° 28′ N. | Mer. parts | 3334 | Long. | 5° 3′ W. |
| St. Mich. | 37 44 | | 2448 | | 25 40 W. |
| | 10 44 | Mer. D. Lat. | 886 | | 20 37 |
| True D. Lat. | 644 | | | Diff. Long. | 1237 |

Then 88·6 as D. Lat. and Dep. 123·7 give Course 54°; and D. Lat. 644 gives 1095 miles, the Dist. required.

327. *By Computation* (1.) For the Course. Find the Mer. Diff. Lat. and the Diff. Long. From the log. of the Diff. Long. (adding 10 to the index if necessary) subtract the log. of the Mer. D. Lat.: the remainder is the log. tan. of the Course.

(2.) For the Distance. Find the course; then to its log. sec. add the log. of the true D. Lat.: the sum is the log. of the Distance.

Ex. above. M. D. Lat. 886; D. Long. 1237; true D. Lat. 644.

| | | | | | | |
|---|---|---|---|---|---|---|
| Diff. Long. | 1237 | log. 3·0924 | | Course 54° 24′ | | log. sec. 0·2350 |
| Mer. D. Dat. | 886 | log. 2·9474 | | Tr. D. Lat. 644 | | log. 2·8089 |
| Course 54° 24′ | | tan. 0·1450 | | Dist. 1106 | | log 3·0439 |

328. *By Construction.* Draw the meridian C S* through one of the places, say Ushant, and on it lay off the Mer. D. Lat., 886 from C to M. Draw M L perpendicular to C S and equal to the Diff Long. 1237; join C L, and S C L is the Course.

Lay off C B the true D. Lat. on C S, draw B A parallel to L M and C A is the Dist. 1106.

329. When the lat. is below 5° and the dist. less than 300 m., see No. 332.

*Examples for Exercise.*

Ex. 1. A ship, in Lat. 36° 40′ S. and Long. 16° 20′ E., sails W.N.W. until she arrives in Lat. 33° 10′ S.: find the Diff. of Long. and also the Long. come to.

Ans. Diff. Long. 620·4 W.; whence the Long. come to is 6° 0′ E.

Ex. 2. A ship from Lat. 42° 25′ N. and Long. 15° 6′ W. sails N.E. by E. for several days, and then finds by observation she is in Lat. 46° 40′ N.: find what Diff. of Long. she has made; also find her Long. in.

Ans. Diff. Long. 536; whence her Long. in is 6° 10′ W.

Ex. 3. A ship, in Lat. 42° 30′ N. and Long. 58° 51′ W., sails S.E. by S. 300 miles: find the Diff. Long., and also the Long. in.

Ans. Diff. Long. 219 miles; Long. in 55° 12′ W

Ex. 4. Find the Course and Distance between Tynemouth and the Naze of Norway.

Ans. Course N. 57° 40′ E.; Distance, 331·4 miles.

Ex. 5. Required the Course and Distance between Tynemouth and Helgoland.

Ans. Course S. 81° 8′ E.; Distance, 324 miles.

Ex. 6. Required the Course and Distance from Diego Ramirez, in Lat. 56° 29′ S., Long. 68° 43′ W., and C. Lopatka, in Lat. 51° 2′ N., Long. 156° 46′ E.

Ans. Course N. 46° 21′ E.; Distance, 9346 miles

## 3. *Selection of Mid. Lat. or Mercator's Sailing.*

### [1.] *Finding the Diff. Long.*

330. The difference of longitude found by Mid. Lat. is true at the equator, and very nearly true for short distances in all latitudes especially when the course is nearly E. or W. In high latitudes, when the distance is great and the course oblique, the error becomes considerable; but the result may be made as accurate as we please by subdividing the distance run into small portions, and finding the Diff. Long. for each portion separately.

331. The Diff. Long. deduced by Mid. Lat. sailing is too small: an estimate of the error for places on the same side of the equator may be formed by the help of a few cases. Suppose the course 4 points or 45°, and the D. Lat. 10° or 600 miles; then if this D. Lat. is made good in any latitude below 30° the error of the D. Long. will not exceed 2′; if made good between the parallels of 40° and 50° the error will be about 3′; and between 60° and 70°, about 19′, or ⅓ of a degree. For smaller distances the errors will be much

* The figure in the preceding page will, after the various examples given, serve sufficiently well to illustrate generally the construction of this case. The learner will merely observe, that if the other place was to the *northward* of Ushant, the Mer. Diff. Lat. C M would be laid off to the *northward* of C. In like manner, if the other place was to the *eastward* of Ushant, the D. Long. M L would be laid off to the *eastward*, or to the right of the meridian.

less, and for greater distances much greater, as they vary in much more rapid proportion than the distances.*

332. It is proper to remark that when the Course is large, that is, near seven or eight points, the D. Long. should be found by middle latitude in preference to Mercator's Sailing; because, although the latter is mathematically correct in principle, yet a small error in the Course may, when the Course is large, produce a considerable error in the Difference of Longitude.

The reason of this is easily shewn. In mid. lat. sailing we convert the *departure* into D. Long. The process increases the Dep. in a proportion which is less than 2 to 1 in all latitudes below 60°, and exceeds 3 to 1 in latitudes beyond 70°. The error of the Dep., increased in the same proportion, becomes thus the error of the D. Long. Now when the course is nearly E. or W. the Dep. is nearly the same as the distance, and an error of some degrees in the course does not affect the Dep. sensibly; hence in this case the error of the D. Long. depends on that of the Dist. alone.

But in Mercator's Sailing, on the other hand, we convert the *Mer. Diff. Lat.* into D. Long., and the process, when the Course is large, converts a given Mer. Diff. Lat. into a D. Long. much greater than itself; and thus increases the error of the Mer. Diff. Lat. in the same proportion. Thus, for example, at the course 80° the D. Long. exceeds the Mer. Diff. Lat. in the proportion of 6 to 1; at the course 85° this proportion is 11 to 1. Now when the course is large a slight change in it sensibly affects the D. Lat., and also the Mer. Diff. Lat., which is deduced directly from it.

In high latitudes the Mer. parts vary rapidly, and the error of the D. Long. is aggravated accordingly; hence the precept more especially demands attention in high latitudes.

[2.] *Finding the Course or Bearing.*

333. The bearing of the port is truly deduced in low latitudes and at short distances by the method of Mid. Lats.; but the result cannot be rendered accurate in high latitudes by subdividing the distance, which is unknown, into small portions: such cases are truly solved by Mercator's sailing.

When the bearing is large, or near 90°, the method of Mid. Lats. should be preferred to Mercator.

334. The course or bearing computed by mid. lat. sailing is too great. The error, however, in ordinary cases, will be much less than that to which the ship's course itself is liable.

335. The Course as reduced by Traverse sailing, from several courses, does not afford accurately whether by Mercator's or Middle Latitude Sailing, the Diff. Long. made good by the ship, because the

* The proper mid. lat. to employ should be somewhat greater than the mean of the lats. A Table has been given, by Workman ("Navigation Improved," London, 1805), shewing the correction to be added to the mean of the latitudes, in order to obtain true results. But for common purposes the usual method, of which the recommendation in practice is its great convenience, would seem to be near enough, and when more precision is required the complete solution by Mercator's Sailing is effected with very little more labour. (See No. 334.)

Diff. Long. made good on any Course depends entirely upon the latitude in which the ship actually moves.

Ex 1. A ship sails from Lat. 70° N.; 1st, N.E. 400 miles to Lat. 74° 43′, then S.E. 400 miles, when she returns to the parallel of 70°, having made Dep. 556 miles, and D. Long. 31° 18′.

Ex. 2. She sails 556 miles on the parallel of 70°, making D. Long. 27° 34′.

Ex. 3. Starting from 70°, as above, she sails S.E. 400 miles to Lat. 65° 17′, then N.E. 400 miles to 70°, having made 556 miles of Dep. and D. Long. 24° 54′.

The 1st and 3d case, reducing the two courses to one by the Traverse Table, give the same Course and Dist. made good as in Case 2, viz. East 556 miles, or Dep. 556 m., and D. Long. 27° 34′, which is erroneous. In Case 1, this Dep. is made good in the average lat. of 72°½; in Case 2, in 70°; and in Case 3, in 68°.

It may appear perplexing to the student that the ship should return to the *same parallel*, after having made a *given Dep.*, and yet that her long., that is, her position in the parallel, should be different in different cases; but he must bear in mind that the Dep. has not been made good *on the parallel*, except in Case 2. If he lays off a case of the kind on the globe, he will perceive clearly the nature of the question.

To obtain accurately the Diff. Long. each course should therefore be separately considered. But, in general, except in very high lats., the distances are not large enough to introduce much error on this account.

## III. Great Circle Sailing.

336. When the ship sails on a rhumb line (No. 198), her track cuts all the meridians as she passes them in succession, at the same angle; and thus, while steering a course, her head is kept on the *same point of the compass* until she reaches her intended port. This condition, namely, keeping the course constant, is the most convenient in practice, and, besides, produces in all the calculations in which the place of the ship is concerned the utmost simplicity of which they are capable. But the track on the rhumb line is not the *shortest distance* measured directly over the surface of the sphere from one place to another, or the distance "as the crow flies," except when the course is due north or south, or east or west on the equator. The shortest distance between two points on the surface of a sphere is the portion or arc which they include of the circle passing through both the points and the centre of the sphere. Such a circle is called a *great circle*,* as distinguished from other circles whose centres do

* The great circle passing through two places may be found on a globe by stretching a thread evenly between them; or, by turning the globe about till the two places fall on the upper edge of the wooden rim, or horizon of the globe, which thus marks the circle. The distance between the points may be measured at once by laying the thread along the equator of the globe. The courses are found by measuring the angles between the thread and the meridians; the most convenient instrument for which is the horn semicircle, or protractor, as it is also called (No. 108). In order to compare the great circle with the rhumb line the latter must be projected on the globe.

not coincide with the centre of the sphere; as, for instance, the parallels of latitude, of which the centres are in the axis between the centre and the pole, and which are called *small* circles. Hence sailing on a circle of the former kind is called GREAT CIRCLE SAILING.* On this course, and on this course alone, the ship steers for her port as if it were in sight.

The three arcs joining two points on the surface of a sphere with each other, and with a third point, and having for their common centre the centre of the sphere, constitute a Spherical Triangle. In the problem under consideration the two places are the two points, and the third point is the pole, and the triangle is formed by the distance between the places and their colatitudes. Some of the rules in this section may be employed accordingly in other problems of spherical trigonometry.

337. Great Circle Sailing is adapted principally to the second only of the two cases, No. 270, or Shaping the Course; because the ship, even when moving on a great circle, must necessarily be kept on the same course (that is, on a rhumb line) for a short distance at a time, and her place may then be deduced by the rules already given in the preceding section with incomparably greater convenience than it could by any rule in which the distance made good was rigorously considered as described on a circle. Although this sailing is thus restricted to one case, we shall, for the sake of clearness, divide the problem of finding the course by *Inspection* into two cases, namely, Case I. in which the places are on the *same* side of the equator, and Case II. in which they are on *opposite* sides.

Case I. *By Inspection.* (The places on the *same* side of the equator.)

(1.) For the Dist. With the two lats. enter the Spherical Traverse Table (Table 5), and take out M and N.

With the complement of the Diff. Long. as a Course and Dist. 100 (Table 2), find the Dep., and write it under N.

When the Diff. Long. is *less* than 90°, *add* this Dep. to N.; when the Diff. Long. is *greater* than 90°, take the *diff.* of the Dep and N.

With this sum (or diff.) as D Lat. and M as Dist. find the arc in Table 2: this is the Distance required in degrees of 60 miles each.

(2.) For the Course. Having found the Distance. With the lat *in*, and the compl. of the Dist. in degrees, find M. and N (Table 5.)

With the lat. *to* as Course and M as Dist. (Table 2), find the Dep., and write it under N. When the Diff. Long. is *less* than 90°, take the *diff.* between this Dep. and N. When the Diff. Long. exceeds 90°, take the *sum* of the Dep. and N.

With this diff. (or sum) as D. Lat. and Dist. 100 (Table 2), find the Course.

---

* Parallel sailing, for a like reason, is sailing on a *small* circle.

The Course is to be reckoned according to the following rule:

| Dist. *less* than 90° (or 5400 miles). | | Dist. *greater* than 90° (or 5400 miles. |
|---|---|---|
| Dep. *less* than N. | Dep. *greater* than N. | Course to be reckoned |
| Course to be reckoned<br>in N. lat. from S.<br>in S. lat. from N. | Course to be reckoned<br>in N. lat. from N.<br>in S. lat. from S. | in N. lat. from N.<br>in S. lat. from S. |

Ex. 1. Find the Distance between St. Helena, in lat. 15° 55′ S., long. 5° 44′ W., and Cape Horn, in lat. 55° 59′ S. and long. 67° 16′ W., and the Course from each place to the other.

The D. Long. between 5° 44′ W. and 67° 16′ W. is 61° 32′; compl. 28°.

For the Distance.

| | | |
|---|---|---|
| 16° and 56° (the lats.) give | M 186·0 | N 42·5 |
| 28° (co-diff. long.) and Dist. 100 give | | Dep. 46·9 |
| (D. Long. less than 90°.) | | *Sum* 89·4 |

The Dist. 186·0 and D. Lat. 89·4 give 61° nearly, or Dist. 3660 miles. The complement of 61° is 29°.

For the Course from St. Helena.

16° (Lat. *in*) and co-Dist. 29° M 118·9 N 15·9
56° (Lat. *to*) and Dist. 118·9 Dep. 98·6
(D. Long. *less* than 90°.) *Diff.* 82·7

Dist. 100 and D. Lat. 82·7 give 34°, which is S. 34° W., the Course required, because the Dist. is *less* than 90°, the Dep. *greater* than N, and the Lat. is south.

For the Course from C. Horn.

56° (Lat. *in*) and co-Dist. 29° M 204·5 N 82·2
16° (Lat. *to*) and Dist. 204·5 Dep. 56·3
*Diff.* 25·9

Dist. 100 and D. Lat. 25·9 give 75°, which is N. 75° E., the Course required, because the Dist. is *less* than 90°, the Dep. *less* than N, and the Lat. is south.

By Mercator's Sailing the Course is 50° from either place to the other, and the Distance 3740 miles.

Ex. 2. Find the Distance between Madeira, in lat. 32° 38′ N., long. 16° 55′ W., and Bermuda, in lat. 32° 20′ N., long. 64° 51′ W., and the Course from Madeira.

The D. Long. is 47° 56′; the compl. 42°.

For the Distance.

32° and 33° M 140·6 N 40·6
42° (co-D. Long.) and 100 Dep. 66·9
Sum 107·5

Dist. 141 and D. Lat. 107·5 give 40°, or 2400 miles, the Dist. required.

For the Course.

33° (Mad.) and co-Dist. 50° M 185·5 N 77·4
32° (Berm.) and 185·5 Dep. 98·3
Diff. 20·9

Dist. 100 and D. Lat. 20·9 give 78°, which is N. 78° W., the Course required, because the Dist. is *less* than 90, the Dep. *greater* than N, and the Lat. north.

Ex. 3. Find the Distance between a point in long. 180° on the equator, and another in lat. 40° N., long. 140° W., and the Courses between these points.

For the Distance. Lats. 0° and 40° give M 130·5 and N 0. Then 50° (the co-D. Long.) and Dist. 100 give Dep. 76·6; the sum of N and this is 76·6, and Dist. 130·5 with D. Lat. 76·6 gives 54°, or Dist. 3240 miles.

For the Course from Lat. 0°. 0° and the co-Dist. 36° give M 123·6, N 0; 40° and 124 give Dep. 79·7; Dist. 100 and D. Lat. 79·7 give 37°, which is N. 37° E., the Course required.

For the Course from Lat. 40°. 40° and 36° give M 161·4, N 61·0; 0 and Dist. 161 give Dep. 0; Dist. 100 and D. Lat. 61·0 give 52°, which is S. 52° W., the Course required as the Dep. 0 is less than N.

338. Case II. *By Inspection.* (The places on *opposite sides* of the equator.)

(1.) For the Distance. With the two lats. take out M and N. (Table 5.)

With the complement of the D. Long. as Course (Table 2), and Dist. 100, find the Dep.

When the D. Long. is *less* than 90°, take the *difference* between this Dep. and N; when the D. Long. is *greater* than 90°, take the *sum*.

With this diff. or sum as D. Lat. and M as Dist. find the Course or arc in Table 2.

When the D. Long. is *less* than 90°. If the Dep. is *greater* than N, this arc is the Dist. required; if the Dep. is *less* than N, take the supplement.

When the D. Long. is *greater* than 90°, take the supplement of the arc.

(2.) For the Course. Having found the Distance, with the Lat. *in* and the complement of the Dist. to 90°, find M and N.

With the Lat. *to* as course and M as Dist. (Table 2), find the Dep.

When the D. Long. is *less* than 90°, take the *sum* of this Dep. and N; when the D. Long. is *greater* than 90°, take the *difference*.

With this sum or diff. as D. Lat. and Dist. 100 (Table 2), find the Course, which is to be reckoned as follows:—

| Dist. *less* than 90° (or 5400 miles.) | Dist. *greater* than 90° (or 5400 miles) | |
|---|---|---|
| Course to be reckoned | Dep. *less* than N. | Dep. *greater* than N. |
| | Course to be reckoned | Course to be reckoned |
| in N. lat. from S.<br>in S. lat. from N. | in N. lat. from N.<br>in S. lat. from S. | in N. lat. from S.<br>in S. lat. from N. |

Ex. 1. Find the Distance between C. Palmas, in lat. 4° 22′ N. long. 7° 44′ W., and C. Frio, in lat. 23° 0′ S. long. 41° 57′ W., and the Course from each place to the other.

The D. Long. is 34° 13′; the complement is 65°.

For the Distance.

| | | |
|---|---|---|
| 4° and 23° (lats.) give | M 108·9 | N 3[illegible] |
| 56° (co-Diff. Long.) and 100 | | Dep. 82·9 |
| (D. Long. *less* than 90°.) | | *Diff.* 79·9 |

Dist. 109 and D. Lat. 79·9 give 43°, or Dist. 2580 miles; the compl. is 47°.

For the Course from C. Palmas.

| | | |
|---|---|---|
| 4° (C. Pal.) and 47° | M 147·0, N | 7·5 |
| 23° (C. Frio) and 147 | Dep. | 57·4 |
| (D. Long. *less* than 90°.) | *Sum* | 64·9 |

Dist. 100 and D. Lat. 64·9 give 49°, which is S. 49° W., the Course required, because the Dist. is *less* than 90° and the Lat. is north.

For the Course from C. Frio.

| | | |
|---|---|---|
| 23° (C. Frio) and 47° | M 159·3, N | 45·5 |
| 4½ (C. Pal.) and 159 | Dep. | 12·5 |
| | *Sum* | 58·0 |

Dist. 100 and D. Lat. 58·0 give 55°, which is N. 55° E., the Course required, because the Lat. is south.

Ex. 2. Find the Courses and Distance between Diego Ramirez, in lat. 56° 29′ S. long 68° 43′ W., and C. Lopatka. in lat 51° 2′ N. long. 156° 46′ E. The D. Long. is 134° 31′, the co-D. Long. 45°.

For the Distance. 51° and 56½° give M 288·0, N 186·6. Then 44½° and Dist. 100 give Dep. 70·1; the *sum* of N. and Dep., or 256·7 as D. Lat., and Dist. 288, give 27°, or DIST. 153°, or 9180 miles: the co-dist. is 63°.

For the Course from Diego Ramirez. 56½° and 63° give M 399·1, N 296·6; 51° and 399 give Dep. 310·0; the *diff.* 13·4 and Dist. 100 give 82°: COURSE, N. 82° W.

For the Course from C. Lopatka. 51° and 63° give M 350·0, N 242·4; 56½° and 350 give Dep. 291·8; the *diff.* 49·4 and Dist. 100 give 60°: COURSE, S. 60° E.

339. To find the Courses and the Distance between the places *by Computation.* Find the co-latitudes of the places. If the places are on different sides of the equator, add 90° to the latitude of one of them for its co-latitude. Find the D. Long., and take half of it.

(1.) For the Courses. Take half the sum of the colats. and half their diff. Add together the log. cot. of half the D. Long., the log. sec. of the half sum, and the log. cos. of the half difference: the sum (rejecting tens) is the log. tang. of half the sum of the two courses.

When the half sum of the colats. exceeds 90°, take the supplement of the resulting arc for the half sum required.

To the same log. cot. add the log. cosec. of half the sum of the colats., and the log. sine of half their diff.; the sum (rejecting tens) is the log. tan. of half the difference of the two courses.

The *sum* of the half sum and half diff. of the two courses is the course from the place in the *smaller* of the two co-latitudes to the other; the *difference* of the said half sum and half diff. is the other course.

The course is to be reckoned from the N. point in north latitude, and from the S. point in south latitude.

Ex. 1. Find the Courses on the great circle, between St. Helena, in lat. 15° 55′ S., long. 5° 44′ W., and C. Horn, in lat. 55° 59′ S., long. 67° 16′ W.

The D. Long. is 61° 32′; half D. 30° 46′.

| | | | | | | |
|---|---|---|---|---|---|---|
| Colat. 34° 1′ (C. Horn) | 30° 46′ | cot. 0·2252 | | 0·2252 | | |
| Colat. 74 5 (St. Helena) | | | | | | |
| Sum 108 6 | half sum 54 3 | sec. 0·2313 | | cosec. 0·0918 | | cos. 9·7687 |
| Diff. 40 4 | half diff. 20 2 | cos. 9·9729 | | sin. 9·5347 | | sin. 9·7089 |
| | 69° 35′ | tan. 0·4294 | 35° 24′ | tan. 9·8517 | 69° 35′ | sec. 10·4574 |
| | 35 24 | | | | 30 34 | cos. 9·9350 |
| COURSE, S. | 104 59 | E. from C. Horn, or N. 75° 1′ E. | | | 2 | |
| COURSE, S. | 34 11 | W. from St. Helena. | | | 61 8 = 3668 m.* | |

Ex. 2. Find the Courses on the great circle between Diego Ramirez, in lat. 56° 29′ S., long. 68° 43′ W., and C. Lopatka, in lat. 51° 2′ N., long. 156° 46′ E.

The D. Long. is 134° 31′; the co-lats. 33° 31′ and 141° 2′. The half sum of the required courses is 79° 8′, and the half diff. 18° 42′. The sum of these is the COURSE from colat. 33° 31′. or Diego Ramirez, S 97° 50′ W., or N. 82° 10′ W.; the diff. is the COURSE from C. Lopatka, or S. 60° 26′ E.

(2.) For the Distance. By above method,* or take the supplement of the Diff. Long. to $12^h$ or 180°. Add together the two co-lats.

Add together the log. sine square of the said supplement, and the log. sines of the co-latitudes: the sum (rejecting tens) is the log. sine square of an auxiliary arc *x*.†

Write *x* under the sum of the colats., and take the sum and difference, and the half sum and half difference.

Add together the log. sines of the last two terms: the sum (rejecting tens) is the log. sine square of the Distance required.

† Log sine square is identical with the log. haversine of Inman's tables.

**Ex.** Find the Distance between St. Helena, in lat. 15° 55′ S., long. 5° 44′ W., and C. Horn, in lat. 55° 59′ S. and long. 67° 16′ W.

| | | | |
|---|---|---|---|
| Diff. Long. | 61° 32′ | | |
| Suppl. | 118 28 ......... | log. sin. sq. | 9·868247 |
| Colat. | 34 1 ......... | log. sin. | 9·747749 |
| Colat. | 74 5 ......... | log. sin. | 9·983022 |
| Sum | 108 6 | | |
| Arc $x$ | 78 8 ......... | log. sin. sq. | 9·599018 |
| Sum | 186 14 | | |
| Diff. | 29 58 | | |
| ½ Sum | 93 7 ......... | log. sin. | 9·999357 |
| ½ Diff. | 14 59 ......... | log. sin. | 9·412524 |
| Dist. 61° 4′, or 3664 miles. | | log. sin. sq. | 9·411881 |

The Distance by Mercator's Sailing (No. 327) is 3736 miles, or 72 more.

340. The course on the rhumb line,* from one of two places to the other, is exactly the opposite of the course to that place from the other; while, on the great circle, as appears from the preceding examples, these courses are very different. The ship, while on the rhumb line, is always changing the direction of her head with respect to her port, for which she never steers exactly until it is in sight, because this track cuts all the meridians at the same angle. and the meridians themselves are not parallel to each other; but on a great circle she steers directly for her port, while, as the angle made by her track with the meridians is perpetually varying, the direction of her head appears by the compass to be continually changing. This track, accordingly, is the only one on which the ship nears her port by the whole amount of distance which she makes good from instant to instant.

Great circle sailing includes the case of sailing on a meridian or due N. and S., and on the equator, because the meridians and equator are great circles.

341. While sailing at the same rate on the same rhumb, the ship always changes her latitude by the same quantity; but while sailing at the same rate on the great circle she may change her latitude, not only by unequal quantities, but in opposite directions. For example, suppose the polar seas navigable, then the shortest way for the ship to go from a point in the arctic circle (or any other parallel of north latitude) to another point 180° of longitude from it, and in the same latitude, would be to cross the pole; in which case she would first steer north and then south, whereas on the rhumb line she would constantly steer east or west.

342. The track on the great circle and that on the rhumb line differ most widely from each other in high latitudes, and between places on nearly the same parallels. On the other hand, when the places are on opposite sides of the equator, the great circle and rhumb line intersect each other, and the difference between them is not so conspicuous. In low latitudes, and in all latitudes when the course is nearly on a meridian, the two curves nearly coincide.

343. If the arc of the great circle passing through the two places (not being both on the same meridian or on the equator) be pro-

* Also called the loxodromic curve.

duced beyond them, and carried round the globe, it will pass through two points diametrically opposite in latitude and longitude, which we have called *vertexes*, each of them being the highest point in latitude N. and S., passed through by the circle. The vertex is 90° from the point where the great circle between the places (or produced beyond them) cuts the equator.

When the course shaped on the great circle from each place is less than 90° (reckoning both courses from the nearest pole), the vertex falls between the places. At this point the ship, neither increasing nor diminishing her latitude for a time, steers E. or W. But when the course from one of the places exceeds 90°, the vertex of the circle falls outside the arc joining them.

344. To find the Latitude and Longitude of the Vertex.

(1.) For the Latitude. To the log. cos. of the lat. of one of the places add the log. sine of the course, on the great circle, from this place to the other: the sum is the log. cos. of the lat. required.

(2.) For the Longitude. Add together the log. cosec. of the latitude already employed, and the log. cot. of the course already employed: the sum is the log. tan. of the D. Long. between the vertex and the place worked from.

Ex. 1. Find the vertex of the great circle passing through Rio de Janeiro, in lat. 22° 55′ S. long. 43° 9′ W., and the Cape of Good Hope, in lat. 34° 22′ S. long. 18° 30′ E.

The Course from Rio is S. 63° 12′ E., that from the Cape S. 84° 54′ W.; each of these courses, reckoned from S., being less than 90°, the vertex falls between the places.

| Latitude. | | | Longitude. | | | |
|---|---|---|---|---|---|---|
| Rio, lat. | 22° 55′ | cos.* 9·9643 | | 22° 55 | cosec. | 0·4096 |
| Course | 63 12 | sin. 9·9506 | | 63 12 | cot. | 9·7034 |
| Lat. | 34° 42′ | cos. 9·9149 | D. Long. | 52° 23′ | tan. | 0·1130 |
| | | | Rio | 43 9 W. | | |
| | | | Long. | 9 14 E. | | |

Ex. 2. Find the vertex on the great circle passing through St. Helena and C. Horn.

By Ex. No. 339, the Course from St. Helena is S. 34° 12′ W., that from C. Horn is S. 104° 58′ E.; since one of these courses exceeds 90°, the vertex falls without.

Ans. Lat. 57° 17′ S.; Long. 85° 10′ W.

345. When the ship sails on a great circle between two places on the same side of the equator, she is always in a *higher latitude* than if she had sailed on the rhumb line; hence, since both tracks coincide at their extremities, there must be a point in the great circle at which its distance from the rhumb line, measured on a meridian, is greater than anywhere else; this point we shall call the point of *Maximum Separation in Latitude.*

When the ship crosses the equator, there are two such points, the one being to the northward of the rhumb line in north latitude, and the other to the southward of the rhumb line in south latitude.

346. The track of the great circle between any two points

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* As none but the logarithmic sines, cosines, &c. are employed in this work, except in No. 234, we shall henceforth, for brevity, dispense with the abbreviation *log.* in the examples.

may be conveniently shewn, by determining the latitude of its point of intersection with each of a certain number of intervening meridians, the degree of exactness being increased according to the number of meridians taken.

To find the latitude of the point where the great circle passing through two places intersects any given meridian,

Find the position of the vertex (No. 344).

To the log. tan. of the lat. of the vertex add the log. cos. of the difference of long. between it and the given meridian, and the sum is the log. tan. of the required latitude.

Ex. Find the latitude of the point where the great circle passing through St. Helena and Cape Horn intersects the meridian of 30° W.

Vertex (Ex. 2, 344) lat. 57° 17′ S., long. 85° 10′ W.

| | | | |
|---|---|---|---|
| Latitude | 57° 17′ | tan. | 0·1922 |
| Diff. Longitude | 55 10 | cos. | 9·7568 |
| Required Latitude | 41 39 | tan. | 9·9490 |

The log. tan. of the lat. of the vertex being constant, the lats. of the points of intersection of the great circle with any desired number of meridians may thus be rapidly computed.

347. To facilitate the practice of Great Circle Sailing, Mr. J. T. Towson in 1847 devised a method by which, using a diagram and a table, the successive courses on the great circle can be found without the labour of calculation.*

The manner of projecting the track, and of measuring the distance on Mercator's chart, are described in Chap. V. Other matters demanding consideration when it is proposed to make a voyage on a great circle, are treated in the division of the work appropriated to Navigating the Ship.†

* Towson's Tables for facilitating Great Circle Sailing. Sold by J. D. Potter, 145 Minories, London, E.

† The Azimuth and Star-azimuth Tables of Burdwood and Davis also facilitate Great Circle Sailing. The lat. in being taken as the Lat., the lat. of the port bound to as the Dec., and the diff. long. as the Hour-angle, gives the Azimuth, which will be the True Course. From these the Great Circle Course may be projected on the Chart. *See* Burdwood and Davis' Azimuth Tables, published by Potter, 145 Minories.

Ex., a ship bound from Cape King, entrance of Yedo Bay, to San Francisco. Cape King, lat. 34° 54′ N., long 139° 53′ E. San Francisco, lat. 37° 48′ N., long. 122° 29′ W. Diff. long. 97° 38′, or $6^h\ 30^m\ 32^s$.

| Lat. in. | Lat. bound to. | Diff. long. as Hour-angle. | Azimuth or True Course. | Cutting Mer. of |
|---|---|---|---|---|
| 35° | 38° | $6^h\ 30^m$ | N. 54° E. | 150° E in lat 41° |
| 41 | 38 | 5 50 | N. 61 E. | 160 E. „ 45 |
| 45 | 38 | 5 10 | N. 68 E. | 170 E. „ 48 |
| 48 | 38 | 4 30 | N 75 E. | 180 „ 49 |
| 49 | 38 | 3 50 | N. 83 E. | 170 W. „ 50 |
| 50 | 38 | 3 10 | N. 91 E. | 160 W. „ 50 |
| 50 | 38 | 2 30 | N. 100 E. | 150 W. „ 49 |
| 49 | 38 | 1 50 | N. 109 E. | 140 W. „ 47 |
| 47 | 38 | 1 10 | N. 119 E. | 130 W. „ 43 |
| 43 | 38 | ... ... | N. 131 E. | San Francisco. |

# CHAPTER IV.

## Taking Departures.

I. By a Single Bearing and Distance. II. Determination of Distance. III. Methods by the Chart.

348. Determining the place of the ship with reference to a point of land, or other position of known latitude and longitude, is called *Taking a Departure.*

The position of the ship with respect to a point of land or other fixed and conspicuous object is defined by the *direction* in which she lies, and her *distance* from it.

The *direction* or bearing of the ship from the land, being the opposite of the bearing of the land from the ship, is furnished at once by the compass, or it may be found by observation of an *Astronomical Bearing;* but the *distance* from the point, when it cannot be estimated or guessed with sufficient precision, must be deduced by means of some further observation, taken at the same time as the bearing, or after an interval.

When a former position of the ship herself is adopted as a point of departure, the direction (or course) and the distance are deduced from the reckoning.

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### I. By a Single Bearing and Distance.

349. The object being set by the compass, its distance is estimated by the eye.

This, which is the common method of taking departures, is near enough when the distance is small; but the error or uncertainty in the estimation of the distance, which, perhaps, may be stated generally at one-fifth of the whole, becomes considerable when the distance is great. Distances thus estimated are generally overrated.

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### II. Determination of Distance.

#### 1. *By two Bearings of the same Object.*

350. When the ship's path lies across the line of direction of the object, the distance can be obtained by two bearings and the distance run by the ship in the interval of time between them

Take the bearing of the object, and note the number of points contained between it and the ship's head. After the bearing has altered not less than two or three points, note the number of points in the same angle again.

NOTE. The course and distance between the positions must be those actually made good.

(1.) To find the distance when the *last* bearing was taken.

Enter Table 7 with the first number of points at the top and the second number of points at the side; take out the number corresponding, and multiply it by the number of miles made good by the ship: the result is the dist. in miles at the time the *last* bearing was taken.*

Ex. The Eddystone bore N.W. by W.; after running W. by S. 8 miles, it bore N.N.E.: required its Dist. at this last bearing.

The number of points between N.W. by W. and W. by S. is 4; that between N.N.E. and W. by S. is 11; under 4 at the top and against 11 at the side stands 0·72, which multiplied by 8 (miles), gives 5·8 miles, the DIST. required.

The student can easily supply a figure.

(2.) To find the distance when the *first* bearing was taken.

Enter the Table with the supplement (or difference from 16 points) of the second number of points at the top, and the supplement of the first number of points at the side; take out the multiplier, and proceed as above directed.

Ex. Find the Distance of the Eddystone at the time the first bearing (or N.W. by W. above) was taken.

The second number of points is 11, the supplement of which is 5; the first number is 4 points, the supplement of which is 12; then 5 at the top and 12 at the side give the number 0·85, which multiplied by 8 gives 6·8 miles, the DIST. required.

When the number of points between the object and the ship's head at either observation is 8, that is, when the bearing is at right angles to the course, the distance may be found by the Traverse Table, by entering the table with the number of points at the other observation as a course, and the distance run as D. Lat.; the corresponding Dep. is the distance of the object when observed at 90° from the course.

351. If the time be noted when an object is 4 points on the bow, and again when it is right abeam, the distance run in the interval on the same course is evidently equal to the distance off the object when abeam. This case is called the *Four-point bearing*. It is, however, only a case of the general problem. If a ship having a point of land or other object at any angle on the bow, proceeds steering the same course till a position is reached where the angle on the bow is doubled, the distance from the object at the last position is equal to the distance between the two positions. The case is most favourable when from the positions chosen the object is 30° before and 30° abaft the beam; the triangle is then equilateral.

* This Table was constructed at the suggestion of Sir F. Beaufort, and first appeared in the *Nautical Magazine*, vol. i. p. 208

The error of the required distance produced by an error in the dist. run, is a matter of simple proportion. For example, if the dist. run be $\frac{1}{10}$ of itself in error, the distance required will also be $\frac{1}{10}$ of itself in error. Hence the dist. run should not be much less than the distance required.

### 2. *By Sound.*

352. An excellent mode of determining the distance is obtained by noting the number of seconds elapsed between seeing the flash of a gun and hearing the report. Sound travels, in a calm, about 1130 feet in one second at a temperature of 66° Fahr.; hence it is easy to deduce the following approximate rule.

Divide the seconds elapsed by 5, and subtract from the quotient $\frac{1}{12}$ of itself; the result is the Dist. in miles very nearly.

Ex. The mean of the intervals given by 4 guns fired from C. Shilling was 14$^s$·1 required the Dist. of the ship.

$$\begin{array}{rr} & 5)\underline{14{\cdot}1} \\ & 2{\cdot}8 \\ \text{1-twelfth of } 2{\cdot}8 & \underline{{\cdot}2} \\ \text{DIST.} & 2{\cdot}6 \end{array}$$

This method is capable of much precision when the gun and the ear are at the same temperature and at the same height.* A moderate breeze in the direction of the sound causes a variation of about 20 feet a second in the velocity; a strong breeze more.

### 3. *By the Altitude of High Land.*

[1.] *When the Object is seen on the Sea-Horizon.*

353. The distance of the visible horizon from the spectator is equal to the true depression or dip of the eye in Table 8, increased by about $\frac{1}{12}$ of itself.† Thus, if the eye be twenty feet above the sea, the horizon is distant five miles and about half a mile more.

When, therefore, the sea-horizon is seen beyond the object, the distance of the latter is less than the depression.

354. When the summit, or any other point of known height of an object situated beyond the sea-horizon is seen *on this line*, its distance is at once known; for since the eye, the horizon, and the object are in the same straight line, the same horizon corresponds to both the height of the eye and that of the object; the distance, therefore, between these two points is, by No. 205, the sum of the depressions corresponding to the two heights.

Ex. From the mast-head, 87 feet above the sea, the Lizard Light, the height of which is 223 feet above low-water mark, is seen on the horizon: required its distance.

The dip (Table 8) to 87 feet is 10′, that to 223 is 16′; the sum 26 increased by $\frac{1}{12}$ of 26, or 2′, is 28 miles the DIST. required.

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* The uncertainty to which this method is liable (though not worth notice in navigation) may, when precision is required, be removed, in the ordinary state of the atmosphere, by firing a gun at each extremity of the line, and taking the mean of the observed intervals.

† In this and the following rules $\frac{1}{12}$ is used instead of $\frac{1}{14}$ (see No. 207), because 12 is an easier divisor than 14. The difference is not worth notice.

This method will often be useful, but from the great uncertainty of terrestrial refraction it is impossible to assign with precision the degree of dependance.

[2.] *When the Object is seen above the Sea-Horizon.*

355. Case I. When the height of the summit, or other point of high land, is known, its distance is found by means of the altitude observed above the sea-horizon with a quadrant or sextant.*

356. *The Observation.* Observe the altitude of the summit, and estimate its distance in miles.

When the altitude exceeds 3° see No. 359.

357. *The Computation.* Alt. under 3°. (1.) Correct the alt. for index error (No. 496), and subtract from it $\frac{1}{12}$ of the estimated distance; the remainder is the true alt.

When the height of the eye exceeds 30 feet, add $\frac{1}{12}$ of the corresponding Depression; the sum is the true altitude.

(2.) From the true alt. subtract the true Depression to the height of the eye, Table 8: note the remainder.

To the square of the Depression corresponding to the height of the summit add the square of the remainder (which is found at once in the column headed "Square," against the remainder as a Depression). Look for the sum in the column headed "Square," and take out the Depression corresponding; from this take the remainder: the result is the distance of the summit in miles.†

Ex. 1. The alt. of a hill 2000 feet high is observed 56′; corr. for index error, −3′; the height of the eye, 20 feet; estimated Dist. 8 leagues, or 24 miles: required its Distance.

Deducting $\frac{1}{12}$ of 24, or 2′, and 3′ error, leaves true alt. 51′.

| | | | | |
|---|---|---|---|---|
| True alt. | 51′ | Square of Depr. to 2000 ft. | | 2304 |
| True Depr. to 20 ft. | − 5 | Ditto of Rem. 46′ | | + 2116 |
| Rem. | 46 | Depr. 67′ | Square | 4420 |
| | | Rem. −46 | | |
| | | Dist. required 21′ or miles. | | |

Ex. 2. April 19th, 1829, Mr. Fisher observed from the poop of H.M.S. Spartiate, 74, the alt. of Mount Etna, 1° 26′ 30″; index corr. + 1′ 30″; height of eye, 30 feet; estimated dist. 20 leagues: required its Distance. Height of Etna, 10900 feet.

| | | | | |
|---|---|---|---|---|
| | 1° 26′ | Square of Depr. to 10900 ft. | | 12321 |
| $\frac{1}{12}$ of 60′, −5′ / Ind. cor. +2 | − 3 | Ditto of Rem. 77′ | | + 5929 |
| Alt. | 1 23 | Depr. 135′ | Square | 18250 |
| True Dep. to 30 ft. | − 6 | Rem. −77 | | |
| Rem. | 1 17 or 77′ | Dist. required 58′ or miles. | | |

The distance by the chart was 57 miles.

358. When the distance is too great for estimation, and the altitude low, the computation must be repeated.

Ex. Captain Beechey observed from H.M.S. Sulphur, the Peak of Teneriffe clearly defined against the setting sun; mean of 3 alts. on the arc, 19′ 32″; off the arc, 19′ 50″; the

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* In this instance, reference is necessarily made to the use of instruments which belong principally to Nautical Astronomy, and are, therefore, described in that subject, Chap. II.

† When the height of the eye exceeds 30 feet, subtract from the sum of the two squares (above) the square of the corresponding Depression. From the nature of the observation, it is enough to work to minutes only.

mean, 19 41 ; height of the eye, 18 feet; height of the Peak, 12172 feet: required its Distance.

| | | | | |
|---|---|---|---|---|
| Alt. | 20′ | Square of Depr. to 12200 ft. | | 13689 |
| Depr. | −4 | Ditto of Rem. 16′ | | +256 |
| Rem. | 16 | Depr. 118′ | Square | 13945 |
| | | −16 | | |
| | | Dist. required 102′ or miles. | | |

Using this now as an *estimated* distance, and repeating the work, gives 109 miles. It was found next day by the chronometers to have been 115 miles.

359. When the altitude is great, or above 3°, the following rule for the computation is preferable to No. 357 :—

(1.) Correct the altitude for index error, subtract from it $\frac{1}{12}$ of the estimated distance in miles, subtract further the true Depr. of the eye (Table 8), and note the remainder.

When the height of the eye exceeds 30 feet, increase the remainder by $\frac{1}{13}$ of the depression.

(2.) Add the log. cos. of this remainder to the log. cos. of the Depr. corresponding to the height of the mountain; the sum (rejecting 10) is the log. cos. of an arc. From this arc take the said remainder, this leaves the Dist. of the summit in miles.

Ex. Mr. Fisher observed the altitude of Mount Etna, 5° 15′; height of the eye, 30 feet; estimated distance, 8 leagues, or 24 miles: required its Distance.

| | | | | |
|---|---|---|---|---|
| Alt. | 5° 15′ | Etna, ht. 10900 ft. Dep. | 1° 51′ | cos. 9·999774 |
| $\frac{1}{12}$ of 24 | −2 | ......................Remainder | 5 8 | cos. 9·998255 |
| Depr. | −5 | | 5° 27′ | cos. 9·998029 |
| | | Remainder | 5 8 | |
| | | Dist. | 19 miles. | |

360. *Degree of Dependance.* To judge of this, repeat the computation, using a new altitude, varied from the former by a number of minutes equal to the extent of the probable uncertainty.

For example. Suppose in Ex. 1, No. 357, the altitude doubtful, or in error, 5′; repeating the work, with the altitude 46′, gives the distance 23 miles, instead of 21: hence we infer that, supposing 5′ to be in this case the utmost probable uncertainty in the altitude, the distance may be depended upon to 2 miles.

The greater the altitude the more accurate is the result.

361. Case II. When the height of the land is not known, the distance may be found while standing directly towards it, or from it, by means of two altitudes, and the distance run in the interval between them.

If the course is not more than two points out of the direction of the object, the distance run may be reduced to the change of distance of the object by means of the Traverse Table.

362. *The Observation.* Observe the altitude. After a considerable change in the altitude, observe a second altitude at the same height of the eye. Note the rate of sailing. Estimate the distance at each observation.

363. *The Computation.* Find the true altitudes, No. 357. (1.) Find from the rate of sailing the dist. run, and reduce it when necessary to the change of distance made good in the direction of the object, thus,—enter Table 1 with the difference between the ship's

course and the bearing of the object as a Course, and the Dist. run as Dist.; the corresponding D. Lat. is the change of distance required.

To the lesser altitude add half the change of distance, and subtract the Depr. corresponding to the height of the eye; call this the first remainder. From the greater altitude subtract the lesser altitude, and the change of distance; call this remainder the second remainder.

Multiply the first remainder by the change of distance, and divide the product by the second remainder; the quotient is the distance in miles when the *greater* altitude was taken.

Ex. 1. Observed altitude of Mount Etna, 1° 28′; estimated distance, 20 leagues. When 38 miles nearer, observed the altitude 5° 15′; height of the eye, 30 feet: required the Distance.

1° 28′, deducting $\frac{1}{12}$ of 60 miles or 5′, is 1° 23′; 5° 15′, deducting $\frac{1}{12}$ of 22 miles or 2′, is 5° 13′.

| | | | | | |
|---|---|---|---|---|---|
| Lesser Alt. | 1° 23′ | Greater Alt. | | 5° 13′ | then $\frac{96 \times 38}{192} = 19$ miles, |
| ½ Dist. run | + 19 | Lesser do. | 1° 23′ | −2 1 | the Dist. required. |
| Depr. | − 6 | Dist. | + 38 | | |
| 1st rem. | 1 36 | 2d rem. | | 3 12 | |
| or | 96 | or | | 192 | |

Ex. 2. Observed the altitude of Dunnose 41′, estimated distance 4 leagues or 12 miles After running 7½ miles directly from it observed the alt. 20′. Height of the eye, 10 feet.

The 1st alt. reduced is 18′; the 2d, 40′. The 1st rem. is 18·7; the 2d, 14·5: the Dist. required 9·7 miles.

364. *Degree of Dependance.* This may be estimated by repeating the work with a new lesser alt., and also with a new change of distance, differing from those used before by 1′, and comparing these two results with the first. If they do not differ much, the case is evidently but little affected by small errors; if, on the contrary, they differ more than 1′, it is shewn that errors of observation are increased in the result.

Thus an error of 1′ in the lesser alt. produces in Ex. 1, above, only 0·3 of a mile error in the distance required, while in Ex. 2, the latter error is 1·2.

Again, an error of 1 mile in the change of distance produces in Ex. 1 only 0·7 of a mile in the result, while in Ex. 2, it produces 2·4 miles.

In ordinary cases an error of 1′ or 2′ is more likely to occur in an alt. than an error of 1 or 2 miles in the change of distance; and as precision is of less consequence in the greater than in the lesser alt. the value of the result will depend principally on the lesser altitude.

The less the 1st rem. is with respect to the 2d, the less is the effect produced by the above errors on the result.

Thus, in Ex. 1, the 1st rem. is to the 2d, or 96 is to 192, as 1 to 2 nearly, and the case is good. In Ex. 2, on the contrary, the 1st rem. 18·7, is greater than the 2d, 14·5, and the result could not be depended upon within 2 or 3 miles.

365. Since these rules suppose the object to be referred to the sea-horizon, they apply to all cases in which the observer, though near the land, can descend so near the surface of the water as to obtain a perfect sea-horizon.

On the other hand, when the land is very distant, or the altitude

very small, the methods in this section must not be too confidently depended upon, especially in a calm, or when, from heat, vapour, or other cause, there is anything unusual in the appearance of the horizon.

Useful tables of *Vertical Danger Angles* of heights from 50 to 18,000 feet, to distances off; from one cable to 110 miles, have been calculated by Lieut. S. T. S. Lecky, R.N.R. Published by George Philip & Son, London and Liverpool, 5th Edition, 1890.

## III. Methods by the Chart.

### 1. *Cross Bearings.*

366. The *true* bearings of two points of land being obtained, draw lines through them on the chart in the directions of the bearings; these lines cross in the place of the ship.

Or a *true* bearing of one of the points of land may be obtained, and an angle measured by the sextant (Nos. 485–504) between it and a second point, when the second point cannot be conveniently seen from the compass.

367. When the difference of bearings is near 90°, this is the most complete of all methods; but if the difference is small, as for example, less than 10° or 20°, or near 180°, the ship's position will be uncertain, because a small error in the bearing will then cause a great error in the distance.

### 2. *By Two Angles between Three Objects.*

368. When the ship's place is required to considerable accuracy, as, for example, in recovering a lost anchor, verifying the soundings on the chart, or other purposes, it should be determined by means of two angles observed between three objects on shore.

(1.) A convenient method of laying down on the chart the angles observed, is to draw with a pencil on tracing or transparent paper, or on paper oiled for the purpose, lines containing the observed angles; then, laying this paper on the chart, and moving it about until the lines drawn pass over the respective objects. The angular point where they meet will shew the true place of the observer.

The horn protractor (No. 108) may sometimes be conveniently employed, as lines may be drawn on it with a pencil.*

369. *By Construction.* The observer is always on a circle passing through his own place and any two objects (No. 103); also the angle

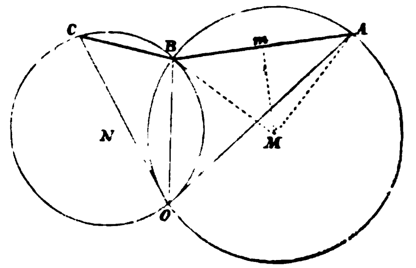
* The Station-pointer, an instrument used in this case to fix a ship's position, consists of three flat rulers, two movable from a common centre right and left of the third, which is fixed. The angular distance at which the movable rulers are required to be placed on either side of the fixed ruler being measured by an attached circular arc.

subtended by the two objects is the same at all points of the circumference on one side of the objects (No. 140). Hence, by observing this angle and laying it off, he can draw the circle on which he is, but cannot determine his position upon it. If now he adds a third object, he can draw a second circle passing through this and either of the other two, and his place is the intersection of the two circles.

Ex. 1. Let A B C be three objects on the chart; the angle between A and B, formed at O, the observer, is 46°; that between B and C is 30°.

Join A B, B C; lay off the angles B A M, A B M, each equal to the complement of 46°, or 44°; then the intersection of the lines A M, B M, is the centre of the circle A B O.

In like manner lay off B C N, C B N, each equal to the complement of 30°, or 60°; then N is the centre of the circle C B O, and O is the place of the observer.

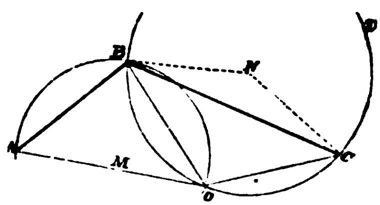



The drawing of the figure is materially simplified, in practice, by the bearing of the middle object, as this shews where the lines must fall.

Ex. 2. The angle between two objects A, B, is 47°, that between B and C is 107°.

Lay off A B M, B A M, each equal to 43°; M is the centre of A B O.

Lay off C B N, B C N, each equal to the complement of 107°, or 17°, then N is the centre of C B O.




370. *Demonstration*. Having laid off two equal angles A B M B A M, and described a circle from M the point of intersection of A M, B M, bisect A B (fig. Ex. 1) in *m*, and join *m* N; also take a point O any where in the circumference, and join O A, O B.

Then M *m* is perp. to A B (No. 144), and also bisects the angle A M B (cor.) or A M *m* is half A M B. Also A O B at the circumference is half A M B at the centre (No. 139); hence, A O B and *m* M A are equal, and *m* A M the complement of A M *m* is also the complement of A O B. A circle therefore has been described which has the given angle at the circumference.

The same proof applies when the angle at O exceeds 90°. Thus, in fig. Ex. 2, B O C, 107°, is measured by half the arc B D C (supposing the circle completed, and B D, D C, joined), which is therefore 214°. Hence the *arc* B O C is 360° − 214°, or 146°, and the angle B D C measured by half this, is 73°; B N C is 2 × 73°, or 146°, and N B C (or N C B its equal), which is the complement of half B N C, is 90° − 73°, or 17°, which is the complement of 107°.

371. It is evident that the place of O is most distinctly marked when the circles cross each other at a considerable angle; and, on the other hand, that the result is unsatisfactory when the two circles nearly coincide, or when their centres are near together. These conditions govern the choice of objects.

372. In thus fixing the ship by two angles observed between

three well-known objects on shore, the centre object should always be the nearest; for if the ship should happen to be on the circumference of the circle passing through the three selected points, her position cannot be obtained by the means of two angles only. A *true* bearing of one of the objects is therefore desirable.

It will readily be seen that in war time, when the compass may be knocked away, or rifle-fire may make it undesirable to expose the person more than necessary, a sextant offers great advantages, as angles can be obtained from any position whence the objects are visible. It is this contingency that makes it especially desirable that sailors should become expert in the method of fixing a ship's position with the sextant.

### 3. *By the Soundings.*

373. When the depth of water is not great, and also varies sensibly with the distance from the point of land set, this distance may be found from the chart by means of the soundings.

### 4. *By a Bearing, and the Lat. or Long. of the Ship.*

374. When the lat. of the ship is known, the true bearing of a well-fixed point, less than 4 points from the meridian, or not much more, affords a very accurate departure. In like manner, when the long. of the ship is known, the bearing of a given point more than 4 points from the meridian, or not much less, affords the departure.

In certain cases the bearing (alone) of a point of land may be determined from the long. by chronometer. See Sumner's Method, p. 363.

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# CHAPTER V.

## CHARTS.

I. USE OF MERCATOR'S CHART. II. CONSTRUCTION OF MERCATOR'S CHART. III. PROPERTIES OF CERTAIN PROJECTIONS.

375. A CHART is a map or plan of a sea or coast. It is constructed for the purpose of ascertaining the position of the ship with reference to the land, and of shaping a course to any place.

376. In charts, the upper part, as the spectator holds it, is the north, and that towards his right hand the east, as on the compass card; latitude is accordingly measured between the upper and lower edges, and longitude between the right-hand and left-hand edges.

Parallels of latitude and meridians are drawn at convenient divisions of latitude and longitude. Compasses are described, by means of which a line can be readily drawn in any proposed direction; and the variation is marked where convenient. The depth of water, at low water springs, is denoted, as also, in some places, the quality of the bottom. The directions and velocities of currents are expressed, and on some occasions the prevailing winds are marked.*

* Charts are also constructed for special purposes, as *variation charts*, to exhibit the variation, as well as *current charts*, *wind charts*, and *ice charts*.

*Caution.*—In purchasing Admiralty charts care should be taken to see that they are corrected up to date. The dates of large corrections are noted on the middle of the lower edge; and of small corrections, in the lower left-hand corner of the chart.

377. Besides charts employed in general navigation, *plans* of harbours, ports, islands, or small districts, are constructed on a different scale, for reference when the ship is close in with the land. On these plans are inserted, besides the above particulars, the leading marks for channels or for avoiding certain dangers, anchorages, places convenient for landing, and for watering, with numerous other details proper to maps. Plans of these kinds are often inserted, for convenience, in a corner of the general chart.*

378. As the surface of the globe is round, while that of the paper is flat, every chart exhibiting any extent of surface is necessarily an artificial construction, or, as it is called, *projection*, of the real state of things. The charts used in navigation are those on Mercator's projection, because on this alone the track of a ship always steering the same course appears a straight line.

379. On Mercator's Chart all the meridians are parallel, and the degrees of longitude are all equal, being the same as those of the *true* difference of latitude. The degrees of latitude are unequal, being extended at each latitude beyond their proper lengths, in the same proportion as the degrees of longitude on the globe are diminished; they are consequently greater as the latitude is greater.

For Ex. the degree of lat. 60°, that is, between 59½° and 60½°, is double of 1° at the equator, being increased in the ratio of the sec. lat. : 1.

## I. Use of Mercator's Chart.

### 1. *Positions on the Chart.*

380. To find the latitude and longitude of a point on the chart.

Through the given point lay a ruler parallel to the nearest parallel of latitude, and look at what degree and minute the edge cuts the graduated meridian at the side, on which the latitude is marked. In like manner lay the ruler parallel to the nearest meridian, and see where the edge cuts the graduated parallel of latitude at the upper or lower edge, on which the longitude is marked.

Or measure, by the compasses or otherwise, the distance of the given point from the nearest parallel of latitude, and setting off this distance from the same parallel on the graduated meridian at the side, note the degree and minute there expressed.

In like manner, for the longitude, refer the point to the nearest meridian, along the graduated parallel at the upper or lower edge.

381. To find the bearing or course on the rhumb line between two places. Lay the edge of the ruler on the places, and refer it to the nearest compass.

Or, hold the thread of the horn protractor (No. 108) on one of the places, and placing the centre and the zero on a meridian, slide

* The paper on which charts are printed has to be damped. On drying distortion takes place, from the inequalities of the paper. This distortion varies greatly with different paper. It does not affect navigation; but angles taken to different points will not always agree when carefully plotted, especially if the lines to the objects be long. The larger the chart, the greater the amount of this distortion.

it with the other hand up or down till the thread covers both the places; the bearing then will be read off on the graduated edge.

382. To find the distance on the rhumb line between two places.

(1.) When the places are on the same meridian. Find, by means of the ruler, where their parallels of latitude meet the graduated meridian at the side: the Diff. Lat. they include is the distance.

(2.) When the places are on a parallel of latitude. Take one or more divisions of the graduated meridian at the parallel in the compasses, and measure with this the distance of the places; or proceed as directed in (3).

(3.) When the places lie obliquely. Take the distance between them by a pair of compasses, and lay it on the graduated meridian so as to be middled by the *middle* parallel between the places: the D. Lat. is the distance.

Of the above modes of measuring distances on the chart the first is accurate. The other two are only approximate, though near enough for common purposes.

When precision is required, the 2d case, which is Case II. of Parallel Sailing, must be solved by No. 307, 308, or 309, as the chart affords no facility. In like manner, if the places are nearly E. and W., the distance should be found by Case II. of Mid. Lat. Sailing, p. 100. In the 3d case, the construction described in No. 328 must be employed. For this the chart is particularly adapted, as it shews the Mer. D. Lat. The true D. Lat. is to be taken from the scale of longitude.

383. To lay off a point on the chart in a given lat. and long. Lay a ruler through the lat. at the side, and parallel to a parallel of lat. draw a pencil line. Do the same with the longitude.

384. The course and distance of the ship on the rhumb line being given from any point, to find her place on the chart.

Lay the ruler through the given point, in the direction of the course. Take the given dist. in degrees and minutes from the graduated meridian, so that the parallel of lat. which the ship is upon shall middle it; lay off this distance along the edge of the ruler from the given point, and the ship's place is determined.

385. To lay down on the chart the position of the ship as given by observation. Lay off the given latitude and longitude as directed, No. 383.

To lay down on the chart the position of the ship by D. R., that is, by her course and distance from a given point of departure; as, for example, her place at last noon.

Lay off the course and distance as directed in No. 384.

Marking the ship's position on the chart is called pricking the ship off.

### 2. *Projection of the Voyage on a Great Circle.*

386. The Great Circle track between any two places may be accurately traced on a Mercator's Chart, by determining the latitudes of its points of intersection with any desired number of intervening meridians. These lats. may be computed (346), or found by the aid of Towson's Tables or Davis's Azimuth Tables (347).

387. But since the course and distance are liable to irregularities of which the Dead Reckoning can take no account, a sailing ship especially cannot be kept for any length of time upon a prescribed track; and since, when she has once deviated from the intended line, the course must be shaped anew, it is evident that the accurate projection of a proposed voyage on a great circle sometimes would be waste of labour. It will accordingly be sufficient, in general, to project the track roughly.

388. The following method by Professor Airy, for drawing on a Mercator's Chart the arc of a great circle between positions on one side of the Equator, is very simple and sufficiently accurate for practical purposes generally.

1.—Join the two points between which it is required to project the great circle, by a straight line. Bisect this line, and from the point of section erect a perpendicular to the line on the side next the Equator, continuing it, if necessary, beyond the Equator.

2.—With the middle latitude (between the two places) enter the following table, and take out the "corresponding parallel."

3.—The centre of the arc of the great circle, required to be drawn, will be the intersection of this parallel with the perpendicular.

| Middle Latitude. | | Corresponding Parallel. |
|---|---|---|
| 20° | | 81° 13′ |
| 22 | Opposite name to lat. of points. | 78 16 |
| 24 | | 74 59 |
| 26 | | 71 26 |
| 28 | | 67 38 |
| 30 | | 63 37 |
| 32 | | 59 25 |
| 34 | | 55 5 |
| 36 | | 50 36 |
| 38 | | 46 0 |
| 40 | | 41 18 |
| 42 | | 36 31 |
| 44 | | 31 38 |
| 46 | | 26 42 |
| 48 | | 21 42 |
| 50 | | 16 39 |
| 52 | | 11 33 |
| 54 | | 6 24 |
| 56 | | 1 13 |

| Middle Latitude. | | Corresponding Parallel. |
|---|---|---|
| 58° | Same name as lat. of points. | 4° 0′ |
| 60 | | 9 15 |
| 62 | | 14 32 |
| 64 | | 19 50 |
| 66 | | 25 9 |
| 68 | | 30 30 |
| 70 | | 35 52 |
| 72 | | 41 14 |
| 74 | | 46 37 |
| 76 | | 52 1 |
| 78 | | 57 25 |
| 80 | | 62 51 |

*N.B.*—If greater accuracy is required the curve of the Great Circle should be drawn by the methods of Godfray, Towson, or by computation.

389. Godfray's Great Circle Chart and Course and Distance Diagram answer all the conditions of great circle sailing as completely and as simply as Mercator's Chart does for sailing on a Rhumb. The track is a straight line which may be drawn and examined; then the various courses and the distances to be run upon each course are obtained, as also the distance from the ship to her destination, by a mere inspection of the diagram.*

### 3. *Figures of Different Tracks.*

390. The track of a ship by Mercator's or by Middle Latitude Sailing, appears, as before stated (No. 378), a straight line on Mercator's Chart, on which the meridians and parallels of latitude are represented as straight lines. But on the globe such a course, unless it be N. or S., is really a *spiral*, winding towards one of the poles, which it can never reach. A ship's keel cannot pass over a point which is kept at any angle on the bow.

* *See* Chart to facilitate the practice of Great Circle Sailing, with accompanying Diagram for the determination of Courses and Distances: by Hugh Godfray, Esq., M.A. Sold by J. D. Potter, 145 Minories, London, E.

The track by Parallel Sailing, on a circle on which the ship always maintains the same distance from the pole, also appears a straight line upon the chart.

The track by Great Circle Sailing, except when on a meridian, appears on Mercator's Chart as a curve line. It may at first seem inconsistent that a curve line can, in any case, represent a shorter distance than a straight line; but every point of this curve line is nearer the pole than a point in the same longitude on the track by Mercator: and accordingly, if we divide the curve into small portions, and measure each portion as in No. 382 (2), or (3), in its own latitude, we shall find that the whole distance measures absolutely less than the length of the rhumb line joining the places.*

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## II. Construction of Mercator's Chart.

391. The following instructions are merely general: practice will supply details.

In N. Lat draw a line along the foot of the paper for the parallel of lowest latitude. In S. Lat. draw the line along the top. Divide this line into degrees and parts, as 30′, 15′, 10′, or 5′. Draw at the sides two perpendiculars to this line, for the graduated meridians. Find, by Table 6, the Mer. D. Lat. between the lowest parallel and 1°, or 30′, &c. above it. Take with the compasses this Mer. D. Lat. from the equally divided parallel, and set it off from this line on the meridian to be graduated. Find, in like manner, the Mer. D. Lat. between the said parallel and 2°, or 1°, &c. above it. In this way the meridians are graduated.

Parallels and meridians being drawn at convenient intervals, and the points of the coasts laid down, the coast-line is filled in by hand.

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## III. Properties of Certain Projections.

392. Since a small portion of a globular surface may be considered, in a practical sense, as a plane, charts of coasts, and maps of

* In order to verify, on a globe, the results of calculations relating to the great circle and the rhumb line, the latter must be projected on the globe. To do this, note on the chart the latitude and longitude through which the rhumb line passes, at each 4° or 5°, or less, according to the degree of precision required; then lay off these points on the globe, in their several lats. and longs. by means of the moveable meridian. A curve traced by hand through the points laid off will represent the rhumb line nearly enough.

If the rhumb line between any two places, differing considerably in latitude and longitude, be produced on the chart, and transferred thus to the globe, its spiral figure will be distinctly perceived.

districts of limited extent, constructed from a scale of equal parts, exhibit, like the plan of a building or an estate, the relative *directions* and *distances* of the places upon them very nearly. On this projection, divisions of latitude and longitude may be laid off in their due proportions by means of parallel and perpendicular lines, drawn at proper distances. In drawing these lines the minute or mile of latitude is taken as the unit of measure (Nos. 186, 199), and the parallels of latitude drawn through certain divisions. The length of a minute of longitude being to that of a minute of latitude as the cosine of the latitude to the radius, is determined by No. 304, 305, or 306. On a small portion of the surface the minutes of longitude are nearly equal, and the meridians are therefore drawn parallel; but if the extent of latitude be increased, the meridians will converge sensibly towards the polar side of the chart (No. 194, note *) and the character of the projection changes.*

393. On Mercator's Chart the figure of each small district or portion of surface is truly represented, as in No. 392 above; but, as the mile or minute of latitude, which is the unit of measure, is of a different magnitude in every different latitude, if we take a greater extent of latitude we introduce a new scale of measurement. A small island, for example, near the pole, is represented, in regard to its shape, as truly as another near the equator, but on a larger scale: hence, though each small portion is truly figured, portions in different latitudes cannot be directly compared. The appearance of distortion of the countries on Mercator's Chart arises, therefore, from the distances in each latitude being drawn to a different scale.

This projection represents, with perfect accuracy, the relative positions of places as respects a rhumb line; it does not, however, exhibit the relative distances between places, which, when required with precision, must be found by the proper construction, No. 328.

The projections here described become identical at the equator.

394. Every bearing, obtained either by means of the magnetic needle or astronomical observation, is a horizontal angle on the surface of the sphere, formed at the eye, and contained between the meridian of the observer and a line drawn from the eye to meet a plumb-line passing through the point set. Such angle is the same thing as the course on a great circle. Hence observed bearings are never, unless due N. or S., or E. and W. on the equator, identical with bearings taken from Mercator's Chart. The difference is not, indeed, perceptible on common occasions, on account of the smallness of the portion of the sphere within the view of the spectator; but in charts of high latitudes, graduated with much precision, it becomes manifest, and must be taken into consideration when it is

* In the *Plane Chart* the degrees of latitude and longitude are all made equal. This projection represents very nearly the relative directions and distances of places near the equator, and serves for plans of ports and seas in those regions; but in higher latitudes it exhibits truly no directions but E. and W., N. and S., and no distances but those on a meridian. Hence the figure of every portion of surface, however small, is distorted. These charts are no longer used.

required to employ the observed bearing of a distant mountain for any purpose in which precision is necessary.*

A distant object cannot, accordingly, be correctly laid down on the chart, from its observed bearing and distance, except in low latitudes; it must therefore be laid down in lat. and long. as determined by Spherical Trigonometry. The line drawn from the observer's place to this position laid down is then the bearing on the chart,—not the *direction* of the object, but the course which a ship must preserve in approaching it while crossing all the meridians at the same angle.

It follows, in like manner, that three objects which lie in the same great circle (not the merid. or the equator), and therefore, when seen in a certain direction, appear in one, form, on the chart, an elongated triangle, the middle object of the three being on the polar side of the line joining the extremes. Thus the summit of Mount Athos, which lies a little (0′ 39″) to the N. of the great circle passing through Mount Olympus and the summit of Imbros, appears, on the chart of the Archipelago, nearly 2′ to the N. of the straight line joining the two latter places.

395. The bearing of a distant object, as taken from the chart or computed by Mercator's or Mid. Lat. Sailing, may be converted, approximately, into the true azimuth, as it would be observed, thus:—

Find half the Diff. Long. between the place of observation and the object, and also the Mid. Lat. between them.

To the log. sine of half the D. Long. add the log. sine of the Mid. Lat.; the sum is the log. sine of the corr. required. Apply the corr. to the N. in N. Lat, and to the S. in S. Lat.

Ex. The observer in N. lat. 40° 2′ sees a peak in lat. 40° 9′ N., and 1° 54′ W. of him: required the true azimuth, as deduced from the rhumb course?

The Course by Mercator's Sailing, is N. 85° 26′ W.

| | | | |
|---|---|---|---|
| D. Long. 114′, half do. 57′ | sin. 8·2196 | Rhumb bearing | 85° 26′ |
| Mid. Lat. 40° 5′ | sin. 9·8088 | Sub. | 37 |
| Corr. 37′ | sin. 8·0284 | True Azim. | 84 49 |

# CHAPTER VI.

## Sounding.

396. Sounding is ascertaining the depth of the water. This is commonly done by a lead attached to a line marked at certain divisions.

* This point, and also some considerations relative to the projection of the great circle on Mercator's Chart by rectangular co-ordinates, are treated in the "Traité de Géodésie à l'Usage des Marins," par P. Bégat. Paris, 1839.

397. The soundings marked on the chart are taken at low-water spring-tides; the depth is noted in fathoms, and, in small depths, in feet, and the nature of the bottom is specified. The "low water" of the charts is, generally, the *average* of the spring low water.*

Since the ship's place on the chart can thus be determined, within certain limits, by the soundings, it is always a proper precaution, however correctly the reckoning may be kept, to sound on approaching the land. In like manner, in a fog or during the night, the navigation is often made to depend upon the lead alone.

398. Two leads are employed for sounding, the *hand-lead* weighing 14lbs. and attached to about 25 fathoms of line, and the *deep-sea lead*, weighing 28lbs. and attached to 100 fathoms or more of line wound on a reel. A small lead of five or six pounds is sometimes used. The quality of the bottom is ascertained by fixing a lump of tallow, called the *arming*, on the lower end of the lead before it is thrown into the sea.

399. In using the hand-lead, the leadsman, standing at the vessel's side, or in the channels, throws the lead as far forward as he can, swinging it once or even twice over his head to give it increased force, and endeavours to draw the line tight from the lead at the instant the ship by her progress places him perpendicularly over it. The hand-lead descends about 10 fathoms in the first six seconds, according to some trials made by Capt. Bullock; hence, when the vessel is going fast, it is often difficult to get soundings.

The line is marked at 3, 5, 7, 10, 13, 15, 17, and 20 fathoms.† These depths are called *marks*, and the intermediate ones *deeps*; for example, in obtaining 10 fathoms the leadsman cries, with a peculiar song, "By the mark ten;" in 9 fathoms he cries, "By the deep nine." On some occasions the leadsman describes the bottom as hard or soft.

The only fractions of a fathom used are a half and a quarter; thus, 7½ fathoms are called, "And a half seven;" 7¾ fathoms are called, "A quarter less eight."

400. In heaving the deep-sea lead, the lead is carried to the fore part of the ship, as the weather cathead or fore-chains, or the lee cathead, if the ship is making much leeway, the line being passed along outside. The ship's way being reduced when necessary, the lead is dropped and the soundings are observed by an experienced seaman at the quarter. The deep-sea line is marked at each 10 fathoms by the corresponding number of knots, and with a single knot at each five. The error of the soundings is generally in excess, because the line can rarely be stretched straight from the lead.

401. In sounding in deep water in small vessels, which drift to leeward rapidly upon losing their way, it is generally advisable to drop the lead before the headway ceases, and to cause the vessel to

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* As this average height is not indicated by nature, the seaman should bear in mind that the water may, under the influence of strong winds, fall quite a foot below this average.

† These divisions require to be measured or rectified from time to time; when this is done, the line should be thoroughly wetted.

gather sternway so as to pass over the lead, which will thus have descended through a considerable depth perpendicularly.

402. The interruption to the voyage, and the inconvenience of rounding the ship in order to allow time for the deep-sea lead to descend to the bottom, have led to the invention of instruments for sounding without stopping the ship's way.*

Burt's buoy and nipper is a simple and well-known instrument. The line being rove through a spring-catch in the buoy, the lead is hove, and the buoy afterwards dropped into the water; the line then continues to run through the catch till the lead reaches the bottom, or is checked by a pull, when the catch firmly seizes the line, attaching the buoy to it at the depth descended through by the lead.

Massey's machine registers the depth by wheelwork set in motion by a fly.—Ericcson's machine measures the depth by the space into which the contained air is compressed.

Sir W. Thomson's Sounding Machine consists of a drum on which is wound about three hundred fathoms of steel pianoforte wire. This is kept at intervals between the casts in a box filled with lime water, which entirely protects the wire from rust.

A brake, partially self-acting, is arranged by a cord round a groove in the circumference of the drum, with two weights attached, one of lead (3 lbs.), the other a long iron weight (56 lbs.).

When ready to take a sounding, the brake is released by holding up the heavy weight and allowing the small one to hang freely in a recess in the heavy one. This opposes a slight resistance to the wire when running out, and when the sinker reaches the bottom the brake is put on by easing down the heavy weight gradually until it is supported by the small one.

Between the sinker (which is of iron, with a hollow at the bottom to receive the arming of tallow) and the depth gauge there is a two-fathom length of *plaited* rope, and the same between the depth gauge and the wire. It is important that *plaited* rope should be used, *not twisted.*

The depth gauge consists of a brass case about 2 feet long, containing a glass tube coated inside with a chemical preparation; this tube is open at one end, and is placed in the brass case with the open end downwards. As the sinker descends, the increased pressure drives the water up the glass tube, and the height is registered by the mark made by the combination of the water and the coating of the tube; this mark, when applied to the graduated boxwood scale, shows at once the depth that has been reached. There is also a counter attached to the wheel that shows approximately the number of fathoms of wire run out.

The instructions sent with the apparatus are ample, and the use of this simple machine is easily learnt; but men should be drilled at it in fine weather, so as to be able to handle it readily in bad. An officer and two men can with ease take soundings in 100 fathoms every quarter of an hour from a vessel going at any ordinary speed.

* Recently an instrument has been introduced wherein the depth is indicated by hydrostatic pressure.

# CHAPTER VII.

## THE SHIP'S JOURNAL.

I. KEEPING THE SHIP'S JOURNAL. II. THE DAY'S WORK.

## I. KEEPING THE SHIP'S JOURNAL.

403. As the keeping of the log or journal, in the Royal Navy and in the merchant service, is a matter strictly professional, and as no one would be intrusted with it whose experience did not qualify him to know what matters to insert and how to express them,—and, moreover, as the log-board, from which the ship's log is copied, is ruled in an established form, the following remarks are inserted merely for reference, and not as a complete description for the instruction of the learner, who must acquire this knowledge with that of the rest of his duty.

404. The time in the ship's log-book is reckoned from midnight, as civil or common time; the first hour is, therefore, 1 o'clock in the morning, and the hours are carried on to 12, or noon, and then to 12, or midnight. The log-board, however, is copied into the log-book each day at noon.*

405. At noon, if the ship is in sight of land, a point or object of known latitude or longitude is set, and its distance estimated. This method of taking a Departure, which, from its convenience, is in general use (No. 349), is sufficiently accurate when the ship is very near the land; but when the land is distant, or enveloped in haze, and when, in consequence, the estimation of distance is liable to great uncertainty, some other method should, if practicable, be adopted in preference, or at least employed as a check. If there is no particular object in sight, the extremes of the land are set; and thus, in case of a fog coming on, the ship is secured, by keeping outside of the bearings of these extremes, from approaching the land.†

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* The log-board, on which were painted the necessary divisions, and the record made in chalk, has long passed away. A log-slate or deck log-book is kept instead.

† Since, when the ship is in sight of land, her place is determined with reference to the land alone, it is customary, during this time, to discontinue heaving the log, and therefore to omit the insertion of the courses and distances on the log-board. It is sometimes, however, proper to keep up the account when in with the land, as it affords the means of discovering a permanent current, or the direction, strength, and time of change of the tide-current.

If the ship is out of sight of land, the Course and Distance made good in the last 24 hours, the Latitude and Longitude by Dead Reckoning, as also by Observations if they are obtained, are inserted, together with the Bearings and Distance of the port or of the land worked for.

406. It often happens, from change of long., that the day of 24$^h$ has expired before the sun has attained the meridian. In this case, the hours having been truly measured, and the hourly distances rightly assigned, the reckoning is truly registered up to the running out of the last glass, and an increased distance must therefore be marked against the last hour or half-hour.

In like manner the day may really have expired by observation before the 24 hours are completed. In this case a diminished distance must be marked at the last hour or half-hour.

407. The Leeway should always be marked on the log-board, since it is impossible for any one to know what leeway the ship may be making in bad weather when he is not on deck.

408. At the end of every watch, at the close and dawn of day, and at the coming on of a fog, the land is set; so that, in case of losing sight of it, a Departure may always be secured at the latest period.

409. The Weather is described at the end of each watch, or oftener, as occasion may suggest. In order to mark the strength of the wind, and the description of the weather, with more distinctness than the terms in general use among seamen are capable of expressing, Sir F. Beaufort has proposed the following system of numbers and letters, which has been adopted by order of the Lords Commissioners of the Admiralty, dated Dec. 28, 1838, in Her Majesty's ships:—

FIGURES *to denote* the FORCE OF THE WIND.

| | | |
|---|---|---|
| 0 — Calm. | | |
| 1 — Light Air ......... | Or, just sufficient to give steerage way. | |
| 2 — Light Breeze ...... | Or, that in which a well-conditioned man-of-war, with all sail set, and clean full, would go in smooth water from...... | 1 to 2 knots. |
| 3 — Gentle Breeze ... | | 3 to 4 knots. |
| 4 — Moderate Breeze | | 5 to 6 knots. |
| 5 — Fresh Breeze ..... | Or, that to which she could just carry in chase, full and by ................................ | Royals, &c. |
| 6 — Strong Breeze .... | | Single-reefed topsails and top-gallant sails. |
| 7 — Moderate Gale.... | | Double-reefed topsails, jib, &c. |
| 8 — Fresh Gale......... | | Triple-reefed topsails, &c. |
| 9 — Strong Gale ... .. | | Close-reefed topsails and courses. |
| 10 — Whole Gale ... .. | Or, that with which she could scarcely bear close-reefed main-topsail and reefed foresail. | |
| 11 — Storm .......... .. | Or, that which would reduce her to storm-staysails. | |
| 12 — Hurricane ..... .. | Or, that which no canvas could withstand. | |

LETTERS *to denote* the STATE OF THE WEATHER

b—Blue sky; whether with clear or hazy atmosphere.
c—Cloudy; but detached opening clouds.
d—Drizzling rain.
f—Foggy—f, Thick fog.
g—Gloomy dark weather.
h—Hail.
l—Lightning.
m—Misty hazy atmosphere.
o—Overcast; the whole sky being covered with an impervious cloud.
p—Passing temporary showers.
q—Squally.
r—Rain; continued rain
s—Snow.
t—Thunder.
u—Ugly threatening appearance of the weather.
v—Visibility of distant objects, whether the sky be cloudy or not.
w—Wet dew.
.—Under any letter indicates an extraordinary degree.

By the combination of these letters, all the ordinary phenomena of the weather may be recorded with facility and brevity. Examples:—b c m, Blue sky, with detached opening clouds, and a misty atmosphere. g v, Gloomy dark weather, but distant objects remarkably visible. q p d l t, Very hard squalls with passing showers of drizzle, and accompanied by lightning with very heavy thunder.

410. When a heavy sea is running, or when a swell rises without corresponding wind, the circumstance is noted.

A swell is named after the point of the compass *from* which the waves proceed, like the wind that produces them. To denote, however, a south-westerly swell (for example) as "a swell from the S.W" removes all ambiguity.

411. The variation of the compass, when observed, is inserted in the remarks; as also the results of occasional observations, as the latitute by double altitude, by the moon, planets, or stars, the longitude by lunar, &c., the exact time of observation being specified.

412. In general, besides the details proper to the particular service on which a vessel may be employed, all matters relating to her *place* are inserted in the log, not only for the safety or convenience of the present voyage, but as matter of intelligence or of evidence in the case of future inquiry. Hence the circumstance of seeing or speaking a vessel is always noticed.

No form of log has been universally adopted in merchant-ships, but several neat forms are in common use. The precise form is not material, as long as the ship's proceedings are exactly and conveniently recorded.

A separate journal, called in the Royal Navy the engine-room register, is generally kept in steam-ships. In this is recorded the revolutions of the engines, the pressure of steam, the consumption of fuel and other materials, the temperature of the engine-room, stoke-holes, coal-bunkers, &c. Generally, it is a record of all matters relating to the performance and state of the engines, and the employment of the engine-room staff.

413. The following is the form in which the logs of her Majesty's ships are at present kept by order of the Board of Admiralty, 1879.

H.M.S.____________, ____ day of____________, 18 .

From____________, to____________, or at____________.

| Initials of Officer of Watch | Hours | Knots | Tenths | Standard Compass Courses | Leeway, Points | Winds: Direction | Winds: Force | Weather | Deviation of Standard Compass | Height of Bar. | Height of Ther. | Temperature of Sea | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | | | | | | | | | | | A.M. |
| | 2 | | | | | | | | | | | | |
| | 3 | | | | | | | | | | | | |
| | 4 | | | | | | | | | | | | |
| | 5 | | | | | | | | | | | | |
| | 6 | | | | | | | | | | | | |
| | 7 | | | | | | | | | | | | |
| | 8 | | | | | | | | | | | | |
| | 9 | | | | | | | | | | | | |
| | 10 | | | | | | | | | | | | |
| | 11 | | | | | | | | | | | | |
| | 12 | | | | | | | | | | | | |

| Course | Distance: made good | Distance: through the water | Latitude | Longitude | Variation allowed | Water Remains | True Bearing and Distance | No. on Sick-list |
|---|---|---|---|---|---|---|---|---|
| — | | | — | — | — | — | | — |
| | | | DR. | DR. | | Daily Expend^re | | |
| Current — | miles | miles | Obs. | Chro. | | — | | |
| | | | | | | Distilled since yesterday | | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | | | | | | | | | | | P.M. |
| | 2 | | | | | | | | | | | | |
| | 3 | | | | | | | | | | | | |
| | 4 | | | | | | | | | | | | |
| | 5 | | | | | | | | | | | | |
| | 6 | | | | | | | | | | | | |
| | 7 | | | | | | | | | | | | |
| | 8 | | | | | | | | | | | | |
| | 9 | | | | | | | | | | | | |
| | 10 | | | | | | | | | | | | |
| | 11 | | | | | | | | | | | | |
| | 12 | | | | | | | | | | | | |

Signals {

Coal expended during 24 hours { For engines / For ship / For distilling

## II. The Day's Work.

417. This is the process of finding the place of the ship, with reference either to her place at yesterday's noon, or to a departure taken since, and comprises,

1st, The Course and Distance made good;

2d, The Lat. and Long. in;

3d, The Bearing and Distance of some port, which is either to be steered for directly, or is an intermediate point of land, with reference to which the course is to be shaped, so as to make it or to avoid it.

418. To work a day's work. (1.) Take the courses, with the distance run on each, from the log-board.

When a departure has been taken, consider it is a course and distance in the *opposite direction*.

Correct each course for deviation of the compass, 229, or p. 159.

If the variation has changed since the departure was taken, correct each course separately, No. 221; if not, defer this correction.

Every course affected by leeway must be corrected accordingly. The quantity, if not marked on the board, must be estimated from the circumstances. When the ship is on the *starboard* tack, allow the leeway to the *left*; when on the *port* tack, allow it to the *right*, the observer being supposed in the centre of the compass. When the ship is hove-to, take the middle point between that to which she comes up and that to which she falls off, for the compass course, and correct this for leeway.

(2.) Having corrected the Courses thus far, take out to each the D. Lat. and Dep. from the Traverse Table, and find the Course and Distance made good by Traverse Sailing, No. 287, or by Traverse Tables (Table 1.)

If the variation has not been allowed for, apply it to the resulting course, No. 221.

(3.) Apply the D. Lat. to Lat. left: the result is Lat. in, No. 190.

With the Lat. left and Lat. in, and the Course, find the D. Long. by Case I. of Mid. Lat. or Mercator's Sailing (No. 315 or 323), or by Traverse Table. If the Course is due E. or W., then proceed by Case I. of Parallel Sailing (No. 304) or by Traverse Table.

Having the Long. left and Diff. Long., find the Long. in, No. 196.

(4.) Having now the Lat. and Long. of the ship, and those of the port to be worked for, find its Bearing and Distance; if in the Lat. of the ship, by Case II. of Parallel Sailing, No. 307; otherwise by Case II. of Mid. Lat., or Mercator's Sailing, No. 318 or 326; or by Traverse Table. To this Bearing apply the Variation and Deviation of the Compass, and so obtain from the True Course, the *Course to be steered.*

To find the Course on a Great circle, *see* No. 337 or 338.

It is mere waste of time to work the Course nearer than to the whole degree; for even if the compass could be depended upon to 1°, the ship cannot generally be steered within that quantity.

Ex. 1. The ship while hove-to for the first two hours, with light north-easterly winds, came up to E., and fell off S.S.E.; taking S.E. by E. as the middle course, allowing 2 pts. leeway, and 3 miles distance, gives S.E. by S. 3 miles, after which the courses and dists. follow as below. Lat. left 29° 26′ N., long. left 127° 42′ E.: var. 3° E.: find the Lat. and Long. in; also set of current in the 24 hours. Position by observation being Lat. 27° 55′ N., Long. 128° 43′ E.

| Courses. | Dist. | N. | S. | E. | W. |
|---|---|---|---|---|---|
| S.E. by S. | 3 | | 2·5 | 1·7 | |
| S.S.E. ½ E. | 23 | | 20·3 | 10·8 | |
| S.S.E. | 49 | | 45·3 | 18·8 | |
| S. by E. ½ E. | 24 | | 23·0 | 7·0 | |
| S. by E. | 6 | | 5·9 | 1·2 | |
| S.W. by S. | 8 | | 6·7 | | 4·4 |
| S.W. | 7 | | 4·9 | | 4·9 |
| S.W. by W. | 7 | | 3·9 | | 5·8 |
| W. by N. | 5 | 1·0 | | | 4·9 |
| S. ½ E. | 6 | | 6·0 | 0·6 | |
| | | 1.0 | 118·5 | 40·1 | 20·0 |
| | | | 1·0 | 20·0 | |
| | | | 117·5 | 20·1 | |

The D. Lat. 117·5 and Dep. 20·1 give Course by Compass S. 10° E. Dist. 119 miles.

Applying 3° (var.) to the right gives Course S. 7° E. true. Then 7° and Dist. 119 give D. Lat. 118·1, and Dep. 14·5.

| | | |
|---|---|---|
| D. Lat. 118 | 1° 58′ | S. |
| Lat. left D.R. | 29 26 | N. |
| Lat. in, D.R. | 27 28 | N. |

Lat. left 29° and Lat. in 27° give Mid Lat. 28°.

| | | |
|---|---|---|
| Then 28° and D. Lat. 14·5 give Dist. | 16′ | E. |
| Long. left | 127 42 | E. |
| Long in, D.R. | 127 58 | E. |

To determine approximate current see Nos. 290 to 297, and 1015.

Position by Obs. Lat. 27° 55′ N., Long. 128° 43′ E.
Position by D.R. Lat. 27 28 N., Long. 127 58 E.
27 45

In Lat. 28° Diff. Long. 45 = Dep. 39·7.

Then D. lat. 27 and Dep. 39·7 gives Course N. 56° E., Dist. 48 m., set of Current in 24 hours.

Probable; the ship being in the Kuro Siwo, or Japan Stream.

In the foregoing example, the deviation of the compass has not been mentioned. From what has been said in Chapter II. it must be evident that the bearing taken for departure and the courses steered must be corrected for deviation, where there is any. As the deviation changes when the direction of head is changed, it is obvious that each course must be corrected separately.

To correct the Compass for Variation or Deviation.

| *Course by Compass given.* | *True Course given.* |
|---|---|
| If Var. or Dev. East, allow to right. | If Var. or Dev. East, allow to left. |
| If Var. or Dev. West, allow to left. | If Var or Dev. West, allow to right. |
| Will give true course. | Will give magnetic course. |

To Correct the Compass Courses.

Easterly Variation or Deviation is + to all points between N. and E.......S. and W.
Westerly Variation or Deviation is − from all points between N. and E....S. and W
Easterly Variation or Deviation is − from all points between N. and W....S. and E.
Westerly Variation or Deviation is + to all points between N. and W.......S. and E.

To Convert a True Course or a Correct Magnetic Course into a Compass Course.

Easterly Variation or Deviation is − from all points between N. and E....S. and W.
Westerly Variation or Deviation is + to all points between N. and E.......S. and W.
Easterly Variation or Deviation is + to all points between N. and W.......S. and E.
Westerly Variation or Deviation is − from all points between N. and W....S. and E.

In the following examples the Deviations from table of No. 227 have been applied to the Compass Courses, to obtain the Correct Magnetic Courses.

Ex. 2. The Departure is taken from the Eddystone, bearing N.N.E. 12 miles. Ship's head S. by E. The ship ran S. by E. 14 (miles), S. by W. 10, and S.W. by W. 8. Allow 25° westerly variation. Find the Bearing and Distance of Ushant, and Course to be steered.*

The Departure gives a Course S.S.W. (No. 418 (1)). Correcting this and the other Courses from the Deviation Table, No. 227, S.S.W. becomes S. 18° W. (No. 228), S. by E. becomes S. 16° W., S. by W. becomes S. 6° W.; and S.W. by W. becomes S. 50° W.

| Compass Courses. | Dists. | Correct Magnetic Courses. | N. | S. | E. | W. |
|---|---|---|---|---|---|---|
| S.S.W. | 12 | S. 18° W | | 11·4 | | 3·7 |
| S. by E. | 14 | S. 16 E | | 13·5 | 3·9 | |
| S. by W. | 10 | S. 6 W. | | 9·9 | | 1·0 |
| S.W. by W. | 8 | S. 50 W. | | 5·1 | | 6·1 |
| | | | | 39·9 | 3 9 | 10·8 |
| | | | | | | 3·9 |
| | | | | | | 6·9 |

Eddystone Lat. 50° 11′ N.
D. Lat. 40 S.
Lat. in, D.R. 49 31 N.

Lat. left 50° and Lat. in 49½° give Mid Lat. 50°.
Then 50° and 10·6 as D. Lat. give Dist. 16′, the D. Long.

Eddystone Long. 4° 16′ W.
D. Long. 16 E.
Long. in, D.R. 4 0 W.

Lat. in 49° 31′ Long. 4° 0′
Ushant 48 29 5 4
1 2 = 62′ 1 4 = 64′
Mid. Lat. 49°.

D. Lat. 39′ 9 and Dep. 6·9 give Co. S. 10° W., Dist. 41. Applying 25° to the left gives Course S. 15° E. true. Then Course 15° and Dist. 41 give D. Lat. 39 6 and Dep. 10 6.

Then Course S. 34° W. + Var. 25° W. gives S. 59° W. + Deviation 7° W. give S. 66° W., Course to be steered for Ushant.

Course 49° and Dist. 64 give D. Lat. 42; this, as Dep. and D. Lat. 62, give Bearing S. 34° W., Dist. 75 m.

*N.B.*—On this Course allow for Channel Tides.

Ex. 3. A ship from lat. 0° 5′ N., and long. 0° 17′ W., sails S.W. by S. 7 miles, S. by E. 22, S.S.W. ½ W. 8, and N.E. by E. 20. Var. 19° W. Position by Obs. Lat. 0° 15′ S., Long. 0° 20′ W. Find Compass Course to be steered,* and the Dist. to C. Palmas; also current experienced in the 24 hours.

| Compass Courses. | Dists. | Correct Magnetic Courses. | N. | S. | E. | W. |
|---|---|---|---|---|---|---|
| S.W. by S. | 7 | S. 29° W. | | 6·1 | | 3·4 |
| S. by E. | 22 | S. 16 E. | | 21·1 | 6·1 | |
| S.S.W. ½ W. | 8 | S. 23 W. | | 7·4 | | 3·1 |
| N.E. by E. | 20 | N. 70 E. | 6·8 | | 18·8 | |
| | | | 6 8 | 34·6 | 24·9 | 6·5 |
| | | | | 6 8 | 6·5 | |
| | | | | 27·8 | 18 4 | |

Lat. from 0° 5′ N.
D. Lat. 0 20 S.
Lat. in, D.R. 0 15 S.

Near the equator Dep. is D. Long., No. 311; hence,

Long. from 0° 17′ W.
D. Long. 26 E.
Long. in, D.R. 0 9 E.

By Obs.
Lat. 0° 15′ S. Long. 0° 20′ W.
C. Pal. 4 22 N. 7 44 W
4 37 = 277′ 7 24 = 444′

D. Lat. 27·8 and Dep. 18·4 give Co. S. 33° E., Dist. 33 miles. Applying 19° var. W. to the left, gives Course S. 52° E. true. Then Course 52° and Dist. 33 give D. Lat. 20·3 and Dep. 26.

To determine approximate Current, see Nos. 290 to 297, and 1015.

Lat. Obsd. 0° 15′ S. Long. 0° 20′ W.
Lat. D.R. 0 15 S. Long. 0 9 E.
Approximate Current West 29 m.

D. Lat. 277 and Dep. 444 give Course N. 58° W., and Dist. 523 miles; Course, N. 58° W. Then
− Var. 19° W. = N. 39° W.
− Dev. 8 W. = N. 31 W.,
Compass Course to be steered.

*N.B.*—On this course allow for crossing the Equatorial and Guinea Currents.

* In shaping the Course, consider the direction and force of the tide or current that may be found, between the position of the ship and the port steered for.

# NAUTICAL ASTRONOMY.

## CHAPTER I.

### DEFINITIONS.

419. THIS branch of the subject, as already defined under the head Navigation, No. 179, relates to finding the place of the spectator on the surface of the earth by observation of the heavenly bodies.

420. To the spectator at the surface of the earth the heavens appear to form a vault, or the upper half of a hollow sphere, of which he is the centre; the earth itself, or the ground or sea on which he stands, occupying the lower half. Any two points on the apparent concave or celestial surface, as two stars, for example, may be supposed to be connected by an arc of a circle drawn on that surface: and thus the apparent celestial sphere may be conceived to be marked with circles like the terrestrial globe.

421. The spectator stands with his feet towards the centre of the globe; that is, a plumb-line, which is vertical, passes through the spectator and this centre;* and thus the spectator always conceives himself on the summit of the globe.† Suppose him now to descend the above line to the centre, and then suppose the upper half of the earth or globe to be cut off horizontally, that is, parallel to the horizon, or perpendicular to the plumb-line. The surface of the lower half-globe, or hemisphere, so exposed, being produced on all sides to meet the concave celestial surface, is called the RATIONAL

* The earth is here supposed to be a globe; the plumb-line does not exactly pass through the centre of the spheroid, but the difference is not worth notice here.

† This is the principle of rectifying the globe, or placing the globe to shew the relative position of the spectator and the heavens.

To rectify the globe, as, for ex., for Greenwich, in 51° N. Lat. Place the globe on a level surface, so that the broad rim, or horizon, shall be horizontal. Take hold of the brass meridian, and turn the globe round in its stand (upwards or downwards) until the N. pole is 51° above the rim.

Direct the N. point of the rim (now under the pole) to the true north. Turn the globe round its axis till Greenwich passes under the meridian; Greenwich will now be the uppermost point.

The axis of the globe now makes the same angle with the wooden horizon that the axis of the heavens (or line joining the centre and the poles) makes with the horizon of the spectator.

HORIZON. Every point of the earth's surface has thus a different rational horizon, but all these horizons have the same centre.

422. It becomes, in general, necessary, for considerations which will appear hereafter, to reduce celestial observations taken at the surface of the earth to what they would have been if taken at the centre; in the following figures, therefore, the observer is supposed to be at the centre of the earth. The dimensions of the earth are so small in comparison with the vast distances of the stars, that the above change of place of the spectator from the surface to the centre, or to any other point, would produce no change whatever in the apparent places or directions of the stars; and, accordingly, the magnitude of the earth, in drawing figures for general purposes, is neglected, the earth itself being considered as a mere point in the centre of the great sphere which circumscribes the stars. In the case of nearer bodies, as the sun and some others, and especially the moon, which, when viewed with delicate instruments, appear in different directions when seen from different points of the surface of the earth, this apparent change of place is allowed for by a special calculation. (See Parallax, No. 435)

423. The ZENITH is the point vertically over the spectator, and distant 90° from the rational horizon at every point.

The point opposite the zenith, or under the spectator's feet, on the other side of the centre, is called the NADIR.

Fig. 1.

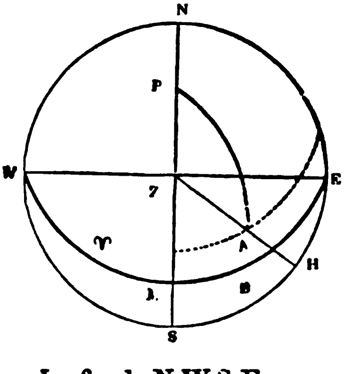
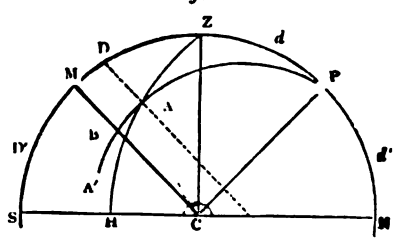



Fig. 2.




In fig. 1, N W S E represents the Rational Horizon; N S, the Meridian of the observer; N, S, E, W, the North, South, East, and West points; Z, the Zenith, which is seen directly over, or in one with the centre. This figure is drawn on the plane of the rational horizon, and shews the several circles as they would appear to an eye looking down vertically from a point at a great distance above the zenith.

Fig. 2 is drawn on the plane of the meridian, and shews the several circles of the upper or visible half of the sphere, as they would appear to the eye situated at a great distance due east of the sphere. In this figure the circle N W S E, or the horizon, appears as a straight line N S being seen edgeways; while the meridian,

which in fig. 1 is the straight line N S, appears here as the semicircle N P Z S. The E and W points are seen in one with the centre.

Of these two figures, that one would naturally be preferred which would best illustrate a proposed case. Fig. 1 may generally be employed to exhibit the hour-angle and azimuth; and fig. 2 the altitude, when the celestial body is near the horizon.*

424. P, the Pole of the heavens, is the point which remains fixed, whilst the rest of the celestial surface seen above the horizon appears to revolve.

The pole P is here represented as the North pole; the other extremity of the axis round which the sphere appears to revolve is the South pole, and takes the place of P when the figure is drawn for S. Lat. This pole is called the *elevated* pole.

425. The circle E M W, 90° from the pole, is the Celestial Equator. The plane of the earth's equator, E M W, fig. p. 55, No. 180, being extended to the heavens, marks on the sphere the celestial equator.

426. A Celestial Meridian is a semicircle passing through the pole of the heavens; P Z S is the celestial meridian of the spectator. The plane of the terrestrial meridian extended to the heavens marks on the sphere the celestial meridian.

427. Circles of Altitude are circles passing through the zenith, and vertical at the place of the spectator. Thus Z A H is the circle of altitude passing through a star A. Such, also, are Z M S, Z P N.

428. The Prime Vertical is the vertical circle E Z W passing through the E. and W. points. In fig. 2, E Z W does not appear, being in one with C Z, a radius joining the centre and zenith.

When the observer is on the equator, the celestial equator and prime vertical coincide.

429. Altitude is measured on a circle of altitude from the horizon; thus A H is the altitude of A.

The arc A H is the measure of the angle A C H, which would be formed at the centre by two straight lines, C H and C A. The alt. of a body M on the meridian is M S, which is the measure of the angle M C S.

430. *Parallels of Altitude* are circles parallel to the horizon.

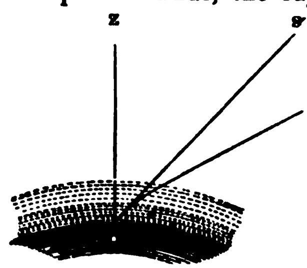
431. Zenith Distance is the arc included between the zenith and the celestial body, or the angular distance of a body from the zenith of which that arc is the measure. The zenith distance is, therefore, the complement of the altitude to 90°, as Z A.

432. The altitude of a celestial body, as seen from the surface of the earth, is called the *apparent* altitude; as seen from the centre, the *true* altitude.

A ray of light, proceeding from the body, when not in the zenith, to the eye, in traversing the earth's atmosphere, which is heavier, or denser, as it is nearer the surface, is bent more and more as it

* In like manner the figure may be drawn in the plane of the equator (as in Nos. 472, 478), in that of the prime vertical, or any other circle.

approaches the earth, towards the perpendicular direction; and as the spectator sees any object, not always in its true direction, but in that direction in which the light from it finally enters his eye, a celestial body appears higher than its true place. Thus, the ray S A, which proceeds from a star, is more and more bent towards the vertical line A Z as it approaches the surface, whereby the spectator sees the star in the direction A S′, and therefore higher than its true position.




The ray A Z, which traverses the atmosphere perpendicularly, undergoes no refraction. Thus to the eye supposed at the centre all rays would proceed without any deviation; because lines drawn towards the centre of the sphere are perpendicular to its circumference, parallel to which the atmosphere is disposed.

433. This alteration in the apparent place of a celestial body, caused by the atmosphere, is called the Astronomical Refraction.

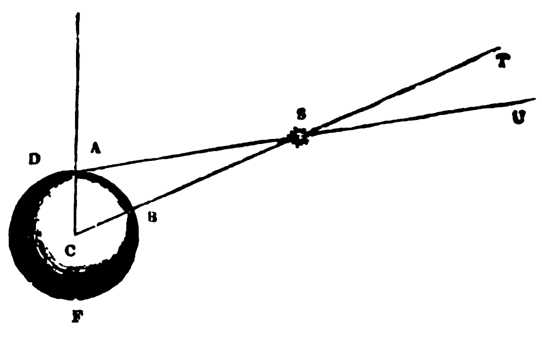
The astronomical refraction is 0 at the zenith, and about 34′ at the horizon; hence a celestial body, when really on the horizon, appears elevated 34′ above it, and is seen on the horizon when really 34′ below it. From the same cause all the celestial bodies rise earlier and set later than they would were there no atmosphere.

The refraction varies with the density or weight of the air, being greater when the barometer is high, or the air cold, and less when the barometer is low, or the air warm. The *mean refraction*, or that in the average state of the atmosphere, is given in Table 31, and corrections for different states of the air in Tables 32 and 33.

Since refraction causes the object to appear too *high*, it is to be *subtracted* from the apparent altitude in reducing it to the true altitude.

434. Twilight is the effect of the illumination of the upper regions of the atmosphere by the sun, before he has risen or after he has set, at the place of the spectator. Twilight continues, generally, while the sun is less than 18° below the horizon.

435. Parallax in Altitude is the angular depression of a celestial body, in consequence of its being seen from the surface instead of the centre of the earth, thus:



The body S, which is vertical to the spectator (who always stands with his feet towards the centre) at B, in the line C S, appears at T, being seen in the direction C S T; while to a spectator at A the same body appears below T at U, or in the direction A S U: the angle A S C, or T S U, which is equal to A S C, No. 116, is the *parallax in altitude.* (Tables 34 and 45.)

The spectator at B sees S in the same line as if he were at the centre; that is, a body in the zenith has no parallax. To a spectator at D, to whom S appears in the horizon, the depression, or parallax, is greater than at any other point.

The parallax at the horizon is called the Horizontal Parallax.

Since parallax makes the object appear too *low*, it is to be *added* to the apparent altitude, in reducing it to the true altitude.

436. It is evident, by the fig. No. 435, that the farther off a celestial body is, the less parallax it will have; and the nearer, the more. The sun has about 9″ hor. par.: the moon has about 1°. Parallax is matter of actual observation, and determines definitively the distances of the sun, moon, and planets.

437. The parallax will obviously be less if the earth's radius is less. Now, the earth being shaped like an orange, the radius, or line from the centre to the surface, in any latitude, is less than at the equator; hence the moon's hor. par. in the Nautical Almanac, which is the *equatoreal* hor. par., is too great for any latitude. The reduction is given in Table 41.

438. Since the apparent altitude is too great on account of refraction, and too small on account of parallax, the diff. between these quantities is the diff. between the true and apparent altitudes. This difference, or the combined effect of parallax and refraction, is called the *Correction of Altitude.*

The moon's Corr. of Alt. is given in Table 39; that of a star is merely its refraction.

439. The Semi-diameter of a celestial body is half the angle subtended by the diameter of the visible disc.

Thus to a spectator at S the semi-diameter of the body is half the angle subtended by the diameter D F, or contained between the lines S D, S F, supposed to be drawn from S to D and F; the half of this angle is D S C or C S F, and is called the semi-diameter.

It is evident that the semi-diameter will be greater as the body is nearer, and smaller as it is farther off. Thus the variations in the semi-diameter of the sun prove that the distance between the sun and the earth varies at different times of the year. (Table 34.)

440. When the body S is in the zenith, it is nearer to the spectator by half the earth's diameter, C B, than when it is on the horizon; hence it appears larger when in the zenith. This increase of apparent dimensions due to increase of altitude is sensible in the case of the moon only, and is called her Augmentation.* This is given in Table 42.

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* The apparent increase of the magnitudes of the sun and moon when near the horizon is a mere optical illusion, whatever explanation may be given of it; for the instruments by

441. The **Declination** of a celestial body is the portion of the meridian between the equator and the body; it is reckoned from the equator, and is either north or south. Thus, A B, fig. 2, p. 162, is the Declin. of A, and is north.

Since the declination is measured on the celestial meridians, these are called also declination circles.

442. *Parallels of Declination* are circles parallel to the equator, as the dotted line through A, in both figures, p. 162.

Thus declination is reckoned from the celestial equator as latitude on the surface of the earth is reckoned from the terrestrial equator; and as both these circles are in one and the same plane, declination and terrestrial latitude correspond: that is, a star in 28° N. Decl. passes every day vertically over all places in 28° N. Lat.

443. **Polar Distance** is the arc of the celestial meridian between a celestial body and the pole, or the angular distance of a body from the pole. When the Lat. and Decl. are of the *same* name, the pol. dist. is the *compl.* of the Decl. to 90°, because the distance from the pole to the equator is 90°; when the lat. and decl. are of *different* names, the pol. dist. is the *sum* of the decl. and 90°. Thus the pol. dist. of A is P A; that of A′ in S. decl., fig. 2, is P A′, which is the sum of 90° and A′ B.

444. The **Azimuth** of a celestial body is the angle at the zenith contained between the meridian of the place of the spectator and the circle of altitude passing through the body. It is reckoned to begin from that part of the meridian which is on the polar side of the zenith, that is, from the N. in north latitude; thus, the angle P Z A is the azimuth of A.

The angle M Z A is the supplement of the azimuth to 180°. This is often used for convenience; thus, instead of N. 132° E., we say S. 48° E.

445. The angle N Z A or P Z A is the same thing as an angle N C H on the horizontal plane, contained between the north and south line C N, and a line from the eye at C to the foot of the circle of altitude H,* which is the "point of the compass" on which A is seen. Now the angle N C H is measured by the arc N H; the azimuth, accordingly, is measured by the arc of the horizon between the meridian of the place and the circle of altitude of the body. The ship's course is the azimuth of the ship's head; so, also, the bearing of an object is its azimuth; and difference of bearing is difference of azimuth.

When a body is on the prime vertical, its azimuth is 90°.

Since refraction and parallax take place vertically, they do not affect the azimuth of a body.

446. The **Amplitude** is the arc of the horizon between a celestial body at rising or setting and the E. or W. point, and is the com-

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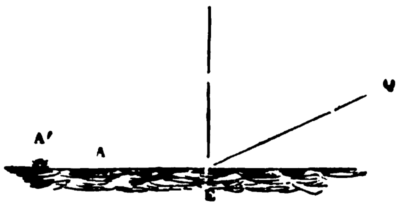
which the angles subtended by the discs are measured discover no change of magnitude. The constellations, as the Great Bear, Orion, &c., appear in like manner, when near the horizon, to occupy a vast space in the heavens, but when near the zenith much less.

* This cannot be distinctly represented to the eye by figs. 1 and 2, because in fig. 1 the points Z and C coincide, and in fig. 2 the horizon N W S E appears as a straight line.

plement of the azimuth; thus E H is the amplitude of a body rising at H. Amplitude is reckoned from the E. or W.; thus, if E H is 27°, the amplitude of H is E. 27° S.

(1.) The great refraction at the horizon affects sensibly the apparent amplitude. Thus, suppose the spectator in north lat. facing the east, E Q part of the equator, E Z part of the prime vertical, A′ a star having north decl. then E A′ is the *apparent* amplitude at the instant of rising; but the star is known to be raised, that is, brought into view, in this case, by refraction, and therefore has not yet, in its revolution, arrived at the horizon; A′ is consequently to the *left* of the place A, where it would rise were there no atmosphere. Hence the arc A′A is applied to the right of the compass-bearing on which A′ is observed, in order to correct the apparent place of the star for the effect of refraction. This quantity is given in Table 59 A.




In facing the west the line E Q (which would become W Q) would lie on the other side of the prime vertical, and the star would be seen to set to the *right* of its true place.

In south lat. the figure drawn above answers to setting, putting W. for E.

(2.) As the elevation of the observer depresses the sea-horizon while it does not affect the place of the star, it produces a further effect of the same kind as that of refraction.

In the case of the moon, as her parallax exceeds the refraction, the opposite effect is produced; that is, when she appears to rise, she has already, to an eye at the centre, passed the rational horizon: thus A would be the apparent place of the moon at rising, to the *right* of the true place A′.

447. The latitude, or distance of the observer from the equator, is measured, on the celestial sphere, by the distance of his zenith from the celestial equator; or Z M is the measure of the latitude, figs. p. 162.

Suppose now D, a star of N. decl., on the meridian at D., then M D is its decl. and Z D its zenith distance; here Z M, the Lat., is the *sum* of the decl. and zen. dist.

If D′ be a star of S. decl., Z M is the *diff.* of Z D′ and M D′.

If a star *d* be between Z and P, the lat. Z M is the difference of M *d* and Z *d*.

448. When the object is to the south of the observer, that is, when his zenith is to the north of the body, the zen. dist. is commonly called N.; when his zenith is to the south of the body, the zen. dist. is called S. In fig. 2, Z D and Z D′ are therefore called North; Z *d* is called South.

It appears, hence, that when the Decl. and Zen. Dist. are of the *same* name, their *sum* is the latitude; when of *different* names, their *difference* is the latitude.

But when the star is below the pole, as at *d′*, the Lat. Z M is

the Diff. of M $d'$ and Z $d'$, and M $d'$ is the sum of M P and P $d'$ or of 90°, and the compl. of the decl.

449. M Z being the lat, P Z is the Colat., since P M is 90°. Also Z N being 90°, P N is the compl. of P Z, and therefore equal to M Z; or the elevation of the pole is equal to the lat. of the place.

450. The altitude of the uppermost point of the equator on the meridian, or M S, is equal to the colatitude, because Z S is 90°. By noting this, and also that the equator passes through the E. and W. points, it is easy, in looking towards the heavens, to figure in the mind, roughly, the position of this circle. This is often useful.

451. In high latitudes, P in the figure falls near Z; in low latitudes, P falls near N. On the equator, Z and M coincide, the celestial equator there passing over the spectator's head.

In S. Lat. the letters N and S in the figures are changed; also the direction of the celestial motions (which we in N. lat. consider from left to right) is there reversed, because in S. lat., in looking towards the equator, the E. is on the right hand.

452. By the help of the preceding considerations (No. 447 and following) it is easy to construct a figure, in any case, to exhibit at once the manner in which the latitude is obtained from the meridian altitude and the declination.

*Fig.* 1.

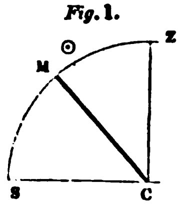



*Fig.* 2.

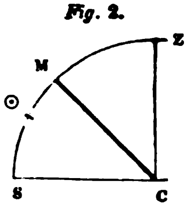
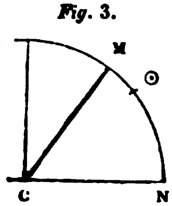



*Fig.* 3.




Ex. 1. The Mer. Alt. of the sun, observed to the southward, is 58°; his Decl. 14° N.

Fig. 1. Draw a quadrant Z C S by means of the chord of 60° (No. 107). Lay off, by the scale of chords, the Alt. S ⊙, 58°, or the zen. dist. Z ⊙, 32°. Lay off the Decl. 14° to the *southward* of the sun, as ⊙ M, since he is to the *northward* of the equator; then M is on the equator, and Z M is the LAT. *north*, and measures 46°.

Ex. 2. The Mer. Alt. of the sun, south of the observer, is 29°; his Decl. 18° S.

Fig. 2. Lay off S ⊙, 29°, and ⊙ M, 18° to the N. of the sun; then M is the place of the equator, and Z M, the LAT. north, measures 43°.

Ex. 3. The Mer. Alt. of the sun, north of the observer, is 38°; his Decl. 14° N.

Fig. 3. Lay off N ⊙, the Mer. Alt. 38°, and ⊙ M the Decl. 14° to the S. of ⊙; then Z M is the LAT. south, and measures 38°.

These figures, which are varieties of fig. 2, p. 162, are of the simplest kind. The point Z being marked on the quadrant, the place of the sun at ⊙, north or south of the observer, is given by the observation; his declination gives M the place where the equator cuts the meridian; whence it is at once seen whether Z is north or south of M, that is, whether the Lat. is N. or S.*

* After a little practice the observer will perceive, at the time of observation, how to deduce the latitude from the mer. alt. and decl. independently of the distinctions of names above (No. 448), which are adopted for the purpose of forming a general rule.

453. The passage of a celestial body over any particular point or circle is called TRANSIT; as the transit of the meridian, or the prime vertical, of a planet over the sun's disc, &c.

454. CULMINATION is another term for transit of the meridian. The transit of the meridian below the pole, whether above or below the spectator's horizon, is called the lower culmination; the other transit is called the upper culmination.

455. OCCULTATION is the disappearance or hiding of a celestial body by the intervention of another. Thus the stars in the moon's path are occulted by her, and the satellites of a planet by the body of the planet.

456. ECLIPSE is the disappearance of a celestial body in the shadow of another. In an eclipse of the moon, she disappears wholly, or partly, in the shadow of the earth, the earth being then in a line between the sun and moon. In an eclipse of the sun, the moon, being then in a line between the sun and the earth, conceals from us, for a time, the whole or part of the sun.

457. Celestial bodies are said to be in *Conjunction* when in a line together, as seen from the centre of the earth. Bodies having the same Right Ascension are said to be in Conjunction in Right Ascension (No. 469).

Two bodies are said to be in *Opposition* when in diametrically opposite points of the heavens.

458. It will be perceived, on attending to the circumstance, that stars which are visible in the west soon after sunset, disappear after some days in the solar light; and, in like manner, that stars which are faintly seen in the east, before sunrise, become more distinct from day to day. Hence the sun, besides revolving daily with the fixed stars* from east to west, has an apparent yearly motion amongst them in the contrary direction, or from west to east, completing the circuit of the heavens in the course of a year.

459. The path on which the sun appears to move, or the great circle which he seems to describe in the heavens, is called the ECLIPTIC.

460. The ecliptic is divided into twelve SIGNS, or portions of 30° each, called the *Signs of the Zodiac*, which term originally meant a space or belt of 8° wide on each side of the ecliptic, to which the planets† are confined. The signs, taken in the order in which the

* The stars are bodies which shine by their own light, and astronomers conclude, from every analogy yet detected, that they are suns. They are called "fixed," because to the eye they appear always in the same relative positions with respect to each other. The distance of the stars is so great that the difference of angular position, as seen from opposite points of the earth's orbit, a distance of a hundred and ninety millions of miles, has been found, in the case of one star only, to amount to so large a quantity as 2″, according to Mr. Henderson's determination of the parallax of α *Centauri*. At this star, therefore, the sun, which to us appears under an angle of above half a degree, would subtend an angle of only two hundredths of a second.

† The planets are bodies which, like the moon, shine by light received from the sun and reflected to us; they revolve round the sun in the same direction as the earth, but in different periods of time. Mercury ☿, the nearest to the sun, revolves in 88 days; Venus ♀, the next, in 225 days. These, moving in orbits inside that of the Earth, are called *inferior*

sun moves through them, that is, in the contrary direction to the apparent diurnal motion, are as follow:—

| | |
|---|---|
| ♈ *Aries* (the Ram). | ♎ *Libra* (the Balance). |
| ♉ *Taurus* (the Bull). | ♏ *Scorpio* (the Scorpion). |
| ♊ *Gemini* (the Twins). | ♐ *Sagittarius* (the Archer). |
| ♋ *Cancer* (the Crab). | ♑ *Capricornus* (the Goat). |
| ♌ *Leo* (the Lion). | ♒ *Aquarius* (Water Bearer). |
| ♍ *Virgo* (the Virgin). | ♓ *Pisces* (the Fishes). |

461. Besides this perpetual motion from west to east, the sun is always changing his declination, which varies between 23° 28′ N. and 23° 28′ S. He crosses the equator twice in the year, namely, about the 20th of March, in coming up to us in N. lat. from the southward, and again about the 23d of Sept. in going to the southward.

462. When the sun crosses the equator, he rises and sets at six o'clock in all parts of the world;* at these times, therefore, the days and nights are every where equal.

463. The two points in which the ecliptic, or sun's path, thus cuts the equator, are called the *Vernal*, or spring, *Equinox*, and the *Autumnal Equinox.*

464. The sun attains his greatest N. decl. about June 21st, and the greatest S. decl. about Dec. 22d. The points at which the sun seems at these times to be stationary in declination before he diminishes it, and at which the ecliptic and equator are most widely separated, are called the *Summer* and *Winter Solstices.*

465. As the light and heat received from the sun at any place vary with his altitude, and the time during which he remains above the horizon, and as both of these depend on the declination, the succession of seasons depends on the changes of the declination of the sun. The common or civil year, as most convenient for the affairs of life, includes the succession of the seasons. It is, therefore, the interval in which the sun leaves any parallel of declination and returns to it again, and is called a *tropical* year. Its length, that is, the average length of a number of such years, is $365^d\ 5^h\ 48^m\ 51^s{\cdot}6$, of common or mean time.†

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planets. Mars ♂ revolves in nearly 2 years; Jupiter ♃, in nearly 12 years; Saturn ♄, in 29 years; Herschel ♅, in 82 years; and Neptune ♆, in 165 years. These last are called *superior* planets. Besides these there are numerous small planets [287 known in 1890] whose orbits lie between those of Mars and Jupiter. Some of the planets have satellites, or moons: Mars has two, Jupiter four, Saturn eight, Herschel six, and Neptune one.

* The observed times differ a little from $6^h$ on account of refraction, No. 446.

† If the tropical year contained exactly 365 days, the arrangement of the calendar would be perfectly simple; but the necessity of counting by entire days in the affairs of life has introduced arbitrary expedients for checking the errors accumulated from time to time, from neglecting the excess over the last complete day. For example, suppose the year ends at midnight on Thursday, then new year's day begins at the same instant, that is, at $0^h$ on Friday morning, while the old year is really not yet out by nearly 6 hours. Next year 6 hours more of the new year will be anticipated, that is, new year's day will be reckoned 12 hours too soon; so that at the end of 4 years the beginning of the new year is anticipated by a whole day. By *adding* 1 day to the fourth year this error is removed, and the commencement of the calendar year is carried back to its true place nearly

The period of the commencement of the year, which has been adopted differently at different times, is at present (as established in this country by act of parliament) on January 1st, which is about 11 days after the winter solstice.

466. Since it is summer on that side of the equator on which the sun is, and winter on that on which he is not, the seasons in south latitude are reversed.

467. In the continual apparent revolution of the heavens round the earth, the circles of declination are perpetually describing angles round the poles, which are called, from the division of time into hours, HOUR-ANGLES.

468. An hour-angle, or horary angle (sometimes called also Meridian Distance), is the angle at the pole contained between the meridian of the place and the celestial meridian passing through the body; thus, Z P A is the hour-angle of A (figs. p. 162). An hour-angle is measured by the arc of the equator contained between the meridian of the place and that of the body; thus M B, fig. 2, measures Z P A.

The hour-angle is thus measured on the celestial equator in the same way as longitude is measured on the terrestrial equator.

469. The RIGHT ASCENSION of a celestial body is the arc of the equator included between the first point of *Aries* and the celestial meridian of the body: it is reckoned from west to east. Thus, if ♈ be the first point of *Aries*, fig. 1, p. 162, the arc ♈ M B is the Right Ascension of the body A. The 360° of the celestial equator are divided into $24^h$ of R.A.

Thus R.A. is reckoned on the celestial equator exactly as the longitude of places on the earth is reckoned on the terrestrial equator. But as the stars do not preserve that constant position with respect to the meridians which they do with respect to the equator, there is not that correspondence between R.A. and longitude which there is between declination and latitude.

470. The apparent revolution of the stars is perfectly regular, and is the only motion of the kind known.

One revolution of the earth round its axis, or, which is the same thing, the return of the same fixed star to the meridian after completing the circle, constitutes a *sidereal day;* this day consists of $23^h\ 56^m\ 4^s$ of common or mean time, as measured by clocks and watches. It is divided into 24 hours, called sidereal hours, and these into sidereal minutes and seconds. Thus a sidereal day is about $10^s$

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But the excess above $365^d$ does not amount to $6^h$ by $11^m\ 8^s$ nearly; hence at the end of the fourth year an error of the contrary kind is introduced of $44^m\ 32^s$, which amounts to nearly 3 days in 4 centuries. This error led to the reformation of the calendar by Pope Gregory XIII., in 1582, when the vernal equinox, which at the Council of Nice, in 325, had taken place on the 21st March, fell on the 11th. Hence, leaving 10 days out of the calendar, which was effected by calling the 4th of October, 1582, the 15th, brought matters right again. The error had amounted to 11 days when the change was adopted in this country in 1751.

This error is prevented for a long period in future by the Act 24 Geo. II., which directs the leap-years 1800, 1900, 2100, and so on, to be considered as common years, and 2000, 2400, 2800 as leap-years.

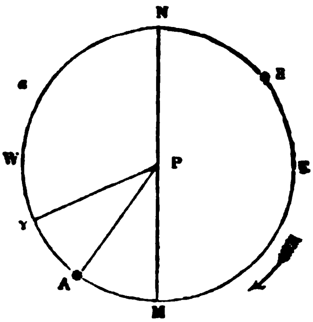
an hour shorter than a common or mean day; and the sidereal hours, minutes, and seconds, in the same proportion.

The sidereal day being thus, in round numbers, $4^m$ shorter than the mean day, a star that passed the meridian last night at 9 P.M will pass this evening at $8^h\ 56^m$, and so on, till after a few months it will pass at noon. (See Table 27.)

471. SIDEREAL TIME begins (that is, a sidereal clock, regulated to sidereal time, shews $0^h\ 0^m\ 0^s$) when the first point of *Aries* is on the meridian, and is counted through 24 hours, till the same point returns again; the hour-angle of this point is accordingly sidereal time.

The hour-angle of the first point of *Aries* is the right ascension of the meridian, No. 469, which is accordingly sidereal time. Difference of R.A. may, in like manner, be considered as a portion of sidereal time.

472. P is the pole, the circle N W M E the celestial equator, to which the measures of all hour-angles are referred. The bent arrow shews the direction of the apparent diurnal motion of the celestial bodies, reckoned from east to west supposing the spectator to face the south. M N is the observer's meridian.




A is any celestial body, as a star, which has passed the meridian at M, then A P M is the *hour-angle* of A, of which the arc A M is the measure.

(1.) B is a star to the eastward of the meridian, which it has passed at N; its hour-angle, reckoned westwards, is measured by M W N B. We may, however, employ also B M, the measure of the hour-angle reckoned eastwards. Thus, instead of $14^h\ 11^m$ W. we may call it $9^h\ 49^m$ E. As in dealing with hour-angles we refer directly to the number of hours which they contain, and which are measured on the equator, it is unnecessary to form the hour-angle of B by joining B and the pole.

(2.) Let the first point or beginning of *Aries* be at ♈, having passed the meridian before the star A; then ♈ M is the *right ascension* of the meridian, that is, sidereal time. The R.A. of A is ♈ A; that of B is ♈ M B, reckoned always from west to east, or opposite to the diurnal motion; and ♈ N B is the supplement of the R.A. of B to 24 hours.

(3.) The *sidereal time* ♈ M is the sum of the arcs ♈ A and A M, that is, of the hour-angle and R.A. of the star A. Again, ♈ M is the difference between the arcs *a* M and *a* ♈, that is, between the hour-angle of the star *a* and the supplement of its R.A. In the case of the star B, the sid. time is the difference between its R.A. ♈ M B, and its hour-angle M B.

Hence it is easy, when the hour-angle of a star of known R.A. is given, at any instant of time, to construct the figure to shew the sidereal time, thus:—Having drawn a circle, with the meridian, lay

off, by a scale of chords, the star's hour-angle; the position of the star being now given, lay off its R.A., reckoning from the *star* in the *same direction* as the apparent diurnal motion (for thus the R.A. reckoned back again from this point ♈ will agree with the place of the star). This gives the place of ♈, the hour-angle of which, reckoned westward, is the sid. time required.*

Ex. 1. The hour-angle of a star is $2^h\ 28^m$ W.; its R.A. $3^h\ 47^m$.

Lay off $2^h\ 28^m$, or $37°$, to the W. of M, and $3^h\ 47^m$, or $56°\ 45'$, further on towards the west: then the sid. time measures $93°\ 45'$, or $6^h\ 15^m$.

Ex. 2. The hour-angle of the moon is $9^h\ 13^m$ W.; her R.A. $18^h\ 34^m$.

Lay off $6^h$, or $90°$ (No. 107), and $3^h\ 13^m$, or $48°\ 15'$, from M, westwards. Then lay off 3 times $6^h$, or $90°$, and $34^m$, or $8°\ 30'$, further: the sid. time measures $56°\ 45'$, or $3^h\ 47^m$.

Ex. 3. The hour-angle of a star is $14^h\ 11^m$ W., or $9^h\ 49^m$ E.; its R.A. $5^h\ 21^m$.
The sid. time is $19^h\ 32^m$.

All hour-angles, which are differences of R.A. of the meridian and a celestial body, may be considered as portions of sidereal time. The *interval of time* in which a body of variable R.A. *describes* an hour-angle depends on the rate at which its R.A. changes.

473. The earth's motion round its axis being perfectly uniform, becomes the real standard of uniform measures of time; but as any star passes the meridian nearly $4^m$ earlier every night, the beginning of the sidereal day has no connexion with that of the common or civil day, as determined by light and darkness.

474. The hour-angle of the sun, reckoning always westward from the meridian, is Apparent Time. Thus, when the sun's meridian has passed over $48°$ of the celestial equator to the westward of the meridian of the place, it is said to be $3^h\ 12^m$ apparent time. This is the time shewn by the sun-dial.

475. The interval between the sun's passing the meridian on one day and the next, or the *apparent solar day*, is not always of the same length, the difference being sometimes half a minute between one day and the next. Apparent time serves well enough in cases where this irregularity does not appear, or is of no importance; as for example at sea, where, from the continual change of longitude, the time must be obtained by observation: but where account of the time is to be kept by mechanism alone, it must necessarily be divided into portions of invariable length.

The time for general use must, accordingly, unite the two advantages of being regulated by the sun, and of being perfectly uniform. The mean or average day of 24 hours must therefore be an average taken of all the days in the year, that is, such a day as the sun would regulate if he moved uniformly in R.A. This average day is called

* In the questions which this figure illustrates, motion *round* the pole only is considered; since, therefore, the place of a celestial body on its meridian is unconnected with the motion of the meridian itself round the pole, no regard is had to declination.

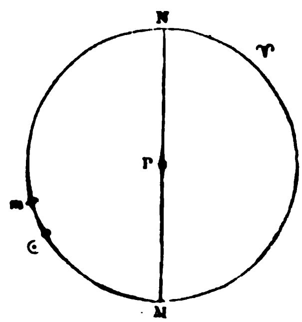
As the spectator will naturally refer the hour-angle of a star to the elevated pole of the place, in south latitude the figure will appear reversed, since the diurnal motion there appears from right to left in facing the equator. The figure, however, may be drawn in that manner which may appear the clearest, the only point essential to be kept in view, being that the R.A is reckoned the opposite way to the apparent diurnal motion.

the *mean solar day*, and time thus regulated is called mean solar time, or MEAN TIME, which is that shewn by clocks and watches.

476. The sun being generally either behind or in advance of the position which he would have occupied if he had moved uniformly, mean time is in general either fast or slow, on apparent time. The correction for this irregularity, that is, the difference between the sun-dial and the mean solar clock, is called the EQUATION OF TIME. Mean time is, therefore, deduced from apparent time, by applying the equation of time. See the Nautical Almanac, p. I. or II., or Table 62.

477. THE SIDEREAL TIME AT MEAN NOON is the right ascension of the meridian at the instant when the sun, if he moved uniformly, would be on it.

It is evident that this element, from its nature, varies uniformly; now, since the sun's R.A. varies irregularly, and since the equation of time, which is the correction that removes this irregularity, must also vary irregularly, it follows that the unequal variations of the equation of time and the sun's R.A. are together equivalent to the single and uniform variation of the sid. time at mean noon; and herein consists the great convenience of employing the sidereal time at mean noon, which has been given in the Nautical Almanac only since 1834.*




478. (1.) Let ☉ be the place of the sun, at about 4 P.M., $m$ the place where he would be if he always moved uniformly; then ☉M is *apparent time* (No. 474), $m$M is *mean time*, and $m$☉ is the *equation of time*. The equation is here *additive* to app. time, as is the case from January to March, and from July to August. (See Table 62.)

(2.) Let ♈ be the first point of Aries; then, while the sun and ♈ revolve, the sun moves contrary to the diurnal rotation, or is always *increasing* his R.A., or the arc ♈N☉, by nearly 1° a-day. The complete revolution of ♈ constitutes a *sidereal day*; that of ☉, an *apparent solar day*; and that of $m$, a *mean solar day*.

After 24 sidereal hours the sun has still to describe about 1°, or one 360th part of the circle to complete it; the time necessary for which is about one 360th of 24 sidereal hours, or 4 sidereal minutes. Thus the solar day is longer than the sidereal day by about $4^m$. The *mean solar day* being divided into 24 hours, the sidereal day is $23^h\ 56^m\ 4^s$ of such a day.

(3.) When $m$ is on the meridian at M, the arc M$m$♈, or the

* This element, which is the R.A. of a mean, or imaginary sun, is a very different thing from the R.A. of the sun *at mean noon*, with which it has been confounded: the latter can differ only a few seconds from the R.A. ☉ at *apparent noon*, but may differ from the *Sidereal Time at mean noon* by the whole amount of the equation of time, or sixteen minutes.

sun's mean R.A., is the *sidereal time at mean noon*. When *m* has arrived at *m* in the figure, this quantity has changed by an amount proportional to the mean time M *m*.

The ⊙ moves sometimes more quickly, at others more slowly; the point *m* (which is merely an imaginary situation of ⊙, deduced by calculation, from knowing the limits within which the irregularities of its motion are confined) moves equably. Hence *m* ⊙, the difference of these two, changes unequally.

(4) By No. 472 (3) the sidereal time, or place of the point ♈, is obtained from the hour-angle of any celestial body. By applying to the place of ♈ the sid. time at mean noon, we obtain the place of *m*, or mean time.

Thus Mean Time is found from the hour-angle of a star.

479. Since the sun *m* passes over 15° of the circle in one mean hour, he arrives at the meridian of a place 15° *west* of N M one hour *after* he has passed N M, that is, at one o'clock of the time at any place, or all places, of which N M is the meridian. In like manner he passes a meridian 15° *east* of M one hour *before* he arrives at M, that is, when the time on M is 11 o'clock in the forenoon, or 23 hours after the noon of the day before.

Thus the beginning of the day, and therefore the hour or time of the day, at one place differs from that of another place by the difference of longitude of the places; the time at the easternmost of the two being in advance of, that is, greater than, the time at the other. Hence when the times proper to two places at the same instant are known, their diff. long. is determined, or the relative positions of their meridians.*

480. The Civil Day is dated from midnight, and the twelve hours are computed twice over; the Astronomical Day is dated from noon, and runs through the twenty-four hours.

Ex. 1. October 3d, $3^h\ 18^m$ P.M., civil time, is the same astronomical time.

Ex. 2. January 3d, $4^h\ 25^m$ A.M. civil time, is reckoned January 2d, $16^h\ 25^m$ astronomical time.

Ex. 3. April 1st, 11 A.M. is, astronomically, March 31st, 23 hours.

481. The Greenwich Date is the time at Greenwich corresponding to any given time elsewhere.†

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* The diff. long. is found as well by means of the motion of a star as of the sun, that is, by means of a clock or chronometer regulated to sidereal time, as well as by one regulated to mean time. For although the absolute interval of time employed by a star in moving from one meridian to the other is less than that employed by the sun, yet it is divided into the same number of hours, minutes, and seconds, but which are of smaller magnitude and thus the difference of time results, in numbers, the same.

† Here terminates all requisite description of the terms used in the rules in the present volume. The other terms which occur in the Nautical Almanac will be described in the *Theory*.

In this chapter we have sometimes spoken of the earth as fixed and the heavens as movable, although this is contrary to fact, because the appearances alone furnish us with the measures of time, without any regard to the actual state of things.

Again, we have considered the earth as a sphere instead of a spheroid (No. 180). The consequences of the oblateness, in an astronomical point of view, are that the planes of the

482. It will be found a useful exercise of what has preceded to verify the following remarks:—

(1.) No star of which the pol. dist. is less than the lat. can set; and no star of which the pol. dist. exceeds 90° *plus* the colat. (S M, fig. p. 162) can be visible.

(2.) When the pol. dist. is less than the lat. the star passes the meridian both above and below the pole.

(3.) When the pol. dist. is less than the colat. the star passes the meridian between the zenith and the pole, and does not pass the prime vertical.

(4.) When the declin. is 0, or the pol. dist. 90°, the body rises and sets in the E. and W. points. The hour-angle at rising and setting is $6^h$, and the body is seen raised on the prime vertical by the effect of refraction; unless it is the moon, which, from her parallax being greater than her refraction, is not seen at the precise time of her rising and setting.

The object is above the horizon for 12 hours, and 12 hours below it.

In this case the amplitude is 0, except from the effect of refraction.

(5.) When the pol. dist. exceeds 90°, the celestial body rises and sets on that side of the E. and W. points which is farthest from the elevated pole; the hour-angle at rising and setting is less than $6^h$: the time during which the body is above the horizon is less than 12 hours, while it is more than 12 hours below the horizon. The body does not pass the prime vertical above the horizon; and the amplitude is reckoned towards the S. in N. lat., and towards the N. in S. lat.

(6.) When the pol. dist. is less than 90°, the celestial body rises and sets on the same side of the E. and W. points as the elevated pole; the hour-angle at rising and setting is greater than $6^h$. The body is more than 12 hours above the horizon, and less than 12 hours below it. The amplitude is reckoned towards the N. in N. Lat., and towards the S. in S. Lat.; the body passes the prime vertical twice The hour-angle at the passage of the prime vertical is less than $6^h$. (See Table 29.)

(7.) A star having a certain declination always rises and sets in the same points, and passes the meridian and prime vertical, or any other circle of altitude at the same altitude, without regard to its R. A.

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circles of altitude (excepting the meridian) do not pass through the centre, and that the length of the radius, or line drawn from the centre to the place of the observer, is different in different latitudes. The first of these conditions produces no sensible effect in practice, because the Time is not affected by it, and the same Latitude (though differing from the latitude on a sphere by the quantity in Table 52) results alike from all observations, of whatever kind, of a body not affected by parallax,—and thus the oblateness, however great, would always be neglected in determining a place by observation of the stars or the sun. By the second condition the parallax of the moon is affected, and a further correction of her apparent place becomes necessary.

We have also described the first point of ♈ as fixed, whereas it has a very slow motion. The stars, also, though called fixed, have slow proper motions. These and other points not necessary to our present subject will be treated more at large in the *Theory*.

(8.) As the place of a star or any celestial body is determined by its R. A. and Decl., and as, at the place of the spectator, the position of the celestial equator, to which both these are referred, is fixed, it is easy to know whereabout any star is to be looked for at any time. When, as is commonly the case, the time (mean or apparent) is given, the sun's hour-angle is known; and therefore, when he is invisible, his place on the equator may be estimated. By means of the sun's place, and his R. A., the place of the first point of Aries may be estimated; then the star's R. A. gives the place of its meridian on the equator, and its declination the place of the star with respect to the equator. When the sidereal time is given, the place of the first point of ♈ is at once known, just as the place of the sun is known from the apparent time.*

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* The position of the equator, and the relations among the Latitude of the place, the Time, and the Hour-angle, Altitude, and Azimuth of a celestial body, are best illustrated by a celestial globe. The broad horizontal rim represents the Rational Horizon (No. 421). The brass meridian of the globe being laid N. and S., and the Pole elevated, by the degrees marked on it, to the latitude (No. 449), the globe represents the celestial sphere as shewn in figs. 1, 2, p. 162. The position of the sun is found by marking the sun in his place in R.A. and Decl., by the help of the divisions on the globe, and then setting the sun at his proper hour-angle by means of the hour-circle near the pole. The Alt. or Zen. Dist. is measured by a graduated slip of brass, or by a thread, as in the note, p. 129. It is unnecessary to enter further into details, as the reader who well understands the definitions above will find no difficulty in solving any useful "problem on the globe" which can be proposed, without burdening his memory with technical rules.

In the absence of a globe, distinct ideas may be obtained of the actual positions of the celestial bodies by a circular card, as a compass-card, having the hours marked on the edge, and an axis, as a pencil, put through the centre perpendicular to the card. If this axis be laid N. and S., and the north end (in north lat.) raised up till it is inclined to the horizon at an angle equal to the latitude, it will represent the polar axis round which the celestial bodies revolve, the card representing the equator. The $0^h$ being brought up to the meridian, the hour of the day at the edge will shew the place of the sun's meridian at the time. If the $0^h$ be made the first point of ♈, the hours become hours of R.A.; if, then, the ☉ be marked on the edge, on its proper R.A., and then turned round to the position proper to the hour of the day, the place of the first point of ♈ is seen.

Suppose, now, a small telescope were placed on the axis making an angle with the plane of the equator, or the card, equal to the declination of some star, then, while this star revolves parallel to the equator, the telescope, kept at the same angle, could at any time be directed towards the star by merely turning the axis round. A large instrument is constructed on this principle, and is called an *Equatoreal.*

# CHAPTER II.

## Instruments of Nautical Astronomy.

I. The Reflecting Instruments.

II. The Artificial Horizon. III. The Chronometer.

## I. The Reflecting Instruments.

483. These are instruments for measuring angles between two objects, by bringing the reflected image of one of them to coincide with the other seen directly. They are necessary for observing altitudes of the heavenly bodies at sea, where the spectator has no fixed point of reference except in the horizon. On shore, and often on a field of ice, the fixed point required in observing altitudes is obtained by means of the artificial horizon.

484. The instruments of this class which are in most common use are the quadrant, sextant, and reflecting-circle. For convenience, we shall describe the adjustments generally under the two former; and as every person in possession of an instrument will be instructed by the maker or some expert person in the names of the different parts, and also in the mode of handling it, and packing it in the case without danger of distortion, we shall confine ourselves merely to matters of general reference.

### 1. *The Quadrant and Sextant.*

485. The quadrant contains an arc of more than 45°, and measures a few degrees more than 90°; it is usually made of wood, and the graduated arc, which is ivory, reads to minutes, and sometimes to 30″. The sextant measures a few degrees more than 120°; it is made of brass, and sometimes reads to 10″. The quadrant serves for common purposes at sea, but the sextant is required for taking a lunar observation.

The observer should be in the habit of employing good instruments of their kind, as inferior instruments naturally induce careless and imperfect observation.

486. The sextant made of a very small size, and thence called the Pocket Sextant, is adapted to the use of surveyors, travellers and others, on occasions in which minute accuracy is not necessary.

[1.] *Manner of Using.*

487. To take the sun's altitude at sea. Set the index at 0, put down a screen before the central mirror, hold the instrument in a vertical position, and direct the sight, through the sight-vane and horizon-glass, to that part of the horizon which is exactly under the sun. Now move the index on with the left hand, and the image of the sun will appear to descend towards the horizon. Vibrate the instrument round the line of sight, and make the lower limb touch the horizon: this gives the *observed altitude of the lower limb.*

488. This last altitude is sometimes near enough; but for accuracy, having made a rough contact as above, put in the telescope, previously set to distinct vision by looking through it at the horizon; the image being now magnified, the contact is made more correctly. In general the telescope should not be fixed till a rough contact has been made, because it narrows the field of view, and increases the difficulty of bringing the images together.

The contact must be made in the centre of the field: if it is too near the plane of the instrument, or too far from it, the angle will be too great by the quantity in Table 54.*

489. When there is a tangent-screw, clamp the index, and make the contact perfect by turning the screw,—some further remarks on which will be made in the proper places.

The tangent-screw should be kept nearly middled when not in use.

490. To take the altitude of a star. Set the index to 0, direct the sight to the star, hold the instrument vertically, and move the index onwards: the image of the star will be seen to descend. This method is proper to avoid bringing down the wrong star, but should not be practised with the sun, as it exposes the eye to an intense light, which may derange it for the whole observation.

491. The shades, or coloured glasses, placed before the two mirrors, tend to equalise the brightness of the object and the image, and sometimes distinguish one from the other by the difference of colour. The shades require to be particularly well ground, because, if the surfaces are not strictly parallel, the rays in passing through the glass are turned out of their former direction: hence, when a defective shade is placed before each of the mirrors, the angle is affected by the sum or the difference of the errors due to the shades. It is advisable, therefore, in general, to employ a dark glass at the eye-end of the telescope, by which the shade before one or both of the mirrors may be dispensed with. Also, if this glass is not perfect, the rays from the object and the image are affected alike, and the angle between them remains unchanged.

A card screen, to slip over the eye-end of the telescope, is useful in protecting the eye from accidental glare.

492. The observer acquires, by attention, the power of estimating

* Mr. Hartnup, director of the observatory at Liverpool, acquaints me that he has constantly found sextant observations to come out more accurately in proportion as he narrowed the field by closing the wires.

the proper angle at which to set the index for a rough contact, and thus saves time. It also effects some saving of time to have the tubes of the telescope marked at the observer's focus.

493. When the angular distance between two objects is to be measured, the plane of the instrument is held in the line joining them, and the sight is directed to the fainter of the two. When, therefore, the brighter object is to the right, the instrument is held face upwards, and the image of the right-hand object brought to touch the left-hand object seen directly; but when the brighter object is to the left (as in observing the distance between the sun and moon in high north latitudes in the forenoon), the instrument must be held face downwards, the sight being directed to the right-hand object. The contact must be made in the centre of the field, as directed above.

[2.] *Reading off the Angle.*

494. The angle having been observed, its measure is to be read off. The arc being divided into degrees, and these subdivided into halves, thirds, &c., the smallest division contains several minutes, and the angle can thus be read, but roughly, from the arc itself.

In order to read to 1′, or a fraction of 1′, a scale called a *vernier* is applied to the arc; this is a portion of an arc having the same centre, and divided into *one part more* than an equal portion of the arc itself. The manner in which a more minute reading is obtained may easily be understood from the following example:—Suppose a division on the arc to be $\frac{1}{3}$ of 1°, or 20′, and the vernier to be equal in length to 19 divisions, or 6° 20′, but divided into 20 equal parts; then each of the divisions on the vernier is $\frac{1}{20}$ of 6° 20′ or 380′, that is 19′, and therefore the difference between one division on the arc and one on the vernier is 1′.

Suppose the beginning of the vernier and that of the arc to coincide, as in Fig. 1; then the first of the dividing lines of the vernier falls short of the first dividing line of the arc by 1′; therefore, if we make these lines coincide, we advance the vernier 1′. Again, to make the second dividing lines of each coincide, we must move the vernier through 2′, and so on.

In Fig. 2 the 0 of the vernier stands between 20′ and 40′ after the division at 3°, and the first coincidence is at 9; hence the arc measured is 3° 29′.

Fig. 1.

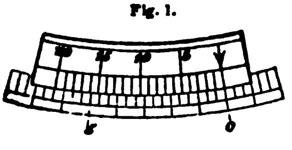


Fig. 2.

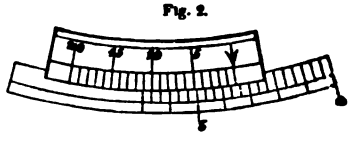
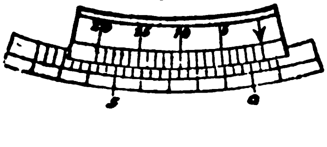


Fig. 3.



When the index is moved the contrary way, the o of the vernier goes off the arc, as seen in Fig. 3. As the 20 of the vernier stands at 6° 20′ when the two zeros coincide, if we move it 1′ to the right, the coincidence will occur at 19, and at 18 if we move it 2′, and so on. Hence, to measure an angle *off the arc*, we must read from the *end* of the vernier. The arc shewn is 32′ off the arc.

[3.] *Adjustments.*

495. (1.) The Index-Glass, or central mirror, must be perpendicular to the plane of the instrument.

Set the index about 60°; then, if the image of the arc in the mirror appear in perfect continuation with the arc itself, the adjustment is perfect; if the reflection seem to droop from the arc itself, the mirror leans back; if it rise upward, the mirror leans forward. The position is rectified (in quadrants only) by the screws on the back. This adjustment generally rests with the maker, but it should be occasionally verified by the observer.

(2.) The Horizon-Glass, or fixed mirror, must be perpendicular to the plane of the instrument.

Set the index to 0, hold the instrument horizontally, look through the glass at the sea-horizon, or other distant object, and give the instrument a small nodding motion: then if the reflected image appear neither above nor below the real object, the adjustment is perfect; if the *image* be the *lower*, the glass stoops *forward;* if it be the *higher*, the glass leans *backward.* The position is rectified by the screws.

(3.) The line of sight of the telescope must be parallel to the plane of the instrument in which the index moves.

Place the two wires of the telescope parallel to the plane of the instrument. Select two distant objects from 100° to 120° apart, as two stars, or the sun and moon, and make an exact contact at the lower wire, or that nearest the instrument. Now move the instrument so as to throw the images in contact upon the upper wire; if the contact is still perfect (the images having overlapped in the middle of the field), the adjustment is perfect; if they have separated, the object-end of the telescope droops; if they overlap, it rises. The position is rectified by the screws in the collar. When this adjustment is defective, the observed angle is always *too great.* (See Table 54.)

[4.] *Index-Error.*

496. The graduation of the arc should commence at a certain point; when this is not the case, the Index-Error, as it is called, must be measured.

The point at which the graduation of the arc is supposed to begin, is that at which the index stands when the mirrors are parallel, as is the case when the image of a distant object is seen to coincide with the object itself. The index-error, therefore, is merely the error of the place of the *beginning* of the divisions, and affects all angles alike.

To find the Index-Error. (1.) By the Horizon Hold the instrument vertically, and make the image of the horizon coincide with the horizon itself as accurately as possible. If the 0, or zero of the

index, now stand at 0, there is no index-error; if it stand *on* the arc, the index-correction is so much *subtractive;* when *off* the arc, *additive.**

Ex. The horizon and its image being made to coincide, the reading is 3′ on the arc Then 3′ is the INDEX CORRECTION to be *subtracted* from every angle observed.

Any distant object, or a bright star, answers the purpose.

(2.) By the Sun. Measure the sun's horizontal diameter,† moving the index forward on the divisions; read off the measure which will be *on* the arc; then cause the images to change sides by moving the index back; take the measure again, and read off; this reading will be *off* the arc: half the difference of the two readings is the index-correction.

When the diameter *on* the arc is the *greater*, the correction is *subtractive;* when the *lesser*, *additive.*‡

| | | | | | |
|---|---|---|---|---|---|
| Ex. 1. | On the arc | 32′ 10″ | Ex. 2. | On the arc | 30′ 10″ |
| | Off | 29 50 | | Off | 33 40 |
| | | 2 20 | | | 3 30 |
| IND. CORR. *subtract* | | 1 10 | IND. CORR. *add* | | 1 45 |

In consequence of the spring or elasticity of the index-bar, the error will be different for the *onward* and for the *backward* motion of the index. It has been recommended, therefore, to turn the tangent-screw right and left alternately, in making successive contacts, by which a partial compensation is obtained. This source of discrepancy is, however, effectually removed by taking all observations, including that for index-error, with the same motion of the index-bar. The *onward* motion being adopted as the most natural, the tangent-screw is always employed to close the object and the reflected image, and is thus always turned in the same direction.§

One-fourth of the sum of the two readings should be equal to the sun's semi-diameter in the Nautical Almanac. This affords a test of the accuracy with which the observation has been made.

497. The adjusting screws are *never to be touched except from*

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* When the mirrors are parallel, a very distant object is exactly covered by its image; but at a near object the distance between the mirrors subtends a sensible angle, or has sensible *parallax*, and this coincidence does not take place. The parallax of a 12-inch sextant at half a mile distance is about 21″, and is smaller for smaller dimensions and greater distances, in simple proportion. Hence, for the purposes of adjustment, distances exceeding this should be employed.

Captain Beechey suggests a method of adjustment by parallel rays. Naut. Mag. 1844. p. 505.

† As the refraction increases towards the horizon, the lower limb is more raised than the upper limb, and the vertical diameter is shortened. This, at very low altitudes, produces a flattened or oval form in the sun and moon.

‡ If both readings are on the arc, which can only occur when the index-error is nearly half a degree, the ind. corr. is the mean, and subtractive; if off, additive.

§ Sir F. Beaufort, to whom I am indebted for the suggestion, acquaints me, that from the sensible influence of the spring of the index-bar in nice observation he uniformly adhered to this plan, and caused it to be followed by his officers.

The late Captain Basil Hall informed me that he made it his practice to obtain the index-error both for the onward and the backward motion of the index employing the former error in all observations by the onward motion, such as the lunar distance when increasing, and the latter in observations by the reverse motion, as for the lunar distance when decreasing.

*necessity*, and then with the greatest possible caution.* When two screws work against each other, care must be taken, in tightening one, to loosen the other if necessary.

498 Besides errors from these causes, there are others which are neither detected nor remedied so easily: the divisions on the arc are liable (though in these days in a very slight degree) to inaccuracy, and the centering of the arc is not always perfect.†

In order to test the accuracy of the arc in either of these respects, in different places, it has been proposed to measure the distance of two stars, comparing the distance with that shewn by a circle, or by an approved sextant, or deduced from calculation.‡ The absolute error being thus found for certain places on the arc, the correction for any angle may be inferred by proportion.

499. As the two sides of the coloured glasses are not always exactly parallel, the shades may vitiate the angle. (No. 491.) Some observers find, by actual trial, the error due to any shade or combination of shades. The shade in the eye-piece, as before stated, has not this defect; § but an image-shade is generally indispensable in taking a lunar observation.

[5.] *Methods of Increasing the Efficiency of the Sextant.*

500. The necessity, under certain circumstances, of observing large angles, and the difficulty of measuring them, arising from the obliquity with which the rays of light, in such cases, fall on the central mirror, have led to the suggestion of various plans for extending the powers of the sextant.

Capt. Fitzroy has employed an additional fixed horizon-glass, placed at a constant angle with the ordinary one, by means of which the image of an object above, or to the right-hand of another in the

* Particular attention is called to this point, because it is a common failing of "over-handy gentlemen" (to use Troughton's language) to "torment" their instruments. It is better that error should exist, provided that it is allowed for nearly, than that mischief should ensue to the instrument from ignorant attempts at a perfect adjustment; and the skilful observer, instead of implicitly depending upon the supposed perfection of his instrument, will endeavour to avail himself of those cases in which errors, if they exist, will destroy each other.

† It is also necessary that the two surfaces of the central mirror should be exactly parallel. This parallelism can be tested only by observing an angle between two objects 120° or 130° apart, and then repeating the observation with the mirror in a reversed position. Half the difference, if there is any, between the two results is the angle between the surfaces. As in the best instruments the mirror is fixed, this cannot be put in practice, and the consideration is therefore omitted from the adjustments in the text. This error, however, when it exists, is obviated by the method described in the next sentence of the text.

‡ The stars for this purpose must be taken from the Nautical Almanac, as the places are required with precision. The true distance may then be computed by the rule No. 339 (2), using the Diff. of the stars' right ascensions for D. Long., and their polar distances for the colatitudes. The true distance may then be reduced to the apparent (which is that measured by the instrument), by No. 842, substituting one of the stars for the moon, omitting the second corr., and applying the other star's correction the *opposite way* to that laid down in the tabulated directions for the star.

§ Working with the artificial horizon, the eye-piece of the inverting tube should, if possible, be used instead of the shades of the sextant; if shades are used, endeavour always to use the same. The meridian altitude of the sun should, if possible, be observed with the eye-piece, as the latitude obtained from it can then be meaned more satisfactorily with that determined by the stars.

line of sight, is seen in the field when the index is at 0, and thus a portion of the angle is measured in addition to that on the arc.

501. Admiral Beechey had a sextant constructed with a second central mirror over the usual one, and working on the same pivot, the arc of which, being concentric with the usual arc, is divided by the same stroke. Both index-glasses are adapted to the same horizon-glass.*

Any angle is measured by putting one index forward upon the arc to any convenient number of degrees, and moving the other until both reflected images are seen in the horizon-glass.

Each arc has its proper index-error.

502. Mr. C. George, R.N., has constructed a double pocket-sextant, by joining two small sextants by the face. This instrument, which scarcely exceeds the box-sextant in size, possesses for various approximate purposes, and for surveying, the advantages of the double sextant.†

503. The double sextant has some important advantages; it affords two alts. of the same or different celestial bodies in quick succession: this is a point of much consequence when the body appears for short intervals only, as between flying clouds, and also in observing at night, as it saves the disturbance to the eye caused by reading off; it measures the angular distance between opposite points of the horizon,‡ and thus serves as a dip sector; it measures two terrestrial angles at the same instant, and thus serves as a director.

The index-error of a compound angle measured by a double sextant is composed of the errors proper to each arc.

The error of parallelism (No. 495) in a compound angle is materially reduced, since in practice each portion is less than 90°.

504. In observing altitudes at sea by the double sextant, set any angle on the upper sextant; then, facing that part of the horizon which is opposite the sun, find his image, and bring up the horizon to the lower limb, by moving the lower index: the sum of the two readings is the suppl. of the alt. of the upper limb, affected by the dip and the index-error.

Now unclamp the indexes, set the upper one to an angle less than the alt., find the image under the sun, and bring up the horizon to the lower limb: the sum of the readings is the alt. of the lower limb, affected by the dip and the index-error.

Half the difference of the two sums is the app. zen. dist. cleared of the dip, semi-diameter, and index-error.

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* Admiral Beechey acquainted me that he constructed this sextant for the purpose of obtaining the measures of the angles between two terrestrial objects at the same instant and by one observer: a point of considerable importance in surveying, or in laying down soundings, while the observer himself is in motion. A further advantage afforded by the construction is, that when the right-hand object is too faint to be reflected, the sextant does not require to be inverted. The instrument is constructed by Cary.

† Made by Cary.

‡ The difference between this angle and 180° is twice the apparent dip. Thus, if this angle, measured downwards, is 179° 48′ 30″, the apparent or actual dip is 5′ 45″. The dip sector, being inconvenient and little used, is not described in the text.

## 2. *The Repeating Reflecting Circle.*

505. On this circle the measure of the angle observed by reflection, as in a sextant, is carried over any part or the whole of the circumference: this is effected by making the horizon-glass itself movable round the centre, and attaching to it a vernier. By thus *repeating* the same angle on different parts of the divided edge, the errors of the index, of the coloured shades, and of the centering, are nearly, if not altogether, removed; also, since the indexes follow each other round the circle (each mirror alternately acting the part of the fixed horizon-glass), the angle finally registered is the sum total of all the repetitions; and thus one reading alone contains the result of any number, however great, of separate observations. The arc read off, divided by the number of observations, gives the measure of the required angle.

506. When the angle changes during the observation, the arc finally registered is not the mere repetition of the same angle, but the sum total of *different angles;* it is therefore necessary to understand how the *time* is to be noted.

Suppose, for example, at $5^h\,20^m$ the angle is $45^\circ$, and at $5^h\,26^m$ it is $46^\circ$ (neither being read off); now, at $5^h\,20^m$ the first index would shew $45^\circ$, and at $5^h\,26^m$ the second index would shew the sum of $45^\circ$ and $46^\circ$, or $91^\circ$, *half* of which, or $45^\circ\,30'$, in this case obviously corresponds to the *middle* time, $5^h\,23^m$.

The same appears generally thus: the last arc read off measures the first angle, the repetition of the same angle, and the change upon it during the interval of the two observations; therefore half the arc measures the angle, and half the change upon it, supposed uniform, which corresponds to the middle time.

If, now, a second pair of angles, as before, be observed, a second angle with its time is obtained, and so on; hence, as long as the change of the angle is *uniform*, the arc read off, being divided by the number of observations, corresponds accurately to the mean of the times.

The time is therefore to be noted at each contact.

507. The Circle is made in various forms: we shall confine ourselves here to the description and use of those known by the names of Borda's and Dollond's Circles.* Figures are purposely omitted, and the general description will be easily followed with the instrument itself.

In using the circle, care must be taken to push the crooked handle out of the way of the telescope.

* Troughton's Reflecting Circle, which does not repeat, is capable of great precision; but it does not seem so well adapted to general practice, especially at sea, as the repeating circle: for the three indexes aggravate the inconvenience and tediousness of reading off; and the instrument, instead of facilitating, like the repeating circle, the multiplication of observations, affords merely a correct measure of an angle which, from the motion of the ship, is itself observed inaccurately.

[1.] *Borda's Circle.*

508. In Borda's Circle, the horizon-glass and telescope revolve together round the centre, like the central mirror, carrying a vernier, which we shall call A.

Sometimes another vernier is placed opposite to A, and moves with it. The central mirror carries, like a sextant, a vernier, which we shall call B. The circle is divided into 720°.

The horizon-glass and telescope are attached to an inner circular arc divided to degrees, which is called the *finder*, as it enables the mirrors to be set to contain any angle, and the objects can thus be at once brought into contact roughly. When B is set to 0 at the middle of the finder, the mirrors are parallel. The divisions on the finder are reckoned in both directions from the 0.

509. To use the circle as a sextant. Before this can be done we must know the reading of B when the mirrors are parallel. To find this, set A accurately to 720°,* and clamp it. Set B to 0 on the finder, nearly, and measure the sun's horizontal diameter: read off. Cross the reflected image to the other side of the sun, and read off: the mean of the two readings is the *constant angle* required, and is clear of index-error.

To observe, move B as in a sextant.

After observation, examine the setting of A, as any error in this is so much index-error.

510. By moving the index opposite ways, observations may be taken backwards and forwards, from the same point on the arc; but the real efficiency of the repeating circle consists in what is called the *cross-observation*, to which we shall now proceed.

To observe an Altitude by the cross-observation. Set A† accurately at 720° (or at 360°); set B to 0 on the finder roughly; observe the alt. with B as with a sextant; read off B roughly on the finder; unclamp A, and move it on the finder, in the order of the divisions on the circle, till the 0 on the other side of B stands at the angle read off. Turn the circle over, hold it in the other hand, and complete the contact by turning the tangent-screw of A.

The vernier A now registers the *first pair*, or *double* the altitude required.

To proceed with the repetition. Unclamp B, set it on the finder at the same angle as before; hold the instrument as for the first observation; complete the contact. Unclamp A, move it onwards as before till the 0 stands at the angle read off; complete the contact. This is the *second pair*, or *four times* the required altitude.

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* This index will, in some circles, stand at 360°, and may require to be moved backwards; 360° would then be subtracted from every angle measured by this index alone. The above instructions will, with a trial or two, be found sufficiently intelligible.

† It is usual to fix first the index called here B, as directed by Borda himself, and repeated by other writers; but it is immaterial which index is first fixed, or at what part of the circle, provided the vernier be read off. The index A is recommended here in order to assimilate as much as possible the use of the circle to that of the instruments with which we are already more familiar. Inaccuracy in this setting is diminished as the number of repetitions is increased.

The next reading of A will be six times the required altitude, and so on.

511. To observe Angular Distance by the cross-observation. Proceed as directed above, reading distance for altitude.

512. If there is not light enough to read the finder, the reflected image must be actually carried across the other object by moving the index through twice the angle first measured.

513. The last pair completed being registered by the vernier A, the disturbing of B at any time is immaterial, since it does not affect the reading of A; but if A is moved, and the observation is interrupted before the new pair is completed, the whole is lost.

514. Two altitudes, of the same or different bodies, may be obtained by reading both verniers;* thus, set A to 720°, observe one alt. with B, as in No. 509. Unclamp A, move it to 0 on the finder, hold the circle in the other hand, and observe the other altitude.

Read off B, and subtract from it the constant angle: the remainder is the first alt. For the second alt. subtract the first alt. from A.

Ex. B 252° 2′; A 98° 11′; const. 213° 35′. The FIRST ALT. is 38° 27′; the SECOND is 59° 44′.

515. We shall now consider the effects of errors. The index-error is obviously removed by measuring the same angle, either on opposite sides of a fixed zero, or between any two points on the arc. Now, after B has been clamped, and the angle is to be repeated by moving A, the horizon-glass passes from one side of the perpendicular upon the central mirror through the same angle on the other side; the angle, therefore, is measured by the motion of A from one point of the arc to another, and the exact point 720° is assumed merely for convenience in reading.

When a coloured shade is defective, it breaks the direct course of the ray from the central mirror to the horizon-glass, and the broken part inclines towards the same side of the horizon-glass, whether the circle is inverted or not. Therefore, if the angle formed on one side of the perpendicular on the fixed mirror is too great, the angle formed on the other side will be too small, by the same quantity, and this error disappears.

The inclination of the line of sight upon the plane of the circle, No. 495 (3), produces the same effect upon the angle formed upon either side of the perpendicular to the central mirror; this error therefore remains.

The error of the eye, and therefore the personal equation (No. 175), likewise remains.

The error of centering is removed by carrying the angle round the whole circumference.

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* This may be found convenient in taking a lunar at night, since the lamp would be required but three times for reading, in obtaining the four altitudes required and the several pairs of distances. Rules might easily be given for repeating both altitudes to any extent, but an allowance would be necessary for the motion in altitude of the second body observed.

[2.] *Dollond's Circle.*

516. Dollond's Circle consists of two concentric circles, the inner one of which, in revolving within the other, carries the horizon-glass and telescope, and a vernier called A, of which the clamp and tangent screw are attached near the telescope. The inner circle is cut to degrees only; the central mirror carries a vernier called B, as in a sextant.

The inner circle answers the purpose of the finder above described. From the position of the telescope, this circle is held, in taking altitudes, exactly like a sextant, which is a convenience. From the general resemblance between the two instruments, it is unnecessary to enter into further details.*

## II. The Artificial Horizon.

517. The Artificial Horizon is a small shallow trough, a few inches in length, containing quicksilver or any other fluid, the surface of which affords a reflected image of a celestial body. The fluid is protected from the disturbing effects of the air by a roof, of which the two opposite sides contain plate-glass. This roof is often made to fold up for the sake of portability. The trough should be so thick as to raise the quicksilver to a level with the lower edges of the glasses.

A piece of talc, which substance splits into thin parallel plates, may be laid on the trough as a substitute for the roof. In some cases a piece of thin cloth, as muslin, sufficiently transparent to allow a bright object to be seen through it, protects the fluid from the wind.

518. The image of a celestial object reflected from the surface of a fluid at rest appears as much below the true horizontal line as the object itself appears above it; the angular distance measured between the object and its image is therefore double the altitude. An advantage resulting from this is that in halving the angle shewn by the instrument we halve, at the same time, all the errors of observation. The reflected image in the fluid is always less bright than the object, but as it is perfectly formed, and as the surface is truly horizontal, the artificial horizon, when it can be employed, is always to be preferred to the sea-horizon.

* It is the opinion of some competent judges that circles should be made much smaller, for the sake of lightness and portability, and that they should accordingly be cut to minutes only, as Borda's Circle formerly was; because, by repetition, the minute or nearest half-minute read off is speedily reduced to quantities smaller than can be measured in the observation.

The case of a sextant, or circle, should be made to receive the instrument permanently with the index in any position, as the reading off, which is always difficult in defective light, might thus be deferred to a more favourable opportunity. It would also be useful for reference in cases of error or doubt in the reading, especially at night, to leave the index undisturbed till the result had been worked out.

When the altitude exceeds 60°, the altitude by reflection exceeding 120° falls without the limits of the sextant. In low latitudes, therefore, it is often impossible to observe with the quicksilver except by a sextant with additional powers.* On the other hand, when the altitude is low, the observer is obliged to increase his distance from the quicksilver, by which it becomes difficult to keep sight of the image reflected in the fluid; and for altitudes less than 12° or 15° the observation is generally impracticable.

519. The roof should generally be placed upon a sheet of some thin material, impervious to vapour, which, condensing on the glass, obscures the image. A leaden stand about the size of an octavo volume, on three legs, and covered with cloth, into which the roof sinks and excludes the external air, is convenient.

520. The film, or scum, which forms on the quicksilver, is prevented from running into the trough by holding the bottle inverted while it is poured out. A wooden scraper, fitting close to the inner breadth of the trough, has been found to remove the scum, which adheres to the wood.

521. The fluid proper for the purposes must possess the qualities of giving a bright image, and of quickly subsiding to a perfect level after being disturbed, such as quicksilver, water, spirit, and others.

An ingenious, handy, and portable mercurial horizon by the late Captain George, R.N., made by Cary, 181 Strand, is recommended. It consists of a disc of glass floating on mercury, in a vessel which it nearly fits, and it has an arrangement by which the mercury is introduced, ready filtered from an attached reservoir, and afterwards withdrawn, in a manner which saves a great deal of trouble. The glass floats without touching the sides of the trough, and the whole of the mercury below is serviceable. Another advantage is, that the edges of the trough cut off proportionally less of the field of view, hence very low altitudes may be observed with this instrument. The glass must necessarily be of the best workmanship.

When the air is calm, a piece of water, or a puddle large enough merely to exhibit the image, is often a complete substitute for the quicksilver.†

522. As the celestial bodies are sometimes distinctly visible when the sea-horizon is enveloped in mist,‡ attempts have been made to

* To remedy this defect, it has been proposed to use a reflecting surface, inclined at a constant angle to the horizon, movable on a level surface or floating in quicksilver. Also, a sextant has been fixed, with its plane vertical, to a pillar turning on an upright axis, and the telescope laid nearly horizontal by a spirit-level, the image of the body being brought down to a horizontal wire in the telescope.

† A small piece of plate-glass levelled by a bubble is sometimes used, but the performance of this instrument is not always satisfactory.

‡ Capt. Scoresby ("Journal of a Voyage to the Northern Whale Fishery," p. 159), remarks, that fogs often cover the sea in the polar regions to the depth only of 150 or 200 feet, while the sky is perfectly clear.

Her Majesty's sloop Zebra was a week without interruption in a dense fog, to the southward of the Snares, during the whole of which time no observation could be taken, though the sun often shone brightly (Naut. Mag. 1844). The like circumstances occur in "the Smokes," on the coast of Africa.

obtain an artificial horizon adapted to be used on board ship, by means of the surface of a viscid fluid, and a mirror attached to a pendulum, which, by its weight, hangs vertically.*

The objections to the first of these have already been stated. With regard to the motion of a pendulum, it is important to observe that when the ship comes to the end of her roll or lurch, it does not at once rest in the vertical position, but continues to move onwards or to swing, with the velocity which it had before the ship's motion was destroyed; hence the pendulum moves through greater angles than the ship. By combining, however, the viscid fluid and the pendulum, Commander Becher has obtained a method of measuring altitudes at sea, independently of the horizon, which appears, from the reports made upon it, to afford sufficient accuracy for common purposes, when the motion of the ship is not very great.† Outside the horizon-glass of the sextant is a small pendulum, an inch and a half long, suspended in oil; to this is attached a horizontal arm, carrying at the inner end a slip of metal, the upper edge of which, when seen in a certain position, is the true horizon.

The error is determined by observation of a known altitude, or by the help of another sextant, and is the same for all altitudes. It should be frequently examined.

A lamp is attached for observing at night.

**523.** Admiral Beechey fitted, within the telescope of the sextant, a balance carrying a glass vane, one half of which is coloured blue, to represent the sea-horizon, and to which the celestial object is brought down. The amount of oscillation above and below the level is indicated by divisions on the glass, the values of which are determined by the maker.

The instructions for using this instrument are as follows:—Bring down the object, as the sun's limb, to the edge of the blue and leave it there. As the ship rolls, catch with the eye the upper and lower divisions reached by the object, and call them out to an assistant. who writes them down with the time against each. When two or more such readings have been taken, read off the alt. and write it down. Take the mean of the readings of the vane and turn it into arc according to the scale furnished. When the mean is *above* the edge, *add* it, when *below*, subtract it. Apply the maker's index-error; the result is the apparent alt. being clear of dip.

Ex. Took an alt., and readings as follows; the divisions 12′ each:—

| | h | m | s | Divis. | | |
|---|---|---|---|---|---|---|
| | 10 | 50 | 0 | (+1) above | the blue edge | |
| | | 50 | 30 | (−1½) below | | |
| | | 50 | 50 | (+1½) above | | |
| | | 51 | 20 | (−2) below | | |
| Mean | 10 | 50 | 40 | (−½), 2½ above, 3½ below; diff. 1 *below*; the half is ½ of 12′ or 6′ to be *sub*. | | |

| | ° | ′ | ″ |
|---|---|---|---|
| Observ. Alt. | 20 | 25 | 20 |
| Mean of Div. | | −6 | |
| | 20 | 19 | 20 |
| Maker's Ind. Corr. | | | −40 |
| App. Alt. | 20 | 18 | 40 |

* It has also been attempted, but without success, to employ the principle upon which a top while spinning tends to preserve a vertical position, by balancing a horizontal mirror on a pivot, and causing it to revolve with great velocity.

† See Naut. Mag. 1844, p. 291. Several reports, with observations made by this instrument, will be found in the Naut. Mag. of 1839, 1842, 1844, &c.

Care is to be taken to observe as near the centre of the field as possible, and exactly under the sun; the elbow should rest on some firm support.

With practice the instrument affords considerable accuracy; and in smooth water the mean of some alts. will be within 2′.

A lamp illuminates the telescope at night.*

524. An instrument for this purpose, indispensable when the horizon cannot be seen, will also be of great service as a check, when haze or fog, by its partial distribution, produces the appearance of the horizon where it is not.† The same applies to the uncertainty in the place of the sea-horizon which is often experienced in moonlight nights.

These instruments are very convenient on shore.

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## III. The Chronometer.

525. The chronometer is a superior kind of watch, furnished with an apparatus by which the changes in the rate arising from the expansion or contraction of the materials by heat and cold are nearly obviated.

Chronometers should be kept near the centre of gravity of the ship, which is a little below the water-line, and not far from the middle of the length, not so much because the motion here is less than elsewhere, as because the temperature below is not liable to sudden changes. In ships in which great attention is paid to the chronometers, they are usually kept in a small apartment abaft the mainmast, on a table, in cases lined with cushions of soft wool, which defend them from the jerks and vibrations of the ship. The table is secured to a beam of the deck below, and in small vessels sometimes rests on a stanchion rising from the kelson. Large chronometers are placed in jimbals, in order to preserve a horizontal position, as inclining a watch from this position affects its rate. They have also been hung, perhaps with the view of obtaining both these objects together, in swing trays; but as this method is found to be very unfavourable, it has been discontinued.‡

The chronometer-table has been itself placed in jimbals. It has also been supported by springs to diminish still further the effect of shocks.

526. When a chronometer is placed on board it should always remain in the same position, that is, with the XII towards the same

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* Made by Cary.

† Adm. Bayfield acquaints me that he has been completely deceived in the place of the horizon at the coming on of a fog.

‡ Mr. Fisher acquaints me that he has found an acceleration of seven seconds a-day produced by suspending a chronometer in a cot with five inches' swing.

part of the ship, since it has been found that disturbing the positions has altered their rates.*

When a chronometer is transported from one place to another, it should be compared, before and after moving, with another chronometer or a good watch, in order to ascertain whether its regularity has been disturbed.

527. A chronometer should be wound up at regular intervals, in order that the same parts of the machine may undergo the same constant action; it should, therefore, be wound up at the same hour every day. In winding, the key should be turned steadily, and about half a turn taken each time, and the watch should be wound close up. After winding, the chronometer should be examined, to ascertain that it has not stopped.

In winding up a watch, the key alone should be moved, as to turn the watch itself is to increase the velocity of winding.

When a chronometer is wound up after running down, it is set a-going by giving it a small horizontal circular motion.

When a chronometer stops, it generally alters its rate.

528. It seems generally admitted that the principal cause of the variation of the rates of chronometers is change of temperature,† and accordingly, in some ships, the temperature of the chronometer-room has been regulated by lamps.

When the ship changes her climate, the rates do not change at the same time with the temperature, but some time afterwards.‡

529. It has been found that magnetism affects the rates of chronometers (see a paper by Mr. Fisher, Nautical Magazine, 1837). Hence it follows, that the magnetism of an iron vessel may produce similar effects. Their rates will certainly be affected by the proximity of apparatus generating or conveying electric currents.

530. Chronometers are generally found to perform best at the

* This depends, however, chiefly on the position of the arm of the balance.

† Captain R. Owen, while employed in surveying in the West Indies, found a fall of 14° in Fahrenheit's thermometer (from 82° to 68°) accelerated the rates 1s·5 a-day, and a fall of 20° (from 82° to 62°) accelerated them two seconds a-day.

‡ Admiral Fitzroy, who employed in his surveys of South America the unusual number of twenty-two chronometers, observes, that the ordinary motions to which chronometers are subjected, both from the incessant action of the sea and in transferring them from one vessel to another, scarcely affect the rates of good watches; and that, in general, temperature is the only cause of the alteration of rate. (Journal of the Royal Geographical Society, vol. vi.)

Sir E. Belcher, however, when engaged in the survey of the west coasts of North America, found the chronometers of H.M.S. Sulphur very materially deranged by the jerking produced by a looseness about the rudder-head and from towing the Starling, her tender; and observes, that when these causes were removed the watches performed admirably.

In the Instruction Réglementaire pour les Bâtiments de la Marine Royale, &c. (Annales Maritimes, 1840), it is recommended that the chronometers should be held in the hand during the firing of guns, and that in transporting a watch from one place to another it should be carried in both hands, in order to avoid giving it suddenly a circular motion, which may be communicated by taking it up by a handle, or becket, at the top of the case.

M. Givry considers that the rates of the chronometers of La Coquille frigate, commanded by M. Duperrey on a scientific expedition, were altered by the severe thunder-storms experienced on the coast of Timor, in August 1823.—Mémoire sur l'Emploi des Chronomètres à la Mer, par A. P. Givry, extracted from the Annales Maritimes, Paris, 1840.

It has been surmised that the hot and moist climate of the coast of Africa has speedily disturbed the rates of chronometers; but Adm. Vidal and Sir E Belcher, in several years' experience, have recognised no such effect.

beginning of a voyage;* many subsequently become useless from irregularity, and some fail altogether. They are liable, also, to change their rates suddenly, and then to reassume the former rates in a few days.†

531. Since there seems no reason why any cause which alters the rate of one chronometer should not alter the rate of another in the same manner, the agreement of any number of chronometers, however great, cannot be unreservedly admitted as evidence for the truth of the time which they shew. Their irregularities, however, in this respect contribute to the security of navigation; for since one chronometer often gains while another, under exactly the same circumstances, loses, the discrepancies prevent the danger of trusting too confidently to any single result.

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# CHAPTER III.

## TAKING OBSERVATIONS.

I. OBSERVING ALTITUDES. II. OBSERVATIONS WITH AND WITHOUT ASSISTANTS. III. EMPLOYMENT OF THE HACK WATCH. IV. FINDING THE STARS.

532. IN treating of observations with reflecting instruments we shall refer chiefly to altitudes, as most convenient for the purposes of illustration. If, however, for the *horizon*, we substitute a celestial body or any other point, what is said of altitudes will apply, with certain obvious exceptions, to angular distance generally. The details proper to the particular observations will be found under their respective heads.

### I. OBSERVING ALTITUDES.

533. The observer will do well to accustom himself to obtain a single sight with accuracy, and not to depend upon the accidental compensation of errors due to want of care. It sometimes happens that a single sight only can be obtained, and no good estimate of its

* Advantage was taken of this circumstance in the late survey of part of the west coast of Africa by Admiral Vidal, who, by direction of the Hydrographer, proceeded at once to run down the coast from Sierra Leone to Corisco Bay, and returned to Sierra Leone as quickly as possible. The whole Diff. Long. between these points, as measured in both runs, agreed within 1s.

† Captain R. Owen remarks, that most of his chronometers took thus a jump of one or two seconds in the daily rate, more than once during his surveys in the West Indies. Other officers have made similar remarks.

value can obviously be formed if the observer knows his observations by their general result only.

## 1. *At Sea.*

### [1.] *Above the Sea Horizon.*

534. The instrument must be vibrated or swung, so that the image may skim the horizon, for the altitude must be measured to the point vertically under the body,* No. 487.

535. When the altitude is above 60°, it may be observed both from the opposite point of the horizon and from that under it, by the common sextant. Half the difference of the two readings is the apparent zen. dist., No. 432. By this means the dip, with the uncertainty to which it is liable, and the index error, are removed. As the apparent dip is always uncertain, and as the rules given in No. 208, though generally true, do not always hold good for small differences of temperature, it will be advisable, whenever precision is required, to attend to this consideration.

536. It is, in general, taken for granted that the dip is in the same state all round the horizon.

This supposition M. Arago, in discussing the observations made by Sir E. Parry in his first polar voyage, by Capt. B. Hall in the China Sea. and by M. Gauttier in the Mediterranean and Black Seas, thinks there is no reason to doubt. ("Conn. des Tems," 1827.)

Capt. Fitzroy found however a difference of 16′ on one occasion; and Capt. Bayfield informs me that he has often observed the dip not to be the same all round the horizon, more particularly on the coast of Labrador and in the Straits of Belleisle, where currents of unequal temperature prevail. See also note *, p. 196.

When circumstances allow, alts. should accordingly be observed at opposite points of the horizon. The mean of two alts. in such cases may not, indeed, be exactly true, but it is probably nearer the truth than one of them alone might be. For the same reason it is advisable to select stars on opposite bearings.

When both the alt. and its supplement are thus measured, and the alt. is in a state of change (as will always be the case except when the object is on the meridian), the time must be noted at each of the two contacts; and the half difference of the alt. and its suppl is the apparent zenith distance of the centre corresponding to the mean of the times.

When the altitude is below 60° a sextant of additional powers, or a circle, is in general necessary for this observation. (See No. 504.)

537. When the altitude of a body is near 90°, it is proper, before attempting to bring down the reflected image, to ascertain, by re-

* When the 4th Adjustment. No. 495 (3), is not perfect, we look at a point of the horizon not directly under the sun. Hence a tube should be used to insure the eye and the contact of the images being at equal distances from the plane of the instrument. On the same ground, Dr. Maskelyne recommends the observer, when without a tube, to turn on his heel while causing the image to skim the horizon. (Nautical Almanac, 1774.)

ference to the zenith, or the compass, the precise point over which the body is vertical.

538. When fog obscures the sea-horizon from the deck, a new horizon may often be obtained by descending the ship's side, or from a boat. See No. 550, note.

539. When the limbs of the sun or moon are indistinct, altitudes of the centre are obtained by bisecting the hazy or cloudy disc upon the horizon.*

540. In observing the moon's altitude there is a choice of the upper or lower limb when she is at the full, and also when the line of cusps, or horns, is vertical. At other times her illuminated limb, whether it be the upper or lower one, must be brought down to the horizon.

Mistakes may arise in observing the moon's altitude at sea by night. When the sky under the moon is unclouded, the upper edge of the illuminated part of the sea is the horizon; but at other times long dark shadows are projected on the water, which render it difficult, and sometimes impossible, to discern the horizon.

When the moon's alt. and its supplement are both measured, if she is full, or if the line of cusps is vertical, her alt. may be observed as directed in No. 535. But in other cases the same limb must be referred to the point of the horizon under her and to that opposite; half the difference is then the app. zen. dist. of the limb observed, and the semidiameter must be applied accordingly.

When the horizon under the moon is unfavourable for observation, and the supplement of the alt. alone is employed, correct the angle observed for index-error and dip, take the suppl. of the result to 180°, and apply the semidiameter as to the alt. taken directly.

541. The obscurity of the sea-horizon in a dark night renders it difficult to observe the altitudes of stars or planets; but in the twilight, when the sky is clear, the boundary of the sea exhibits a strong dark edge, most favourable for observation.

The difficulty of reading off at night is easily overcome by having a well-trimmed dark lanthorn, and a handy assistant.†

When the alt. of a star or a planet is measured both from the horizon under it and opposite to it, half the diff. of the two angles is the app. zen. dist. If the supplementary arc alone is employed, correct it for index-error and dip; the supplement of the result is the apparent altitude.

542. When a telescope is used the unemployed eye must be closed, but when the plain tube is used it should, when convenient, be kept open, because the image being seen by both eyes under the same magnitude, one assists the other.

This should be practised in observing stars at night.

La Caille recommends keeping the eye some minutes in complete

* Mr. Fisher tells me that he has repeatedly employed, with complete success, altitudes of the sun faintly seen through watery clouds, when those who had been used to depend solely upon the perfectly defined disc had despaired of an observation altogether. In such cases the altitudes have not greatly differed from each other, and the mean of several has been quite equal to an ordinary observation of the limb.

† A small electric light (half candle power) is found useful.

darkness before observing stars at night. (Guépratte, "Problêmes d'Astron. Naut." &c., tom. i. p. 20, 1839.)

543. Different powers suit different eyes. Too low a power does not magnify enough; too high a one makes it difficult to keep the object in the field on the least motion of the instrument. The observer, therefore, will employ those powers only in which the advantage gained by a larger image exceeds the disadvantage of increased unsteadiness.

A plain tube, however, should be used in all other cases, both for directing the sight to the proper point of observation, and for defence against disturbing lights.

544. All observed angles are vitiated by the errors of the instrument enumerated in the last Chapter, Nos. 495, 498, and 499. Again, each observer has in general some peculiarity in the manner of observing, or in the quality of the eye itself, which gives rise to a *personal* error, the correction for which is called the *personal equation*. No. 175.

545. Besides these errors, altitudes taken at sea are subject also to others which change with circumstances.

1st. The running of the waves causes the horizon to be in continual motion; 2d. The rise and fall of the observer, both from the lifting of the vessel by the waves, and by her rolling, cause the dip to be in continual change.

The effects of these alternating motions will, in taking two or three altitudes, in part disappear.

3d. The place of the visible horizon changes with the temperature of the sea and the air. See No. 208.* Also, since the sea-horizon is formed by the eminences of the waves, it should be higher in bad weather.†

Besides these distinct causes of error, the motion of the ship disturbs the attention and efforts of the observer.

546. The height of the eye should be ascertained with some precision, that is, within two or three feet, because an error in the dip causes an error of the same amount in the altitude. This is of most importance when the observer is very near the water, as the dip then changes most rapidly; thus, it appears in Table 30, that a change of three feet in the height produces, near the beginning of the table, a change of more than 1′ in the dip, but near the end only

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* M. Givry observes ("Mémoire sur l'Emploi des Chronomètres," p. 23), that when the sea is shoal near the horizon, the relation of the temperatures of the sea and the air being different from that at places where the water is deeper, may produce extraordinary refraction: and he attributes to this cause errors amounting to 8ˢ in the time deduced from some altitudes taken near the mouth of the Jeba, in 1818, although circumstances appeared at the time in every respect favourable for observation.

M. Givry remarks, further, that extraordinary refraction sometimes takes place in the neighbourhood of sandy plains, the heated air of which, passing over the sea, produces partial inequalities of temperature; and he adds, that small undulations in the horizon are always indicative of irregular refraction.

† It is stated, "Voyage autour du Monde," 1840, by M. Du Petit Thouars, in the Vénus French frigate, that the observations shewed this. It is probable, however, that the errors of observation due to the motion would, in general, far exceed that due to the above cause.

4″. An altitude observed at the top of a heavy sea will differ considerably from another taken at or below the mean level.*

If the altitude be observed above the deck, as in the top for instance, the horizon will appear better defined, and the variations of the dip by the ship's motion will be less sensible; also the difference of temperature of the sea and the air appears to affect the place of the visible horizon less as the observer is more elevated. Hence it would appear that altitudes should be taken from aloft when convenient.

547. Some observations on the heights, distances, and velocities of waves have been put on record of late years. Sir G. Grey,† in his voyage home from Australia in 1837-8, obtained numerous measures of the distance and velocity of waves, amongst which are the following:—

| Dist. | Vel. | Dist. | Vel. |
|---|---|---|---|
| 121 ft. | 14½ Naut. miles. | 211 ft. | 19·5 miles. |
| 178 | 18·7 | 234 | 20·5 |
| 201 | 22·5 | 326 | 22 |
| 205 | 20·6 | 338 | 28 |

Lieut. Wilkes ("U.S. Exploring Expedition") found the highest waves in a heavy sea off Madeira from 14 to 25 feet high, and their velocity 23 miles an hour; and at another time and place, with a remarkably high and regular sea, 32 feet, with a velocity of 26 miles.

The highest waves observed by Sir Jas. C. Ross, in the North Atlantic, were 36 feet high. The highest sea seen by M. Lazarev, in the Russian Expedition of Admiral Bellingshausen, 1819, was in 56° S. and 103° E., but he does not state the height.

In the Naut. Mag. 1848, p. 228, are the following observations taken near the Cape of Good Hope:—

| Height | Dist. | Vel. |
|---|---|---|
| 17 f. | 35 fath. | 22 miles. |
| 20 | 43 to 50 | 24 |
| 22 | 55 to 57 | 26 to 27 |

548. When the spectator nears or recedes from the celestial body, by the progress of the ship, the effect produced on the altitude is the same as that of a motion in the body itself, since exactly the same appearances result from the motion of either while the other remains fixed. Accordingly, in all observations, in which, from the sensible change of altitude, the time requires to be noted at each sight, the progress of the ship is included in the observed change of altitude; and the *place* to which the observation corresponds is that at which the ship was at the mean of the times.

* The height of waves is ascertained by placing one's self at such a height on the vessel, or her rigging, that the tops of the highest waves which pass near the ship may be seen on with the distant well-defined horizon, at the instant when the ship is at the bottom of the hollow between two heavy seas. The height of a wave thus observed, that is, the difference of level between the summit and the bottom of the hollow (which difference is *twice* the height of the summit above the *mean level*), is very nearly the height of the eye above the bottom of the same hollow, the ship at the instant of observation being upright. The distance is measured, when before the wind, by a line with marks on it.

† Governor of New Zealand. I am indebted to the author for these observations, of which I find a few only reduced for the course and rate of sailing of the ship.

[2.] *Altitudes above the Shore Horizon.*

549. It often happens that the horizon is concealed by the intervention of land, while the level surface of the water marks on the shore a distinct horizontal line, which is a substitute for the sea-horizon, and is called a *shore-horizon.*

When the distance of the shore-horizon is known, enter Table 35 with this distance and the height of the eye, and use the correction therein instead of the dip in Table 30.

| | | |
|---|---|---|
| Ex. From the height 20 feet, observed a merid. alt. 28° 18′, above a shore-horizon, 2 miles and a quarter distant. | Alt. | 28 18′ |
| | Corr. | − 7 |
| | Alt. corrected for dip | 28 11 |

550. When the distance of the shore-horizon, or water-line, is not correctly known, it may be found by means of two altitudes, the one being observed from the deck, and the other as high as possible, at the same time.

Divide the difference of the heights in feet by the number of minutes in the diff. of alts.; the quotient is the number of feet subtending an angle of 1′ at that distance. Look in Table 9 for this number of feet, and the corresponding distance is the distance required.

Ex. An observer, at the height of 91 feet above the sea, observed the sun's alt. 41° 37′ above the water-line of the sea; another observer, at the height of 22 feet, observed it 41° 25′: find the distance of the water-line, and correct the alt. for dip.

The diff. of the heights, 69 feet, divided by 12 (the minutes in the diff. of alts.), gives 5·7 feet, which answers, in Table 9, to 3 miles, the DIST. required. Then the cor. in Table 35 to 3 miles, and height 22 feet, is 5′, which subtracted from the alt. taken at 22 feet, gives 41° 20′, the ALT. CORRECTED FOR DIP.

But as this result, like the preceding, becomes uncertain when the distance is very small, it is always advisable in such cases to endeavour to find, by descending, a natural horizon.*

## 2. *Observing Altitudes on Shore.*

551. Altitudes are well observed above the sea-horizon from a hill or cliff of known height. Nos. 544, &c. apply, with certain obvious exceptions, to altitudes of this kind taken on shore.

552. In taking the altitude of the *lower* limb in the quicksilver, the *lower* limb of the object is made to touch the *upper* limb of the image in the quicksilver, as reflection inverts the object. In taking the altitude of the *upper* limb, the image of the body is in like manner brought below the quicksilver image altogether. Hence, when the sun is *rising*, and the *lower* limb is observed, the images are continually *separating;* but when the upper limb is observed, they are continually *overlapping;* and the contrary when the sun is falling.

It is useful to attend to this, as it is sometimes doubtful, especially with the inverting telescope, which limb was observed.

* This is the practice recommended, on his own experience by Dr. Scoresby, "Voyage to the Northern Whale Fishery, 1822, London," p. 441.

553. It is advisable, when circumstances permit, to move the index a little too much, whether forwards or backwards, and clamping it, to wait the instant of contact while the instrument is in a state of repose, in preference to making the contact by moving the tangent screw up to the instant of observation, because the material always springs more or less. Again, moving the tangent screw diverts a portion of the attention which should be devoted to the contact alone. At sea this is rarely practicable in any observation on account of the motion of the ship.

554. The roof of the quicksilver should be reversed at each set of three or five altitudes, in order to remove the effects of errors in the glasses; one face is accordingly marked A and the other B, and these letters marked against the altitudes.

The roof should obviously be used only when it cannot be dispensed with.

555. A stand for the sextant or circle, on shore, is a great convenience, and allows a higher power to be used; practice is, however, necessary, in order to derive the full advantage from it.

556. The accuracy with which a set of altitudes has been observed may, in part, be inferred from their agreement with each other. For since the change of altitude in small intervals of time is nearly proportional to the intervals (unless the object is near the meridian), any considerable irregularity must be a consequence of an error of observation.

The comparison of the differences of altitude, with their respective intervals, may easily be made by means of the Traverse Table, as in the following example:—

**Ex.** Observed altitudes of Arcturus in the artificial horizon.

| | Time | Diff. | | Alt. | Diff. |
|---|---|---|---|---|---|
| Time | $10^h\ 5^m\ 43^s$ | | Alt. | $78°\ 59'\ 20''$ | |
| | 10 8 17 | $2^m\ 34^s$ | | 78 14 30 | $45'$ |
| | 10 11 29 | 3 12 | | 77 17 30 | 57 |
| | 10 14 20 | 2 51 | | 76 33 40 | 44 |

In Table 2, $2^m\ 34^s$, or $154^s$, as D. Lat., corresponds to 44 as Dep. at 16°. On the same page $3^m\ 12^s$, or $192^s$, as D. Lat., corresponds to 55 as Dep., which is near enough. $2^m\ 51^s$, or $171^s$, as D. Lat., corresponds to Dep. 49, the Diff. 44′ is therefore in error, and the 3d alt. about 5′ too great.

557. Several altitudes are taken in immediate succession, on the supposition that they are liable to errors of opposite kinds; for, in this case, if one altitude be observed a little too great, and another a little too small, the mean of the two will be nearer the truth than either of them separately; and thus, by increasing their number, the effects of irregularities of observation will be much diminished in the general result.

558. But if the portion of time during which the altitudes are taken be too long, an error of a new kind will arise from the unequal variation of the altitude itself, which never, strictly speaking, varies at the *same rate* at the beginning, middle, and end of an interval.

If a series of alts., at observed equal intervals of time, be cleared of errors, and the differences between them be taken in succes-

sion, these differences will generally afford, in like manner, differences among themselves, which are called *second differences;* and if the observations be prolonged, third differences will appear, and so on. When the 2d diff. is insensible, ½ the sum of 2 alts., or ⅓ the sum of 3 alts., or ⅕ the sum of 5 alts., corresponds exactly to the middle of the time occupied in the observation; but when the 2d diff. is considerable, the arithmetical mean is in error by a quantity which is as follows:—

The half sum of two alts. at the beginning and end of the interval differ from the alt. proper to the middle instant of the interval by $\frac{1}{8}$ of the 2d diff. proper to the whole interval. The third of the sum of the three alts. at the beginning, middle, and end of the interval, differs from the same alt. by $\frac{1}{12}$ of the whole 2d diff.; and the fifth of the sum of 5 alts. at four equal intervals, by $\frac{1}{16}$ of the 2d diff.

Ex. Lat. 51° 30′ N. Decl. 22° 20′ N.

| | Hour-Angles. | Alts. | Diff. | 2d Diff. |
|---|---|---|---|---|
| 1st. | $0^h\ 16^m\ 0^s$ | 60° 40′ 8″ | 5 33″ | |
| 2d. | 0 20 0 | 60 34 35 | 6 43 | 1′ 10″ |
| 3d. | 0 24 0 | 60 27 52 | 7 54 | 1 11 |
| 4th. | 0 28 0 | 60 19 58 | 9 6 | 1 12 |
| 5th. | 0 32 0 | 60 10 52 | | |

The mean 2d Diff. is 1′ 11″ for $4^m$; hence, as the 2d Diff. varies as the square of the interval (that is, is 4 times greater when the interval is doubled, 9 times greater when it is trebled, and so on), the whole 2d Diff. for $16^m$ is 4 times 4, or 16 times 1′ 11″, which is 18′ 56″. Then the mean of the 1st and 5th Alts. is 60° 25′ 30″, which differs from the 3d Alt. by 2′ 22″, or 1-8th of 18′ 56″.

The mean of the 1st, 3d, and 5th Alts. is 60° 26′ 18″, which differs from the 3d by 1′ 35″, or 1-12th of 18′ 56″.

The mean of the 5 Alts. is 60° 26′ 41″, which differs from the 3d by 1′ 11″, or 1-16th of 18′ 56″.

The error cannot be materially diminished by further increasing the number of alts.

The correction for this error cannot be given in a concise and convenient form.* But in practice the intervals are not exactly equal; and even if they should be, the errors of observation will often conceal the 2d diff. When, therefore, from circumstances, altitudes can be obtained only at considerable intervals, it is proper to deduce a separate result from each.

The 2d diff. of alt. disappears in two cases: 1st, when the object is E. or W.; 2d, when its motion is vertical.

559. The effect of the elevation of the spectator upon the altitude observed in the quicksilver, is insensible in practice, since, even in the case of the moon, an elevation of a mile does not produce a change of 1″ in her horizontal parallax.

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* The change of altitude in a very small portion of time depends on the latitude, and on the azimuth of the object (see No. 669); but the 2d Diff., or *variation* of the change of alt., which becomes conspicuous in a longer interval, depends, further, upon the altitude itself. To exhibit this correction, therefore, a table of *treble entry* would be required.

## II. Observations with and without Assistants.

560. When the arc observed is in a state of continual change, the quantity measured corresponds to a particular instant of time. When, therefore, the complete observation consists of various elements whose measures are required at the same instant, either the observer must have assistance, or he must himself obtain the several measures in succession, and these must be reduced afterwards to the same instant by calculation.

When two or more altitudes at sea are required at the same instant, assistants have been employed to observe them. The impropriety of this custom will, however, appear on considering the nature of the errors of altitude (No. 545); for it is obviously impossible for an observer to keep the motion of the index so exactly adjusted to the irregular and often violent motion of the ship, as to be able to seize the altitude at command.

561. The assistant is useful chiefly in noting the time. An observation of a set of altitudes, with their times, for example, is conducted as follows:—

(1.) The observer sets the index to the estimated alt. (No. 492); about ½ of a minute before he expects to complete the contact, he cries, "Look out!" at the instant of contact, he cries, "Stop!" on which the assistant writes down the second, the minute, and the hour. The observer then reads off the degree, minute, and division of the seconds, as 10″, 20″, 30″, &c., which the assistant writes down. Three, five, or more altitudes make, generally, a set of *sights*.

When the assistants have watches shewing seconds, each takes his altitudes at leisure, and the whole is reduced to the same instant by calculation.

(2.) The times are then added together, and the sum divided by the number of alts. The alts. are then in like manner added together, and the sum divided by their number is, when the second difference is not considerable (No. 558), the alt. corresponding to the mean of the times. When the number of alts. is odd, and the intervals are nearly equal, the means will not differ much from the middle time and its corresponding altitude.

562. When two sets of observations are taken by different persons, nearly at the same time, they are reduced to the same instant thus:—

The difference or change of altitude (or other angular measure) in the time occupied by the observation is given; then the interval between the given mean of the times, and that to which it is proposed to reduce the observation, being found, the quantity to be applied to the altitude is determined by proportion. For accuracy, the change of alt. must be properly computed by No. 669 or 671.

563. The observer should, however, take the whole observation himself, and he will then learn to estimate his results at their real

value, of which he can be no judge when they are taken by other persons.

When the observer takes his own time, he holds his watch in his hand, or places it either where he can obtain sight of it readily, or where he can hear it tick plainly. In the latter case, the first beat after the instant of contact he counts 1, the next 2, &c.; then, looking at the watch, he counts on till the second hand arrives at a marked number of seconds, as 10, 15, &c.; he then writes down these seconds, and after them the number of beats counted, to be *subtracted.*

If the observer can count 10 or 20 seconds without an error of more than $1^s$ or $2^s$, he may put the watch wherever it is most convenient to inspect the face, and thus avoid the principal difficulty in taking the entire observation himself, especially at night.

He then reads off the alt., and sets it down.

The sum of the beats is to be deducted before the mean of the times is taken.

Most watches beat 5 times in $2^s$, or each beat counts $0^s{\cdot}4$.

Ex. After the instant of contact, 14 beats are counted; the second-hand is then at $30^s$, the min. 42, and the hour 10, and so on, as follows:—

| | | | | | |
|---|---|---|---|---|---|
| | $10^h$ | $42^m$ | $30^s$ | subtract | 14 beats. |
| | 10 | 44 | 10 | | 32 |
| | 10 | 46 | 0 | | 11 |
| | | 132 | 40 | | 57 |
| | | | −22·8 | (corres. to | 57 beats.) |
| 3) | | 132 | 17·2 | | |
| Mean | 10 | 44 | 5·7 | | |

## III. Employment of the Hack Watch.

564. This is a portable chronometer, or good watch, used for observation, to save moving the standard chronometer. Since the watch and chronometer will not in general go exactly together, they must be compared both before and after observation, in order to find what time the chronometer shewed when the observation was taken. Thus,

Within 5 or 10 seconds of a whole minute by the watch the observer tells the assistant to "look out" on the chronometer. At the minute he cries "Stop!" when the assistant writes the times, and takes their differences. This should be repeated two or three times, and the mean result employed. The observer can compare alone, by counting the beats of the chronometer till the expiration of the minute.

If the difference between the watch and the chronometer be the same before and after observation, the time of observation by the chronometer is at once deduced from that by the watch; if not, a correction must be applied, as in the following example:—

| | Before Obs. | | After Obs. | | Intervals. |
|---|---|---|---|---|---|
| Watch | $3^h\ 1^m\ 0^s$ | ......... | $4^h\ 3^m\ 0^s$ | ......... | $0^h\ 52^m\ 0^s$ |
| Chron. | 10 31 18·4 | ......... | 11 23 21·7 | ......... | 0 52 3·3 |
| Diff. | 7 20 18·4 | | 7 20 21·7 | | 3·3 |

Time of observation by watch, $3^h\ 32^m\ 37^s$: required the time of do. by chron.

The watch here has *lost* $3^s{\cdot}3$ on the chron. in $52^m$. The observation taking place $21^m\ 37^s$ by watch, after the first comparison, we have $52^m : 3^s{\cdot}3 :: 21^m\ 37^s : 1^s{\cdot}4$, the *loss* of the watch on the chron. at the time of observ.; this, *added* to $21^m\ 37^s$, gives $21^m\ 38^s{\cdot}4$, which, added to $10^h\ 31^m\ 18^s{\cdot}4$, gives $10^h\ 52^m\ 56^s{\cdot}8$, the TIME BY CHRON. required.

565. When the times by watch are separated by considerable intervals, and the rate of the watch is large, each time may require to be thus corrected for its proper gain or loss.

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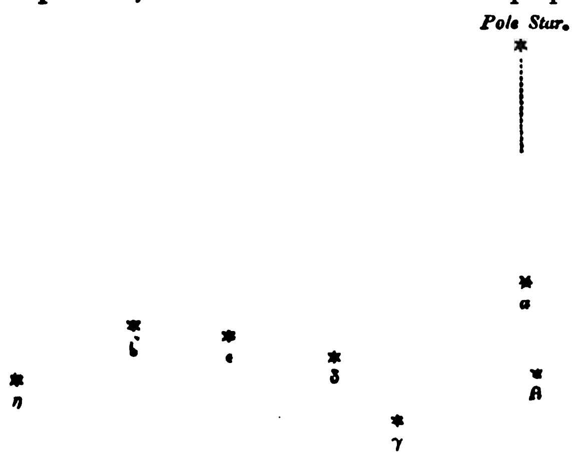
## IV. FINDING THE STARS.

566. The most conspicuous stars have been designated, from remote antiquity, by names; besides which, the stars in each constellation or group are distinguished, for reference, by letters and numbers. The letters chiefly used for this purpose are the small letters of the Greek alphabet, which, with their names, are written as follows:—

| | | | | |
|---|---|---|---|---|
| α alpha | ζ zeta | λ lambda | π pi | φ phi |
| β beta | η eta | μ mu | ρ ro | χ ki |
| γ gamma | θ theta | ν nu | σ sigma | ψ psi |
| δ delta | ι iota | ξ ksi | τ tau | ω omega |
| ε epsilon | κ kappa | ο omicron | υ upsilon | |

567. In finding any star in the heavens, it is necessary to refer to some one star or constellation as known: the Great Bear, called also by the Latin name *Ursa Major*, a constellation of the figure shewn below, in the northern part of the heavens, and consisting of seven principal stars, is the most convenient for the purpose.



The two stars $\alpha$ and $\beta$ point nearly to the POLE STAR (or *Polaris*), and are hence called the Pointers. This star will not easily be mistaken, as it appears always in the same place.

A line from Polaris through $\eta$ (the last of the tail) passes, at 31° beyond $\eta$, through ARCTURUS, one of the brightest stars.

A line drawn from *Polaris* perpendicular to the line of the Pointers, and on the opposite side to the Great Bear, passes, at 48° distance, through CAPELLA, one of the brightest stars.

In this same line, about the same distance on the opposite side of the pole, is $\alpha$ *Lyræ*, or the bright star in the Harp, called also *Vega*, and also by seamen Lyra, a large white star.

At one-third of the distance from Arcturus to $\alpha$ *Lyræ* is ALPHACCA, the brightest of a semicircular group called the Northern Crown (*Corona Borealis*).

A line drawn from $\delta$ (the faintest of the Great Bear) through *Polaris*, passes through the constellation of *Cassiopeia*.

About 23° to the eastward of $\alpha$ *Lyræ*, and about the same distance as this star from *Polaris*, is the bright star in the Swan (or $\alpha$ *Cygni*). DENEB.

A line from Polaris passing between this last and $\alpha$ *Lyræ*, produced to an equal distance beyond them, passes through ALTAIR ($\alpha$ *Aquilæ*), a bright star between two small ones, the three lying in the direction of $\alpha$ *Lyræ*.

The line of the Pointers, carried through the pole to about 62° beyond it, passes through $\beta$ *Pegasi*, called also SCHEAT, and about 13° further, through MARKAB ($\alpha$ *Pegasi*).

A line from *Polaris*, drawn between Capella and a star near it to the eastward, passes to the westward of the constellation Orion The two northern stars of the four at the corners are the shoulders, the northernmost of which is BETELGUESE, or $\alpha$ *Orionis*. The brightest of the two southern stars, the feet, is called RIGEL. In the middle are three small stars forming the belt, the northernmost of which is nearly on the equator.

About 25° to the northwestward of the belt, and not far out of the direction in which it points, are the *Hyades* and *Pleiades* in *Taurus*; in the former cluster lies the red star ALDEBARAN.

A line from Aldebaran through the belt passes, at about 20° on the other side, through SIRIUS, the brightest of the stars.

*Sirius*, the eastern shoulder, and PROCYON (to the northward of Sirius and eastward of Orion), form an equilateral triangle.

Nearly midway between Orion and the Great Bear are the Twins, CASTOR and POLLUX (the southern and brightest), about 4° apart. The line from *Polaris* to *Procyon* passes between them.

A line from *Rigel* through *Procyon* passes, at an equal distance beyond, to the northward of REGULUS. $\delta$ and $\gamma$ *Urs. Maj.* serve as pointers for *Regulus*.

A line drawn from *Procyon* through *Regulus*, at nearly an equal distance beyond it, passes through $\beta$ *Leonis*, or DENEBOLA.

A line from $\delta$ *Urs. Maj.* through *Regulus,* passes, at 30° beyond, through Cor Hydræ.

A line from *Polaris* through $\zeta$ *Urs. Maj.* passes, at 70° distance, through Spica Virginis.

A line from the last star in the tail of the Great Bear through Arcturus will lead to $\alpha$ and $\beta$ *Libræ.*

*Arcturus, Spica,* and *Denebola* form an equilateral triangle.

A line from *Regulus* through *Spica* passes, at 45° distance, through Antares, a very bright and reddish star.

A line from $\alpha$ *Orionis* (*Betelguese*) through *Aldebaran* passes, at 30° distance, through $\alpha$ Arietis, not a very distinct star.

The Southern Cross is about as far from the South Pole as the Great Bear is from the North Pole; $\alpha$ is the foot, and $\gamma$ the head.

To the left of the Cross when on the meridian and pointing towards it are $\alpha$ and $\beta$ *Centauri,* both of the first magnitude.

A line from *Scheat* through *Markab* passes, at 45° from Markab, through Fomalhaut, a very bright star.

*Scheat* and $\alpha$ Andromedæ, called also *Alpheratz,* form the north side of a square; *Markab* and Algenib on the south side.

Achernar, *Fomalhaut,* and Canopus, are in a line, and nearly equidistant, being about 40° apart.

568. When a few stars are known, the rest are easily found by the times of their Meridian Passages, Table 27, and their Declinations, Table 63, as described in No. 482 (8).

A star may also occasionally be identified by means of its altitude, or azimuth, computed roughly.

# CHAPTER IV.

## Subordinate Computations.

I. The Greenwich Date. II. Reduction of the Elements in the Nautical Almanac. III. Conversion of Times. IV. Hour-Angles. V. Times of certain Phenomena. VI. Altitudes. VII. Azimuths.

569. Such parts of computations as are common to more operations than one are collected, both to avoid repetition and for facility of reference, in this chapter, which contains also some smaller computations not relating directly to the principal divisions of the subject.*

* Certain computations in this chapter, though not of immediate application in the present volume, may be found useful for the purposes of verification.

## I. The Greenwich Date.*

### 1. *Conversion of Arc and Time.*

570. To turn Degrees and Minutes into Time.

*By Inspection.*—(1.) To the whole second. Enter Table 68 or 69 with the given arc, and take out the hour, minute, and second.

Table 68 shews the time to the nearest two seconds.

(2.) To parts of seconds. Take out of Table 17 the hours, minutes, seconds, and parts corresponding to the given degree, min., and sec.

Ex. 1. Turn 36° 11′ into Time.

In Table 68, or 69, 36° 11′ is seen to be $2^h\ 24^m\ 44^s$ in Time.

Ex. 2. Turn 101° 41′ 45″ into Time.

Ans. by Table 69, $6^h\ 46^m\ 47^s$ in Time.

Ex. 3. Turn 134° 52′ 9″·7 into Time.

| | | | | |
|---|---|---|---|---|
| In Table 17, | 130°, | $8^h$ | $40^m$ | $0^s$ |
| | 4 | | 16 | |
| | 52′ | | 3 | 28 |
| | 9″ | | | 0 6 |
| | 0·7 | | | ·05 |
| Time required | | 8 | 59 | 28·65 |

571. *By Computation.*—Multiply the arc by 4; this turns the degrees into minutes of time, the minutes (′) into seconds of time, and the seconds (″) into thirds of time.†

Ex. 36° 11′ multiplied by 4, is $144^m\ 44^s$, or $2^h\ 24^m\ 44^s$ in Time.

572. To turn Time into Degrees, Minutes, and Seconds of Arc.

*By Inspection.*—(1.) To the nearest second or two seconds. Employ Table 68 or 69.

(2.) To parts of seconds. Take out of Table 18 the deg., min., and sec. corresponding to the hours, mins., and secs. of time.

573. *By Computation.*—Turn the hours into minutes, and divide by 4; the quotient is the deg., min., and sec.

Ex. 1. $2^h\ 24^m\ 44^s$ are $144^m\ 44^s$, which, divided by 4, gives 36° 11′ in Arc.

Ex. 2. $5^h\ 20^m$ are $320^m$, which divided by 4 gives 80° in Arc.

### 2. *Deduction of the Greenwich Date.*

574. The Civil Date begins at midnight, No. 480; the Astronomical Date begins at noon: thus the civil date Oct. 1st, 3 P.M., is the astronomical date Oct. 1st, $3^h$; but 11 A.M. on this day, civil date, is the astronomical date Sept. 30th, $23^h$.

In most cases it is necessary to refer to the astronomical time at Greenwich, or the *Greenwich Date*, No. 481, because it is for the time at this meridian that the elements of astronomical calculations, which are in perpetual change, are given in the Nautical Almanac.

The Greenwich Date is always *mean time*, unless the contrary be expressed. At sea, however, it is often convenient to deduce the Greenwich Date in App. Time.

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* The term *Greenwich Date*, used always by Dr. Inman, is preferable to *Greenwich Time*, because it is essential to note the day as well as the hour.

† The reason of these rules will appear on considering that dividing 360° into $24^h$ gives 15° for 1 hour, 15′ for $1^m$, and 15″ for $1^s$; and further, that to multiply by 60, and at the same time to divide by 15, is the same as to multiply by 4; and to multiply by 15 and to divide by 60 is to divide by 4.

575. To find the Greenwich Date by the Chronometer:—

Since the chronometer is regulated to Greenwich mean time, apply the gain or loss up to the time proposed. No example is necessary, as this is no more than the common process of allowing for the error of a watch.

576. To find the Greenwich Date without the Chronometer:—

(1.) In W. Long. Find the Astron. Date, No. 574; *add* to it the Long. converted into time, No. 570. If the sum amounts to or exceeds $24^h$, deduct $24^h$ and reckon the time on the *next day*.

Ex. 1. June 3d, at $3^h\ 30^m$ P.M., long. 31° W.: find the Greenwich Date.

| | |
|---|---|
| Astron. Date, June 3d, | $3^h\ 30^m$ |
| 31°, | +2 4 |
| GREENWICH, JUNE 3d, | 5 34 |

Ex. 2. June 4th, $5^h\ 18^m$ A.M., long. 130° W.: find the Greenwich Date.

| | |
|---|---|
| Astron. Date, June 3d, | $17^h\ 18^m$ |
| 130°, | +8 40 |
| | 25 58 |
| GREENWICH, JUNE 4th, | 1 58 |

(2.) In E. Long. Find the Astronomical Date, No. 574; *subtract* from it the Long. in time: the remainder is the Greenwich Date. If the Long. be greater than the Astron. Date, add $24^h$ to this last, and reckon the time on the *preceding day*.

Ex. 3. April 15th, $4^h\ 17^m$ P.M., long. 28° E.

| | |
|---|---|
| Astron. Date, 15th, | $4^h\ 17^m$ |
| 28°, | −1 52 |
| GREENWICH, APRIL 15th, | 2 25 |

Ex. 4. Dec. 31st, $6^h\ 57^m$ A.M., long. 40° E.

| | |
|---|---|
| Astron. Date, 30th, | $18^h\ 57^m$ |
| 40°, | −2 40 |
| GREENWICH, DEC. 30th, | 16 17 |

(3.) When it is noon at the place. In W. Long. the Greenwich Date is the Long. in time. In E. Long. take the Long. in time from $24^h$: the remainder is the Greenwich Date on the *preceding day*.

Ex. 5. February 13th, noon, long. 122° W.

GREENWICH, FEB. 13th, $8^h\ 8^m$ P.M.

Ex. 6. March 31st, long. 91° E.

| | |
|---|---|
| Long. | $6^h\ 4^m$ |
| GREENWICH, MARCH 30th, | 17 56 |

577. It is easy to perceive, on all occasions, what the Greenwich Date must be, by proceeding from noon at the place.

Thus, in Ex. 2, when it is noon in 130° W., it is $8^h\ 40^m$ *later* at Greenwich; hence, when it is $6^h\ 42^m$ *before* noon at this place, it is $6^h\ 42^m$ before $8^h\ 40^m$, or $1^h\ 58^m$ P.M. at Greenwich, on the same day.

Ex. 4. When it is noon in long. 40° E., it is $2^h\ 40^m$ *before* noon at Greenwich; hence, when it is $6^h\ 57^m$ A.M., or $5^h\ 3^m$ before noon at this place, it wants $2^h\ 40^m$ and $5^h\ 3^m$, or $7^h\ 43^m$ of noon at Greenwich on this day; or it is $16^h\ 17^m$ on the day before.

## II. Reduction of the Elements in the Nautical Almanac.

578. This Reduction is effected by Inspection, or by Logarithms, No. 597. When extreme precision is required, a further correction is necessary, on account of 2d Differences, No. 598.

## 1. *Reduction by Inspection.*

### [1.] *The Sun's Declination.*

579. *At Sea.*—(1.) At noon. Take out of the Nautical Almanac, p. I., or Table 60, the sun's decl. at noon of the day, and note whether it is increasing or decreasing; take out of Table 19 the correction for long., and apply it, as there directed, to the decl. at noon.

If the correction, when *subtractive*, exceed the decl. at noon in the table, the difference is the decl. of the *contrary* name.

Ex. 1. Nov. 13th, 1902, long 64° W.: find the decl at noon.

| | |
|---|---|
| Sun's decl. 13th, noon, | 17° 48′ S. (*incr.*) |
| 64° W. Table 19 | + 3 |
| Red. Decl. | 17 51 S. |

Ex. 2. March 20th, 1902, long. 178° W.: find the Sun's decl. at noon.

| | |
|---|---|
| Decl. 20th, noon | 0° 25′ S. (*decr.*) |
| 178° W. Table 19 | − 12 |
| Red. Decl. | 0 13 S. |

Ex. 3. June 20th, 1902, long. 120° W.: find the decl. at noon.

| | |
|---|---|
| Decl. 20th, noon, | 23° 26′ N. (*incr.*) |
| 120° W. Table 19 | 0 |
| Red. Decl. | 23 26 N. |

Ex. 4. Sept. 22d, 1902, long. 167° W.: find the Sun's decl. at noon.

| | |
|---|---|
| Decl. 22d, noon, | 0° 35′ N. (*decr.*) |
| 167° W. Table 19 | − 11 |
| Red. Decl. | 0 24 N. |

Ex. 5. Aug. 6th, 1902, long. 85° E.: find Sun's decl. at noon.

| | |
|---|---|
| Decl. 6th. noon, | 16° 54′ N. (*decr.*) |
| 85° E. Table 19 | + 4 |
| Red. Decl. | 16 58 N. |

Ex. 6. March 20th, 1902, long. 80° W.: find Sun's decl. at noon.

| | |
|---|---|
| Decl. 20th. noon, | 0° 25′ S. (*decr.*) |
| 80° W. Table 19 | − 5 |
| Red. Decl. | 0 20 S. |

When the declination at noon at Greenwich is 0° 0′ in *east* long., the correction is the decl. of the same name as that of the day *before*; in *west* long. the correction is the decl. of the same name as that of the day *after*.

(2.) At a given hour. Correct for long. as above, and then apply the correction for the hour.

Ex. 1. March 21st, 1902, long. 123° W. at $3^h$ P.M.: find the decl.

| | | |
|---|---|---|
| Decl. 21st, noon, | | 0° 1′ S. (*decr.*) |
| 123 W. | + 8′ | + 11 |
| $3^h$ | + 3′ | |
| Red Decl. | | 0 10 N. |

For $3^h$ A.M. the corr. will be for $9^h$, or 9′, *subtractive*, and the Decl. is 0° 2′ S.

Ex. 2. Feb. 12th, 1902, long. 78° E. at $7^h$ $50^m$ P.M.: find the decl.

| | | |
|---|---|---|
| Decl. 12th, noon, | | 13° 54′ S. (*decr.*) |
| 78° E. | + 4′ | − 2 |
| $7^h$ $50^m$ | − 6′ | |
| Red Decl. | | 13 52 S. |

For $7^h$ $50^m$ A.M. the corr. is that for $4^h$ $10^m$, or 3′, *additive*, and the Decl. is 14° 1′ S.

580. *Accurately.*—(1.) Find the Greenwich Date.* Take out of the Nautical Almanac, p. II., the decl. for noon of the same and the next days, and take the diff. between them, or the Daily Variation.

When the declination changes its name, the daily variation is the *sum* of the two declinations.

(2.) With the Greenwich Date and daily variation take out the proportional part from Table 21.

* When the Greenwich Date is given in App rent Time, the Sun's de l., &c., are taken from p. I. of the Naut. Alm. instead of p. II.; the computation in other respects is the same.

The reduction of the elements in the Nautical Almanac can also be effected by using the Hourly Variation given on p. I. of each month: taking care always to use the elements for the noon or hour nearest to the Greenwich Date. Several examples given under Nos. 579-584, and 592 are thus worked:—

## 1. *Reduction by Hourly Variation in Nautical Almanac.*

579. [1.] *The Sun's Declination.*

Ex. 1. Nov. 13th, 1878, long. 64° W.: find the decl. at noon.

Long. 64° W. = $4^h\ 16^m = 4^h\!\cdot\!3$
Hourly Var. $39''\!\cdot\!7 \times 4\!\cdot\!3 = 171''$ or $+3'$.
Sun's decl. 13th, noon, 18° 1′ S. (*incr.*)
64° W. Table 19 +3
RED. DECL. 18 4 S.

Ex. 4. Sept. 22d, 1878, long. 167° W.: find the Sun's decl. at noon.

Long. 167° W. = $11^h\ 8^m = 11^h\!\cdot\!1$
Hourly Var. $58''\!\cdot\!5 \times 11\!\cdot\!1 = 649''$ or $-11'$.
Decl. 22d, noon, 0° 16′ N. (*decr.*)
167° W. Table 19 −11
RED. DECL. 0 5 N.

### (2.) At a given hour.

Ex. 1. March 21st, 1878, long. 123° W., at $3^h$ P.M.: find the decl.

Long. 123° W. = $8^h 12^m + 3^h = 11^h 12^m = 11^h\!\cdot\!2$.
Hourly Var. $59''\!\cdot\!1 \times 11\!\cdot\!2 = 663''$ or $+11'$.
Decl. 21st, noon, 0° 18′ N. (*incr.*)
$\left.\begin{array}{ll} 123^\circ \text{ W.} & +8' \\ 3^h & +3' \end{array}\right\}$ +11
RED. DECL. 0 29

For $3^h$ A.M. the corr. will be for $9^h$, or 9′, *subtractive*, and the DECL. is 0° 17′ N.

Ex. 2. Feb. 12th, 1878, long. 78° E., at $7^h\ 50^m$ P.M.: find the decl.

Long. 78° E. = $5^h 12^m - 7^h 50^m = 2^h 38^m = 2^h\!\cdot\!6$.
Hourly Var. $50''\!\cdot\!1 \times 2\!\cdot\!6 = 130''$ or $-2'$.
Decl. 12th, noon, 13° 38′ S. (*decr.*)
$\left.\begin{array}{ll} 78^\circ \text{ E.} & +4' \\ 7^h\ 50^m & -6' \end{array}\right\}$ −2
RED. DECL. 13 36 S.

For $7^h\ 50^m$ A.M. the corr. is that for $4^h\ 10^m$, or 3′, *additive*, and the DECL. is 13° 45′ S.

580. (3.)

Ex. 1. May 9th, 1878, at $11^h\ 30^m$ mean time at Greenwich: find the Sun's declin.

Hourly Var. $39''\!\cdot\!5 \times 11^h 30^m$ or $11^h\!\cdot\!5 = 454''\!\cdot\!3$
= + 7′ 34″·3
Decl. 9th, at noon, 17 23 58 ·9 N.
RED. DECL. 17 31 33 ·2 N.

Ex. 2. March 21st, 1878, $15^h\ 27^m$ mean time at Greenwich: find the Sun's decl.

$15^h\ 27^m - 24^h = 8^h\ 33^m$ or $8^h\!\cdot\!55$.
Hourly Var. 22d, $59''\!\cdot\!2 \times 8^h\!\cdot\!55 = 506''\!\cdot\!2$
= − 8′ 26″·2
Decl. 22d, at noon, 0 41 42 ·6 N.
RED. DECL. 0 33 16 ·4 N.

582. [2.] *The Sun's Right Ascension.*

Ex. 1. June 6th, 1878, at $8^h\ 11^m$ A.M., mean time, long. 17° W.: required the Sun's R.A.

Astron. Time, June, $5^d\ 20^h\ 11^m$
Long. 17° W. +1 8
Green. Time, June, 5 21 19
$21^h\ 19^m - 24^h = 2^h\ 41^m$ or $2^h\!\cdot\!7$.
Hourly Var. 6th, $10^s\!\cdot\!31 \times 2^h\!\cdot\!7 = -27^s\!\cdot\!8$
R.A. 6th, 4 57 26 ·4
RED. R.A. 4 56 58 ·6

Ex. 2. March 22d, 1878, at $2^h\ 20^m$ P.M., mean time, long. 43° E.: required the Sun's R.A.

Astron. Time, March, $22^d\ 2^h\ 20^m$
Long. 43° E. −2 52
Green. Time, March, 21 23 28
$23^h\ 28^m - 24^h = 0^h\ 32^m$ or $0^h\!\cdot\!53$.
Hourly Var. 22d, $9^s\ 09 \times 0^h\!\cdot\!53 = -4^s\!\cdot\!8$
R.A. 22d, 0 6 24 ·7
RED. R.A. 0 6 19 9

583. [3.] *The Equation of Time.*

Ex. 2. Nov. 29th, 1878, long. 103° E. at apparent noon: find the Equation of Time.

Astron. Time, Nov. $29^d\ 0^h\ 0^m$
103° E. −6 52
Green. App. T., Nov. 28 17 8
$17^h\ 8^m - 24^h = 6^h\ 52^m$ or $6^h\!\cdot\!9$.
Hourly Var. 29th, $0^s\!\cdot\!89 \times 6^h\!\cdot\!9 = +6^s\!\cdot\!1$
Equation 29th, at noon, $-11^m$ 30 0
RED. EQ. OF T. −11 36 ·1

Ex. 3. Dec. 25th, 1878, long. 18° W. at $5^h\ 0^m$ A.M. (app. time): find the Equation of Time.

Astron. Time, Dec. $24^d\ 17^h\ 0^m$
18° W. +1 12
Green. Time, Dec. 24 18 12
$18^h\ 12^m - 24^h = 5^h\ 48^m$ or $5^h\!\cdot\!8$
Hourly Var. 25th, $1^s\!\cdot\!25 \times 5^h\!\cdot\!8 = -7^s\!\cdot\!3$
Equation 25th, at noon, $+0^m$ 20 ·0
RED. EQ. OF T. +0 12 ·7

[*To face p.* 208.

(3.) When the first decl. is *increasing*, *add* this prop. part to the decl. at noon; when *decreasing*, *subtract* it.

If the prop. part, when *subtractive*, exceed the decl. itself, the difference is the decl. of the *contrary name*.

Ex. 1. May 9th, 1878, at 11ʰ 30ᵐ mean time at Greenwich: find the Sun's declin.

| | |
|---|---|
| 9th, Page II., N.A. | 17° 23′ 58″·9 N. |
| 10th, | 17 39 47 ·4 N. |
| Daily Var. | 15 48 ·5 |
| 11ʰ 30ᵐ, var. 15′ 30″ | 7 25 ·6 |
| 18·5 | 8 ·9 |
| | +7 34 ·5 |
| 9th, at noon, | 17 23 58 ·9 N. |
| Red. Decl. | 17 31 33 ·4 N. |

Ex. 2. March 21st, 1878, 15ʰ 27ᵐ mean time at Greenwich: find the Sun's declin.

| | |
|---|---|
| 21st, Page II., N.A. | 0° 18′ 2″·4 N. |
| 22d, | 0 41 42 ·6 N. |
| Daily Var. | 23 40 ·2 |
| 15ʰ 0ᵐ, var. 23′ 30″ | 14 41 ·2 |
| 10 ·2 | 6 ·4 |
| 27ᵐ, 23 40 | 26 ·6 |
| | +15 14 ·2 |
| 21st, at noon, | 0 18 2 ·4 N. |
| Red. Decl. | 0 33 16 ·6 N. |

The sun's decl. changes nearly 1′ an hour, or 1″ in 1ᵐ, in March and Sept.; hence, to ensure it to 1″ in the extreme case, the Greenwich Date must be true to 1ᵐ.

The 2d. diff. (see No. 598) is 26″ a-day in June and December. The greatest error of omitting it is then $\frac{1}{8}$ of 26″, or 3″.

### [2.] *The Sun's Right Ascension.*

581. *Approximately.*—Find it in the Nautical Almanac, or from Sidereal Time in Table 61, for noon. *See* Note to p. 211 and p. 421.

Ex. 1901, April 21st, find the Sun's Right Ascension. Sidereal Time, April 21st, 1ʰ 55ᵐ·4 − 1ᵐ·2 Equation of Time = 1ʰ 54·2, Sun's R.A.

582. *Accurately.*—(1.) Find the Greenwich Date. Take out of the Nautical Almanac, p. II., the R.A. for noon of the same day and the next. Take the difference between them, which is the Daily Variation.

When the first R.A. has 23ʰ and the second 0ʰ, add 24ʰ to the second, and subtract the first from it: the remainder is the Daily Variation.

(2.) With the Greenwich Date and the Daily Variation find the proportional part from Table 21.

(3.) *Add* this prop. part to the first R.A.: if the sum exceed 24ʰ, reject 24ʰ.

Ex. 1. June 6th, 1878, at 8ʰ 11ᵐ A.M., mean time, long. 17° W.: required the Sun's R.A.

| | |
|---|---|
| Astron. Time, June, | 5ᵈ 20ʰ 11ᵐ |
| Long. 17° W. | +1 8 |
| Green. Time, June, | 5 21 19 |
| R.A. 5th, Page II., N.A., | 4ʰ 53ᵐ 19ˢ·2 |
| 6th, | 4 57 26 ·4 |
| Daily Var. | 4 7 ·2 |
| 21ʰ 0ᵐ, var. 4ᵐ 0ˢ | 3 30 |
| 7 ·2 | 6 ·3 |
| 19ᵐ, 4 7 | 3 ·3 |
| Corr. | +3 39 ·6 |
| 5th, R.A. | 4 53 19 ·2 |
| Red. R.A. | 4 56 58 ·8 |

Ex. 2. March 22d, 1878, at 2ʰ 20ᵐ P.M., mean time, long. 43° E.: required the Sun's R.A.

| | |
|---|---|
| Astron. Time, March, | 22ᵈ 2ʰ 20ᵐ |
| Long. 43° E. | −2 52 |
| Green. Time, March, | 21 23 28 |
| R.A. 21st, Page II., N.A., | 0ʰ 2ᵐ 46ˢ·4 |
| 22d, | 0 6 24 ·7 |
| Daily Var. | 3 38 ·3 |
| 23ʰ 0ᵐ, var. 3ᵐ 30ˢ | 3 21 ·2 |
| 8·3 | 8 ·0 |
| 28ᵐ, 3 38 | 4 ·2 |
| | +3 33 ·4 |
| 21st, noon, | 0 2 46 ·4 |
| Red. R.A. | 0 6 19 ·8 |

When the R.A. in the tables is 0, the prop. part is R.A. required.

The greatest daily change of R.A. is $4^m\ 30^s$ in December; the smallest, $3^m\ 30^s$ in September.

[S] *The Equation of Time.*

583. *At Sea.*—(1.) Find the Greenwich Date. Take out the equation of time from the Nautical Almanac, p. I., or Table 62, for the same day and the next. When both the equations are directed to be added, or both to be subtracted, take their difference: if one is to be added and the other subtracted, take the sum: the result is the Daily Variation.

(2.) With the Greenwich Date and the Daily Variation find the correction or proportional part by Table 21.

(3.) When the first Equation is *increasing*, *add* the prop. part; when *decreasing*, *subtract* the lesser from the greater.

If the prop part, when subtractive, exceed the first Equation, their diff. is the Reduced Equation, and is *additive* or *subtractive* according to the direction for the second Equation.

Ex. 1. June 25th, 1902, long. 41° W. at $3^h\ 28^m$ P.M. (app. time): find the Equation of Time.

| | |
|---|---|
| Astron. Time, June, | $25^d\ 3^h\ 28^m$ |
| 41° W. | +2 44 |
| Green. Time, June, | 25 6 12 |
| Eq. T. 25th, | $+2^m\ 11^s{\cdot}0$ |
| 26th, | +2 24 ·0 |
| Daily Var. | 13 ·0 |
| $6^h\ 12^m$, var. $13^s$ | +3 ·0 |
| 25th, noon, | 2 11 ·0 |
| Red. Eq. of T. | +2 14 ·0 |

Ex. 2. Nov. 29th, 1902, long. 103° E. at apparent noon: find the Equation of Time.

| | |
|---|---|
| Astron. Time, Nov. | $29^d\ 0^h\ 0^m$ |
| 103° E. | −6 52 |
| Green. App. T. Nov. | 28 17 8 |
| Eq. T. 28th, | $11^m 50^s{\cdot}0$ |
| 29th, | 11 29 ·0 |
| Daily Var. | 21 ·0 |
| $17^h\ 8^m$, var. $21^s$ | −15 ·1 |
| 28th, noon, | −11 50 ·0 |
| Red. Eq. of T. | −11 34 ·9 |

Ex. 3. Dec. 26th, 1902, long. 18° W. at $5^h\ 0^m$ A.M. (app. time): find the Equation of Time.

| | |
|---|---|
| Astron. Time, Dec. | $25^d\ 17^h\ 0^m$ |
| 18° W. | 1 12 |
| Green Time, Dec. | 25 18 12 |
| Eq. T. 25th, | $-0^m\ 8^s{\cdot}6$ |
| 26th, | +0 21 ·3 |
| Daily Var. | 0 29 ·9 |
| $18^h\ 12^m$, var. $29^s{\cdot}9$ | − 22 ·7 |
| 25th, noon, | −0 8 ·6 |
| Red. Eq. of T. | +0 14 ·1 |

Ex. 4. Sept. 1st, 1902, long. 84° E. at $4^h\ 34^m$ A.M. (app. time). find the Equation of Time.

| | |
|---|---|
| Astron. Time, Aug. | $31^d\ 16^h\ 34^m$ |
| 84° E. | −5 36 |
| Green. App. T. Aug. | 31 10 58 |
| Eq. T. 31st, | $+0^m\ 28^s{\cdot}3$ |
| 32d, | 0 9 ·7 |
| Daily Var. | 18 ·6 |
| $10^h\ 58^m$, var. $18^s{\cdot}6$ | −8 ·5 |
| Eq. T. 31st, | 0 28 ·3 |
| Red. Eq. of T. | +0 19 ·8 |

As the Equation of Time is generally required for a particular hour, the above method by Table 21 is more convenient that that by Table 20, in which the correction is given corresponding to the longitude, and the time at ship, without reference to the time at Greenwich. The first example worked by Table 20 will stand thus (no

further explanation being necessary, as the table is entered precisely like Table 19):—

Ex. 1. June 25th, 1878, long. 41° W. at $3^h$ $28^m$ P.M.

| | | |
|---|---|---|
| Eq. T. 25th, p. I., N.A. | | $+2^m$ $18^s$·5 |
| 26th, | | +2 31·2 |
| Daily Var. | | 12·7 |
| 41° W. | $+1^s$·4 | |
| $3^h$ $28^m$ | +1·8 | + 3·2 |
| Eq. 25th. | | +2 18·5 |
| Red. Eq. of T. | | +2 21·7 |

Ex. 2. March 26th, 1878, long. 109° E. at $7^h$ $42^m$ A.M. (app. time).

| | | |
|---|---|---|
| Astron. Time, March $25^d$ $19^h$ $42^m$ | | |
| Eq. 25th, | | $+6^m$ $4^s$·2 |
| 26th, | | +5 45·7 |
| Daily Var. | | 18·5 |
| $12^h$ $0^m$ | $-9^s$·2 | |
| 7 42 | −5·9 | −9·5 |
| 109° E. | +5·6 | |
| 25th, noon, | | +6 4·2 |
| Red. Eq. of T. | | +5 54·7 |

584. *Accurately.*—Proceed as directed in No. 583, with more attention to precision in the several quantities.

Ex. 1. Green. Date, June 25th, 1878, $6^h$ $11^m$ (app. time): find the Equation of Time.

| | |
|---|---|
| Eq. 25th, page I., N.A. | $2^m$ $18^s$·5 |
| 26th, | 2 31·2 |
| Daily Var. | 12·7 |
| $6^h$ $0^m$, var. $12^s$·7 | 3·2 |
| $11^m$, do. | ·1 |
| | +3·3 |
| Eq. 25th, | +2 18·5 |
| Red. Eq. of T. | +2 21·8 |

Ex. 2. Green. Date, Dec. 24th 1878, $15^h$ $49^m$ (app. time): find the Equation of Time.

| | |
|---|---|
| Eq. 24th. N.A. | $-0^m$ $10^s$·0 |
| 25th, | +0 20·0 |
| Daily Var. | 30·0 |
| $15^h$ $30^m$, var. $30^s$ | 19·4 |
| $19^m$, do. | ·4 |
| | −19·8 |
| 24th, Eq. | −0 10·0 |
| Red. Eq. of T. | −0 9·8 |

[4.] *The Sidereal Time.**

585. Take from Table 23 the Acceleration corresponding to the hours, minutes, and seconds of the Greenwich Date; *add* them to the Sidereal Time at the preceding mean noon, from N.A. or Table 61. When the sum exceeds $24^h$, reject $24^h$.

Ex. 1. Green. Date, Nov. 1st, 1901, $3^h$ $41^m$ $39^s$: find the Sid. Time. By Tables 61 and 23.

| | |
|---|---|
| Sid. T. mean noon, Nov. 1st, | $14^h$ $40^m$·3 |
| Accel. $3^h$ | ·5 |
| $41^m$ | ·1 |
| $39^s$ | ·0 |
| Red. Sid. Time | 14 40·9 |

Ex. 2. Green. Date, March 23rd, 1901, $20^h$ $36^m$ $57^s$: find the Sid. Time. By N.A.

| | |
|---|---|
| Sid. T mean noon, March 23d, | $0^h$ $1^m$ $7^s$·0 |
| $20^h$ | 3 17·1 |
| $36^m$ | 5·9 |
| $57^s$ | ·2 |
| Red Sid. Time | 0 4 30·2 |

[5.] *The Moon's Horizontal Parallax.*

586. *At Sea.*—As the Moon's Horizontal Parallax does not change more than 27″ in 12 hours, it may be, in most cases, taken out of the Nautical Almanac at sight.

587. *Accurately.*—(1.) Find the Greenwich Date. When the Greenwich time is less than $12^h$, take out the hor. par. for the noon and midnight of the given day; when it exceeds $12^h$, take out the quantities for the midnight of the same day and the noon of the next. Take the difference between them, which is the variation in 12 hours.

* The Sun's Right Ascension may be found roughly thus:—To the Sidereal Time in Table 61 apply the Eq. of Time from Table 62, as there directed: for ex., the Sidereal Time on Nov. 1st, 1901, is $14^h$ $40^m$·3, the Eq. of Time is $16^m$ 3 *sub.*; hence, *subtracting* $16^m$·3 from $14^h$ $40^m$·3, gives $14^h$ $24^m$, the Sun's R.A. required.

(2.) Enter Table 21 with the Greenwich Time and the 12-hourly var., and take out the proportional part. When the horizontal parallax is *increasing*, *add* this prop. part; when *decreasing*, *subtract* it from the horizontal parallax at the preceding noon or midnight.

Ex. 1. Green. Date, Jan. 15th, 1878, $5^h 11^m$: required the Hor. Par.

| | |
|---|---|
| H.P. 15th, noon, | 57′ 45″·2 |
| 15th, midn. | 58 12 ·7 |
| Var. in $12^h$, | 27 ·5 |
| $5^h 11^m$, var. 27″·5 | +11 ·9 |
| 15th, noon, | 57 45 ·2 |
| RED. HOR. PAR. | 57 57 1 |

Ex. 2. Green. Date, Aug. 12th, 1878, $15^h 28^m$: required the Hor. Par.

| | |
|---|---|
| H.P. 12th, midn. | 54′ 56″·9 |
| 13th, noon, | 54 45 ·9 |
| Var. in $12^h$, | 11 ·0 |
| $3^h 28^m$, var. 11″·0 | −3 ·2 |
| 12th, midn. | 54 56 ·9 |
| RED. HOR. PAR. | 54 53 ·7 |

When necessary to correct for latitude (No. 437), see Table 41.

[6.] *The Moon's Semi-diameter.*

588. As the variation in $12^h$ does not exceed 8″, the semi-diameter may be taken out of the Nautical Almanac at sight. In general the hor. par. is required at the same time, and the semid. corresponding is then taken at once from Table 40.

[7.] *The Moon's Declination.*

589. *At Sea.*—(1.) Find the Greenwich Date. Take out of the Nautical Almanac the decl. corresponding to the hour of the Greenwich Time, and also the diff. for $10^m$.

(2.) Enter Table 22 with this diff. and the minute of the Greenwich Date, and take out the prop. part at sight to the nearest minute.

(3.) When the declination is *increasing*, *add* this prop. part to it; when *decreasing*, *subtract* the lesser from the greater. If the prop. part, when subtractive, exceed the decl., their diff. is the decl. of the *contrary* name.

Ex. 1. Green. Date, Feb. 16th, 1878, $11^h 56^m$: find the Moon's declin.

| | |
|---|---|
| Decl. $11^h$, | 14° 39′ N. *decr.* D. 154″ |
| $56^m$, D. 154″ | −14 |
| RED. DECL. | 14 25 N. |

Ex. 2. Green. Date, April 24th, 1878, $10^h 47^m$: find the Moon's declin.

| | |
|---|---|
| Decl. $10^h$, | 18° 15′ S. *decr.* D. 108″ |
| $47^m$ D. 108″ | −8 |
| RED. DECL. | 18 7 S. |

Ex. 3. Green. Date, June 25th, 1878, $6^h 50^m$: find the Moon's declin.

| | |
|---|---|
| Decl. $6^h$, | 18° 33′ N. *incr.* D. 105″ |
| $50^m$, | +9 |
| RED. DECL. | 18 42 N. |

Ex. 4. Green. Date, Sept. 22nd, 1878, $9^h 37^m$: find the Moon's declin.

| | |
|---|---|
| Decl. $9^h$, | 18° 34′ N. *decr.* D. 122″ |
| $37^m$, | −8 |
| RED. DECL. | 18 26 N. |

When the decl. for the given hour is 0, the prop. part is the decl. of the name of the next hour.

590. *Accurately.*—Employ the decimals of the diff. for $10^m$ as whole seconds, taking care to divide the prop. part corresponding by 10, or by 100. Proceed as above directed in No. 589, (1) and (3); also take the seconds of the Greenwich Date as minutes, taking care to put the minutes of the prop. part into the place of the seconds,

and the seconds into that of thirds: it is near enough to work to the fraction of $1^m$.

| Ex. 1. Green. Date, Aug. 16, 1878, $17^h\ 38^m\ 20^s$: find the Moon's declin. | | Ex. 2. Green. Date, Jan. 22d, 1878, $4^h\ 31^m\ 45^s$: find the Moon's declin. | |
|---|---|---|---|
| Decl. $17^h$, | $8°\ 10'\ 3''{\cdot}2$ N. *incr.* D. $130''{\cdot}28$ | Decl. $4^h$, | $0°\ 15'\ 27''\ 7$ N. *dec.* |
| $10^m : 130''{\cdot}28 :: 38\frac{1}{3}^m$ | $+8\ 19\ {\cdot}4$ | $10^m : 170''{\cdot}92 :: 31\frac{3}{4}^m$ | $-9\ 2\ {\cdot}7$ |
| Red. Decl. | $8\ 18\ 22\ {\cdot}6$ N. | Red. Decl. | $6\ 25\ {\cdot}0$ N. |

The greatest change of decl. in 1 hour is 17′; hence, to obtain the decl. in the extreme case, true to 1′, the Greenwich Date must be true to $4^m$, or 1° of long.; and to obtain it to 1″, the Greenwich Date must be true to $4^s$, in the extreme case.

| | | | | | |
|---|---|---|---|---|---|
| | 3 3 | 2 ·4 | | 9·3 | 8 ·4 |
| $17^m$, | 2 5 ·5 | 1 ·4 | $17^m$, | 5 9 ·3 | 3 ·6 |
| | | 1 1 ·3 | | | 4 53 ·2 |
| R.A. Sept. 11th, | | 11 37 18 ·8 | R.A. May 5th, | | 5 17 49 ·3 |
| Red. R.A. | | 11 36 17 ·5 | Red. R.A. | | 5 22 42 ·5 |

The greatest daily change of R A. is $6^m$.

(2.) Enter Table 21 with the Greenwich Time and the 12-hourly var., and take out the proportional part. When the horizontal parallax is *increasing*, *add* this prop. part; when *decreasing*, *subtract* it from the horizontal parallax at the preceding noon or midnight.

Ex. 1. Green. Date, Jan. 15th, 1878, $5^h 11^m$: required the Hor. Par.

| | |
|---|---|
| H.P. 15th, noon, | 57′ 45″·2 |
| 15th, midn. | 58 12 ·7 |
| Var. in $12^h$, | 27 ·5 |
| $5^h 11^m$, var. 27″·5 | +11 ·9 |
| 15th. noon, | 57 45 ·2 |
| Rᴇᴅ. Hᴏʀ. Pᴀʀ. | 57 57 ·1 |

Ex. 2. Green. Date, Aug. 12th, 1878, $15^h 28^m$: required the Hor. Par.

| | |
|---|---|
| H.P. 12th, midn. | 54′ 56″·9 |
| 13th, noon, | 54 45 ·9 |
| Var. in $12^h$, | 11 ·0 |
| $3^h 28^m$, var. 11″·0 | −3 ·2 |
| 12th, midn. | 54 56 ·9 |
| Rᴇᴅ. Hᴏʀ. Pᴀʀ. | 54 53 ·7 |

When necessary to correct for latitude (No. 437), see Table 41.

592. [9.] *Right Ascension of Venus.*

Ex. 3. Green. Date, Sept. 11th, 1903, $11^h 47^m$: find Venus' R.A.

| | |
|---|---|
| R.A. Sept. 11th, noon | $11^h 37^m 18^s·8$ |
| Hourly Var.* 11th, | |
| $5^s·1 \times 11^m·8$ | 1 0 ·2 |
| Rᴇᴅ. R.A. Vᴇɴᴜs | 11 36 18 ·6 |

Ex. 4. Green. Date, May 5th, 1903, $22^h 47^m$: find Venus' R.A.

| | |
|---|---|
| R.A. May 5th, noon | $5^h 17^m 49^s·3$ |
| Hourly Var.* 5th, | |
| $12^s·9 \times 22·8$ | 4 54 ·1 |
| Rᴇᴅ. R.A. Vᴇɴᴜs | 5 22 43 ·4 |

593. [10.] *Declination of Venus.*

Ex. 1. Green. Date, Sept. 11th, 1903, $11^h 47^m$: find Venus' Declination.

| | |
|---|---|
| Hourly Var.* Sept. 11th | |
| $23''·9 \times 11^h 47^m =$ | −4′ 42″·0 |
| Decl. Venus, Sept. 11th, | 6° 51 30 ·0 |
| Rᴇᴅ. Dᴇᴄʟ. Vᴇɴᴜs | 6 46 48 ·0 |

Ex. 2. Green. Date, Sept. 11th, 1903, $11^h 47^m$: find Venus' Declination.

| | | |
|---|---|---|
| Decl. Sept. 11th, | | 6° 51′ 30″·0 |
| „ Sept. 12th, | | 6 41 53 ·7 |
| Daily Var. | | 9 36 ·3 |
| $11^h 30^m$, var. | 9 30 | 4 33 ·1 |
| | 6·3 | 2 ·9 |
| $17^m$, | 9 36·3 | 6 ·9 |
| | | −4 42 ·9 |
| Decl. Venus, Sept. 11th, | | 6 51 30 ·0 |
| Rᴇᴅ. Dᴇᴄʟ. Vᴇɴᴜs | | 6 46 47 ·1 |

* The Hourly Variations are taken from the Planetary Ephemerides at Transit in the Nautical Almanac.

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of the name of the next hour.

590. *Accurately.*—Employ the decimals of the diff. for $10^m$ as whole seconds, taking care to divide the prop. part corresponding by 10, or by 100. Proceed as above directed in No. 589, (1) and (3); also take the seconds of the Greenwich Date as minutes, taking care to put the minutes of the prop. part into the place of the seconds,

and the seconds into that of thirds: it is near enough to work to the fraction of $1^m$.

Ex. 1. Green. Date, Aug. 16, 1878, $17^h\ 38^m\ 20^s$: find the Moon's declin.

| | | |
|---|---|---|
| Decl. $17^h$, | $8°\ 10'\ 3''\cdot2$ N. *incr.* | D. $130''\cdot28$ |
| $10^m : 130''\cdot28 :: 38\frac{1}{3}^m$ | $+8\ 19\ \cdot4$ | |
| Red. Decl. | $8\ 18\ 22\ \cdot6$ N. | |

Ex. 2. Green. Date, Jan. 22d, 1878, $4^h\ 31^m\ 45^s$: find the Moon's declin.

| | |
|---|---|
| Decl. $4^h$, | $0°\ 15'\ 27''\cdot7$ N. *dec.* |
| $10^m : 170''\cdot92 :: 31\frac{3}{4}^m$ | $-9\ \ 2\ \cdot7$ |
| Red. Decl. | $6\ 25\ \cdot0$ N. |

The greatest change of decl. in 1 hour is 17′; hence, to obtain the decl. in the extreme case, true to 1′, the Greenwich Date must be true to $4^m$, or 1° of long.; and to obtain it to 1″, the Greenwich Date must be true to $4^s$, in the extreme case.

### [8.] *The Moon's Right Ascension.*

591. Take the diff. of R.A. for $1^h$. To the const. 9·5229 add the prop. log. of the diff. for $1^h$, and the prop. log. of the minutes and seconds of the Greenwich Date: the sum is the prop. log. of the proportional part, always *additive*.

When the sum exceeds $24^h$, reject $24^h$.

Ex. 1. Green. Date, Feb. 2d, 1878, $1^h\ 17^m\ 15^s$: find the Moon's R.A.

| | | |
|---|---|---|
| R.A. $1^h$, | $21^h\ 11^m\ 45^s\cdot3$ | |
| $2^h$, | $21\ 13\ 41\ \cdot3$ | 9·5229 |
| Var. $1^h$, | $1\ 56\ \cdot0$ | 1·9690 |
| Time, | $17\ 15$ | 1·0185 |
| | $+0\ 33\ \cdot3$ | 2·5104 |
| R.A. $1^h$, | $21\ 11\ 45\ \cdot3$ | |
| Red. R.A. | $21\ 12\ 18\ \cdot6$ | |

Ex. 2. Green. Date. April 28th, 1878, $16^h\ 56^m\ 45^s$. find the Moon's R.A.

| | | |
|---|---|---|
| R.A. $16^h$, | $23^h\ 58^m\ 54^s\cdot6$ | |
| $17^h$, | $0\ 0\ 40\ \cdot4$ | 9·5229 |
| Var. $1^h$, | $1\ 45\ \cdot8$ | 2·0089 |
| Time, | $56\ 45$ | ·5013 |
| | $1\ 40$ | 2·0331 |
| R.A. $16^h$, | $23\ 58\ 54\ \cdot6$ | |
| Red. R.A. | $0\ 0\ 34\ \cdot6$ | |

The greatest change in $1^h$ is $2^m\ 55^s$, the smallest is $1^m\ 45^s$; hence to have the result true to $1^s$, the Greenwich Date must be true to $20^s$.

### [9.] *Right Ascension of Venus.*

592. With the Green. Date and daily variation of R.A. deduce the prop. part by Table 21; this is to be *added* to the R.A. at the preceding noon when *increasing*, and *subtracted* when *decreasing*.

Ex. 1. Green. Date, Sept. 11th, 1903, $11^h\ 47^m$: find Venus' R.A.

| | | |
|---|---|---|
| R.A. Sept. 11th, | | $11^h\ 37^m\ 18^s\cdot8$ |
| Sept. 12th, | | $11\ 35\ 13\ \cdot3$ |
| Daily Var. | | $2\ 5\ \cdot5$ |
| $11^h\ 30^m$, var. $2^m\ 0^s$ | | $0\ 57\ \cdot5$ |
| | $5\ \cdot5$ | $2\ \cdot4$ |
| $17^m$, | $2\ 5\ \cdot5$ | $1\ \cdot4$ |
| | | $1\ 1\ \cdot3$ |
| R.A. Sept. 11th, | | $11\ 37\ 18\ \cdot8$ |
| Red. R.A. | | $11\ 36\ 17\ \cdot5$ |

Ex. 2. Green. Date, May 5th, 1903, $22^h\ 47^m$: find Venus' R.A.

| | | |
|---|---|---|
| R.A. May 5th, | | $5^h\ 17^m\ 49^s\cdot3$ |
| May 6th, | | $5\ 22\ 58\ \cdot6$ |
| Daily Var. | | $5\ 9\ \cdot3$ |
| $22^h\ 30^m$, var. $5^m$ | | $4\ 41\ \cdot2$ |
| | $9^s\cdot3$ | $8\ \cdot4$ |
| $17^m$, | $5\ 9\ \cdot3$ | $3\ \cdot6$ |
| | | $4\ 53\ \cdot2$ |
| R.A. May 5th, | | $5\ 17\ 49\ \cdot3$ |
| Red. R.A. | | $5\ 22\ 42\ \cdot5$ |

The greatest daily change of R A. is $6^m$.

[10.] *Declination of Venus.*

593. Find the proportional part, and apply it to the declin. at the preceding noon, as directed in No. 580. As the process, whether Approximate or Accurate, is the same as that for the sun, no example is necessary.

The greatest daily change of declination is 35′.

[11.] *Right Ascension and Declination of Mars.*

594. Proceed as for Venus. The greatest daily change of R.A. is $4^m$; that of declination, 25′.

[12.] *Right Ascension and Declination of Jupiter.*

595. Proceed as for Venus. The greatest daily change of R.A. is $1^m$; that of declination, 4′.

[13.] *Right Ascension and Declination of Saturn.*

596. Proceed as for Venus. The greatest daily change of R.A. is $40^s$; that of declination, 2′.

## 2. *Reduction by Logarithms.*

597. (1.) The proportional part may be found by the Proportional Logarithms, Table 74, thus:—For 24-hourly variations take the constant log. 9·1249; for 12-hourly variations take 8·8239; for 3-hourly variations, no constant; and for hourly variations, 9·5229.

Then to the constant add the prop. log. of the Green. Date, (reading hours and min. as min. and sec. when the var. corresponds to more than $3^h$), and the prop. log. of the variation as given for $24^h$, $12^h$, $3^h$, or $1^h$; the sum is the prop. log. of the proportional part required.

Ex. 1. (Daily Variation.) Green. Time $11^h\ 30^m$, Daily Var. 14′ 42″.

| | | | |
|---|---|---|---|
| | | const. log. | 9·1249 |
| Gr. Time | $11^h\ 30^m$ | p. log. | 1·1946 |
| Var. | 14′ 42″ | p. log. | 1·0880 |
| PROP. PART | 7′ 2″·6 | p. log. | 1·4075 |

Ex. 2. (Twelve-hourly Var.) Green. Time $4^h\ 11^m$, Var. 16″·6.

| | | | |
|---|---|---|---|
| | | const. log. | 8·8239 |
| Gr. Time | $4^h\ 11^m$ | p. log. | 1·6337 |
| Var. | 16″·6 | p. log. | 2·8133 |
| PROP. PART | 5″·8 | p. log. | 3·2709 |

Ex. 3. (Three-hourly Var.) Green. Time $7^h\ 18^m\ 12^s$, change in 3 hours 1° 31′ 41″: find the Prop. Part for $1^h\ 18^m\ 12^s$.

| | | | |
|---|---|---|---|
| Gr. Time | $1^h\ 18^m\ 12^s$ | p. log. | 3621 |
| Var. | 1° 31′ 41″ | p. log. | 2930 |
| PROP. PART | 0° 39′ 49″ | p. log. | 6551 |

Ex. 4. (Hourly Var.) Green. Time $10^h\ 56^m\ 10^s$, Hourly Var. 8′ 47″·2.

| | | | |
|---|---|---|---|
| | | const. log. | 9·5229 |
| Gr. Time | $56^m\ 10^s$ | p. log. | ·5058 |
| Var. | 8′ 47″·2 | p. log. | 1·3114 |
| PROP. PART | 8′ 13″·5 | p. log. | 1·3401 |

(2.) The proportional part for $24^h$ is obtained conveniently from Table 21 A;* thus:—

* In common practice at sea the prop. part may be taken out at sight from Table 21: when extreme precision is required the logarithms to four places only are not sufficient. For ex., at sea, for the Time $7^h\ 10^m$, and Daily Variation 22′ 27″·5, we enter the table with 22′ 30″, and take out at once (No. 50) the quantity about ⅓ between 6′ 33″·7 at $7^h\ 0^m$, and 7′ 1″·9 at $7^h\ 30^m$, that is, 6′ 40″, or 6′·7. Now this mental interpolation is performed in very considerably less time than it takes to write down the quantities, while the small inaccuracy to which it is liable, amounting here to 6′ 42″·4 − 6′ 40″, or 2″·4 only, would be wholly inappreciable in practice at sea. The logarithms in Table 21 A give in this case the result true to 0″·1; but if the prop. part were above 8′ the logs. could no longer be depended

Take out from this Table the log. of the Greenwich Time, and add to it the log. of the Daily Variation; the sum is the log. of the prop. part required.

Ex. 1. (The Sun's Declination.) Green. Date, May 13th, $11^h\ 30^m$.

| | | | |
|---|---|---|---|
| Gr. Time | $11^h\ 30^m$ | log. | 3195 |
| Daily Var. | $14'\ 42''$ | log. | 2129 |
| Prop. Part | $7'\ 2''\cdot6$ | log. | 5324 |

Ex. 2. (The Sun's Right Ascension.) Green. Date, June 6th, $9^h\ 19^m$.

| | | | |
|---|---|---|---|
| Gr. Time | $9^h\ 19^m$ | log. | 4109 |
| Daily Var. | $4^m\ 7^s\cdot5$ | log. | 7648 |
| Prop. Part | $1^m\ 36^s$ | log. | 1·1757 |

Ex. 3. (The Equation of Time.) Green. Date, June 25th, $6^h\ 11^m$.

| | | | |
|---|---|---|---|
| Gr. Time | $6^h\ 11^m$ | log. | 5890 |
| Daily Var. | $12^s$ | log. | 3010 |
| Prop. Part | $3^s$ | log. | 8900 |

Ex. 4. (Right Ascension of Venus.) Green. M.T. $19^h\ 13^m$, Daily Var. $4^m\ 54^s$.

| | | |
|---|---|---|
| Gr. Time | $19^h\ 13^m$ | 0965 |
| Daily Var. | $4^m\ 54^s$ | 6900 |
| Prop. Part | $3^m\ 55^s$ | 7865 |

### 3. *Correction for Second Differences.*

598. The quantities in the Nautical Almanac do not in general change uniformly, that is, by equal portions in equal times, but the differences of any series of quantities taken in order exhibit differences among themselves, or *second differences*, as in the case of alts., p. 200. Hence the proportional part found by the preceding rules is not always the *actual change* in the interval, but may require a correction, which is called the *equation of second differences.*

The greatest error which can arise in any case from neglecting this correction, that is, the greatest value of the equation itself, is $\frac{1}{8}$ of the whole 2d diff.; this takes place when the interval for which the proportional part is required is *half* the interval for which the quantities are set down in the table.

For example, suppose the second diff. of the sun's decl. to be 26″ in $24^h$; the greatest error of neglecting the equation will be 1-8th of 26″, and will take place when the Green. Date is $12^h$, or midnight.

599. To find the Equation of Second Differences. Take the two quantities in the table next on each side of the given one, and set them down in order. Add together the 1st and 4th, and the 2d and 3d; write against the sum of the 2d and 3d, whether it be the *greater* or the *lesser* of the two sums.

Half the diff. of these two sums is the 2d diff.

Under the Tabular Interval, and with the Green. Date as intermediate time, enter Table 25 and take out the multiplier, by which multiply the 2d diff.; this is the Equation of 2d differences. If the 2d sum is marked the *greater*, *add* the equation to the prop. part deduced by one of the preceding rules; if the *lesser*, *subtract* the equation.

---

upon as shewing the true tenth, not only because the last figure ceases to change by lat. $7^h\ 58^m$, but because the last figure of any logarithm is itself but an approximation.

Although logarithms afford material service in multiplication or division of many figures, yet in short and easy reductions they are attended, as is well known to experienced arithmeticians, with considerable loss of time, and should accordingly be resorted to only when they unequivocally effect a saving of time and labour.

It is also important to observe that the facility of mental interpolation constantly improves by exercise, and that the habit sharpens the perception of arithmetical proportions.

By Logarithms. To the prop. log. of the 2d diff. add the ar. co. log. of the multiplier; the sum is the prop. log. of the equation required.

Ex. Greenwich Date, June 17th, 1878, $13^h\ 11^m$ M.T.: find the Sun's Declination.
The two declinations preceding are those of the 16th and 17th; the two following are those of the 18th and 19th.

| | |
|---|---|
| June 16th, | 23° 22 3″·5 |
| 17th, | 23 23 57·3 |
| 18th, | 23 25 26·3 |
| 19th, | 23 26 30·6 |
| | 46 48 34·1 |
| | 46 49 23·6 (*greater*) |
| | 2) 49·5 |
| 2d Diff. | 24·75 |

In Table 25, Tabular Interval $24^h$ and $13^h\ 11^m$ give ·124.

This multiplied by 24·75 gives 3″·07, the EQUATION of 2d DIFFS.; which being added to prop. part as found by No. 580, gives DECLIN. required.

By Logs.

| | | |
|---|---|---|
| 24″·75 | p. log. | 2·6400 |
| Log. 9·0925 | ar. co. | 0·9075 |
| | p. log. | 3·5475 |

600. This correction is of the most importance when the quantity attains its *maximum*, that is, arrives at its greatest amount between two times given in the Nautical Almanac. This circumstance is known thus:—When the sum of the vars. in 1 hour opposite the Green. day and the following one is equal to the diff. of the vars. in 1 hour opposite the Greenwich day and the preceding one; for ex. on Dec. 20th, 21st, and 22d, the vars. in 1 hour of the sun are 1″·70, 0″·52, and 0″·66 respectively, hence the declin. is maximum at some time between the noons of the 21st and 22d.

## III. Conversion of Times.

### 1. *Intervals.*

[1.] *To convert an Interval of Mean Time into an Interval of Sidereal Time.*

601. *Approximately.*—Increase the Interval by $1^m$ for every 6 hours, or by $10^s$ for each hour, or by $1^s$ for every $6^m$.

602. *Accurately.*—*Add* to the Interval the *Acceleration* (Table 23), corresponding to the hours, minutes, and seconds.

Ex. 1. (Approximately.) Convert $7^h\ 12^m\ 6^s$ of M.T. into S.T.

| | |
|---|---|
| | $7^h\ 12^m\ 6^s$ |
| $70^s$ and $2^s$ | + 1 12 |
| INTERV. IN SID. T. | 7 13 18 |

Ex. 2. (Accurately.) The same ex. $7^h\ 12^m\ 6^s$

| | | |
|---|---|---|
| $7^h$ | $1^m\ 8^s·99$ | |
| $12^m$ | 1·97 | + 1 10·98 |
| $6^s$ | ·02 | |
| INTERV. IN SID. T. | | 7 13 16·98 |

[2.] *To convert an Interval of Sidereal Time into an Interval of Mean Time.*

603. *Approximately.*—Diminish the Interval by $1^m$ for every 6 hours, or by $10^s$ for each hour, or by $1^s$ for every $6^m$.

604. *Accurately.*—*Subtract* from the Interval the *Retardation** (Table 24), corresponding to the hours, minutes, and seconds.

* Or from corresponding tables in Naut. Almanac.

Ex. 1. (Approximately.) Convert $7^h\ 13^m\ 17^s$ of S.T. into M.T.

| | |
|---|---|
| | $7^h\ 13^m\ 17^s$ |
| $70^s$ and $2^s$ | $-1\ \ 12$ |
| Interv. in M.T. | $7\ \ 12\ \ \ 5$ |

Ex. 2. (Accurately.) The same ex.

| | | |
|---|---|---|
| | | $7^h\ 13^m 17^s$ |
| $7^h$ | $1^m\ 8^s{\cdot}81$ | |
| $13^m$ | $2\ {\cdot}13$ | $-1\ 10\ {\cdot}99$ |
| $17^s$ | ${\cdot}05$ | |
| Interv. in M.T. | | $7\ \ 12\ \ 6\ {\cdot}01$ |

The above precepts relate to *Intervals* of time; the following are employed in the conversion of *absolute time* of one kind into that of another.

## 2. *Absolute Times.*

### [1.] *To convert Apparent Time into Mean Time.*

605. Reduce the Equation of Time, taken from page I. of the Nautical Almanac, or from Table 62 by No. 583, or 584, and apply it to the given App. Time as directed in the said page I. or in Table 62.

If the Eq. of T. when subtractive exceeds the A.T., add $24^h$ to the A.T. and date the time on the day before.

Ex. 1. March 2d, 1902, at $11^h\ 56^m\ 43^s$ A.M., A.T., long. 148° W.: find M.T.

The Green. Date is $2^d\ 9^h\ 49^m$.

| | |
|---|---|
| Eq. T. 2d, | $12^m\ 27^s{\cdot}8$ |
| 3d, | $12\ \ 15\ {\cdot}6$ |
| Daily Var. | $12\ {\cdot}2$ |
| $9^h\ 49^m$, var. $12^s{\cdot}2$ | $-5\ {\cdot}1$ |
| 2d, | $12\ \ 27\ {\cdot}8$ |
| Red. Eq. T. | $+12\ \ 22\ {\cdot}7$ |
| App. T. | $23\ \ 56\ \ 43$ |
| Mean Time, 2d | $0\ \ \ 9\ \ \ 5\ {\cdot}7$ |

Ex. 2. Nov. 10, 1902, $0^h\ 13^m\ 40^s$ P.M., A.T., long. 36° E.: required M.T.

Green. Date, $9^d\ 21^h\ 50^m$.

| | |
|---|---|
| Eq. T. 9th, | $-16^m\ 7^s{\cdot}6$ |
| 10th, | $-15\ \ 2\ {\cdot}7$ |
| Daily Var. | $4\ {\cdot}9$ |
| $21^h\ 50^m$, var. $4^s{\cdot}9$ | $-5\ {\cdot}0$ |
| 9th, | $16\ \ 7\ {\cdot}6$ |
| | $-16\ \ 2\ {\cdot}6$ |
| App. T. | $0\ \ 13\ \ 40\ {\cdot}0$ |
| Mean Time, 9th | $23\ \ 57\ \ 37\ {\cdot}4$ |

### [2.] *To convert Mean Time into Apparent Time.*

606. Find the Green. Date; reduce to it the Eq. of T. from page II. of the Nautical Almanac, or from Table 62, and apply it to the given M.T. as directed in the said page II., or the *contrary way* to that directed in Table 62.

If the Eq of T. when subtractive exceeds the M.T., add $24^h$ to the M.T. and date the time on the day before.

Ex. 1. Aug. 31st, 1902 long. 18° W., $20^h\ 58^m\ 51^s$ M.T.: find A.T.

Green. Date, M.T., $31^d\ 22^h\ 11^m$.

| | |
|---|---|
| Red. Eq. T. | $-0^m\ 11^s{\cdot}1$ |
| M.T, 31st, | $20\ \ 58\ \ 51\ {\cdot}0$ |
| App. Time 31st | $20\ \ 58\ \ 39\ {\cdot}9$ |

Ex. 2. Feb. 17th, 1902, long. 120° E., $0^d\ 5^m\ 18^s$ M.T.: find A.T.

Green. Date, M.T., $16^d\ 16^h\ 5^m$.

| | |
|---|---|
| Red. Eq. T. | $-14^m\ 17^s$ |
| M.T. | $0\ \ 5\ \ 18$ |
| App. Time, 16th | $23\ \ 51\ \ \ 1$ |

### [3.] *To convert Sidereal Time into Mean Time.*

That is, having given the Right Ascension of the Meridian, to find Mean Time.

607. In W. long. *add* the Acceleration for the long. to the Sid. T. at mean noon; in E. long. *subtract* it.

From the given Sid. Time (increased if necessary by $24^h$) sub-

tract this reduced Sid. T. at the preceding noon; the remainder is the approximate M. T.; subtract from this time the Retardation corresponding (Table 24).

**Ex. 1.** Jan. 1st. 1878, long. $9^h\ 50^m\ 40^s$ E., at $21^h\ 9^m\ 23^s$ Sid. T.: find M.T.

| | | |
|---|---|---|
| Sid. T. M. Noon, | | $18^h\ 44^m\ 0^s{\cdot}7$ |
| Accel. $9^h$ | $1^m\ 28^s{\cdot}7$ | |
| $50^m$ | $8{\cdot}2$ | $-\ 1\ 37{\cdot}0$ |
| $40^s$ | $\cdot 1$ | |
| Sid. T. M. Noon, | | $18\ 42\ 23{\cdot}7$ |

| | | |
|---|---|---|
| Given Sid. T. | | $21^h\ 9^m\ 23^s{\cdot}0$ |
| Red. Sid. T. M. Noon, | | $18\ 42\ 23{\cdot}7$ |
| Approx. M.T. | | $2\ 26\ 59{\cdot}3$ |
| Ret. $2^h$ | $19^s{\cdot}7$ | |
| $26^m$ | $4{\cdot}3$ | $-24{\cdot}2$ |
| $59^s$ | $0{\cdot}2$ | |
| MEAN TIME, | | $2\ 26\ 35{\cdot}1$ |

**Ex. 2.** March 22d, 1878, long. $7^h\ 22^m\ 35^s$ W., at $11^h\ 5^m\ 27^s{\cdot}2$ Sid. T.: find M.T.

The RED. SID. T. is $0^h\ 0^m\ 37^s{\cdot}9$; whence the approx. M.T. is $11^h\ 4^m\ 49^s{\cdot}3$, and the Ret. to this $1^m\ 48^s{\cdot}9$ *sub.* leaves MEAN TIME $11^h\ 3^m\ 0^s{\cdot}4$.

[4.] *To convert Mean Time into Sidereal Time.*

That is, having given the Mean Time, to find the R.A. of the Meridian.

608. In W. long. *add* the Acceleration for the long. to the Sid. T. at the preceding mean noon; in E. long. *subtract* it.

To this reduced Sid. T. at mean noon add the given M. T. and the Acceleration for the said M.T.; the result (rejecting $24^h$ if it exceed $24^h$) is the Sid. T. required.

Ex. 1. June 29th, 1878, long. $10^h\ 39^m\ 6^s$ W., at $3^h\ 37^m\ 46^s{\cdot}6$ M.T.: find Sid. T.

| | | |
|---|---|---|
| Sid. T. at M. Noon, 29th, | | $6^h\ 29^m\ 44^s{\cdot}3$ |
| Accel. for long. $10^h\ 39^m\ 6^s$ | | $+\ 1\ 45{\cdot}0$ |
| Red. S.T. M. Noon, | | $6\ 31\ 29{\cdot}3$ |
| M.T. | | $3\ 37\ 46{\cdot}6$ |
| Accel. $3^h$ | $29^s{\cdot}6$ | |
| $37^m$ | $6{\cdot}1$ | $+\ 35{\cdot}8$ |
| $47^s$ | $\cdot 1$ | |
| SID. TIME, | | $10\ 9\ 51{\cdot}7$ |

**Ex. 2.** Nov. 26th, 1878, long. $8^h\ 52^m\ 15^s$ E., at $14^h\ 55^m\ 7^s{\cdot}8$ M.T.: find S.T.

| | | |
|---|---|---|
| Sid. T. M. Noon, 26th, | | $16^h\ 21^m\ 7^s{\cdot}6$ |
| Accel. for $8^h\ 52^m\ 15^s$ | | $-\ 1\ 27{\cdot}4$ |
| Red. S.T. at M. Noon, | | $16\ 19\ 40{\cdot}2$ |
| M.T. | | $14\ 55\ 7{\cdot}8$ |
| Accel. $14^h$ | $2^m\ 18^s{\cdot}0$ | |
| $55^m$ | $9{\cdot}0$ | $+2\ 27{\cdot}0$ |
| $7^s{\cdot}8$ | $\cdot 0$ | |
| | | $31\ 17\ 15{\cdot}0$ |
| SID. TIME, | | $7\ 17\ 15{\cdot}0$ |

## IV. HOUR-ANGLES.

### 1. *To find the Hour-angle, Mean Time being given.*

[1.] *Hour-angle of the Sun.*

609. Find the Green. Date; Reduce to it the Eq. of T., and apply it to the M.T. as directed page II. of the Nautical Almanac, or the contrary way to that directed in Table 62; the result is A.T.

If A.T. is less than $12^h$, it is the Sun's Hour-angle, reckoning from the meridian westwards; if A.T. exceed $12^h$, subtract it from $24^h$: the remainder is the Hour-angle, reckoning from the meridian eastwards

Ex. 1. May 19th, 1878, long. 57° 4′ W., at $3^h\ 7^m\ 46^s$ M.T.: find the Sun's Hour-angle.

The Green. Date is $19^d\ 6^h\ 56^m\ 2^s$.

| | |
|---|---|
| Eq. T. 19th, Page II. | $+3^m\ 45^s{\cdot}3$ |
| 20th, | $+3\ \ 42{\cdot}5$ |
| | $2{\cdot}8$ |
| $6^h\ 56^m$, var. $2^s{\cdot}8$ | $-{\cdot}8$ |
| | $3\ \ 45{\cdot}3$ |
| Red. Eq. T. | $+3\ \ 44{\cdot}5$ |
| M.T | $3\ \ 7\ \ 46{\cdot}0$ |
| Hour-angle, | $3\ \ 11\ \ 30{\cdot}5$ |

Ex. 2. July 2d, 1878, long. 62° 1 E., at $20^h\ 26^m\ 53^s$ M.T.: find the Sun's Hour-angle.

The Green. Date is $2^d\ 16^h\ 18^m\ 49^s$.

| | |
|---|---|
| Eq. T. 2d, Page II. | $3^m\ 43^s{\cdot}9$ |
| 3d, | $3\ \ 55{\cdot}1$ |
| Daily Var. | $11{\cdot}2$ |
| $16^h\ 19^m$, var. $11^s{\cdot}2$ | $+7{\cdot}7$ |
| | $3\ \ 43{\cdot}9$ |
| Sub. from M.T. | $3\ \ 51{\cdot}6$ |
| M.T. | $20\ \ 26\ \ 53{\cdot}0$ |
| | $20\ \ 23\ \ 1{\cdot}4$ W. |
| Hour-angle, | $3\ \ 36\ \ 58{\cdot}6$ E. |

610. When the Sun's Hour-angle is required from midnight, if A.T. is less than $12^h$, subtract it from $12^h$; the remainder is the Hour-angle, reckoned westwards. If A.T. exceed $12^h$, subtract $12^h$ from it; the remainder is the Hour-angle, reckoned eastwards.

### [2.] *Hour-angle of a Star.*

611. (1.) Find the Green. Date, to which reduce the Sid. T. at mean noon.

(2.) To the M.T. add this reduced Sid. T., and from the sum (increased if necessary by $24^h$) subtract the star's R.A.; the result is the Hour-angle W.

If the Hour-angle exceed $12^h$, subtract it from $24^h$; the remainder is the Hour-angle E.

Ex. 1. July 21st, 1878, long. 32° 10′ W., at $9^h\ 45^m\ 21^s$ M.T.: required the Hour-angle of Arcturus.

Green. Date, $21^d\ 11^h\ 54^m\ 1^s$.

| | |
|---|---|
| Sid. T. Mean Noon, 21st, | $7^h\ 56^m\ 28^s{\cdot}5$ |
| Accel. $11^h$, | $1\ \ 48{\cdot}4$ |
| $54^m$, | $8{\cdot}9$ |
| Red. Sid. T. | $7\ \ 58\ \ 25{\cdot}8$ |
| M.T. | $9\ \ 45\ \ 21{\cdot}0$ |
| | $17\ \ 43\ \ 46{\cdot}8$ |
| ✱ R.A. | $14\ \ 10\ \ 8{\cdot}4$ |
| Hour-angle, | $3\ \ 33\ \ 38{\cdot}4$ |

Ex. 2. Sept. 1st, 1878, long. 169° 57′ E. at $8^h\ 57^m\ 39^s$ M.T.: find the Hour-angle of Altair.

Green. Date, Aug. $31^d\ 21^h\ 37^m\ 51^s$.

| | |
|---|---|
| Sid. T. at M. Noon, 31st, | $10^h\ 38^m\ 7^s{\cdot}3$ |
| Accel. $21^h$, | $3\ \ 27{\cdot}0$ |
| $37^m$, | $6{\cdot}1$ |
| $51^s$, | ${\cdot}1$ |
| Red. Sid. T. | $10\ \ 41\ \ 40{\cdot}5$ |
| M.T. | $8\ \ 57\ \ 39{\cdot}0$ |
| | $19\ \ 39\ \ 19{\cdot}5$ |
| ✱ R.A. | $-19\ \ 44\ \ 53{\cdot}5$ |
| | $23\ \ 54\ \ 26{\cdot}0$ W. |
| Hour-angle, | $0\ \ 5\ \ 34{\cdot}0$ E. |

Ex. 3. Oct. 1st, 1878, long. 92° 48′ E., at $5^h\ 58^m\ 19^s$ M.T.: required the Hour-angle of Markab. Hour-angle, $4^h\ 20^m\ 7^s{\cdot}8$ E.

Ex. 4. Dec. 25th, 1878, long. 86° 45′ W., at $5^h\ 7^m\ 35^s$ M.T.: find Rigel's Hour-angle. Hour-angle, $5^h\ 43^m\ 55^s$ E.

Ex. 5. March 22d, 1878, long. 110° 39′ W., at $11^h\ 3^m\ 37^s$ M.T.: find the Hour-angle of Antares. Hour-angle, $5^h\ 15^m\ 53{\cdot}9^s$ E.

### [3.] *Hour-angle of a Planet or the Moon.*

612. (1.) Find the Green. Date, and reduce thereto the Sid. T. at mean noon, and the R.A. of the body.

(2.) Add this reduced Sid. T. to the M.T., and proceed as for a star.

Ex. 1. Oct. 15th, 1878, long. 41° 44′ W., at $6^h\ 56^m\ 54^s$ P.M. M.T.: find the Moon's Hour-angle.

Green. Date, Oct. $15^d\ 9^h\ 43^m\ 50^s$.

| | | | |
|---|---|---|---|
| Sid. T. Mean Noon, 15th. | | | $13^h\ 35^m\ 32^s.2$ |
| Accel. $9^h$ | | | 1 28 .7 |
| $43^m$ | | | 7 .1 |
| $50^s$ | | | .1 |
| Red. Sid. T. | | | 13 37 8 .1 |
| ☾'s R.A. $9^h$ | $4\ 40^m\ 20^s.5$ | | |
| $10^h$ | 4 42 37 .5 | | 9.5229 |
| | 2 17 | | 1.8967 |
| | 43 50 | | 0.6135 |
| | 1 39 .9 | | 2.0331 |
| ☾'s R.A. $9^h$ | 4 40 20 .5 | | |
| Red. R.A. | 4 42 0 .4 | | |
| Red. Sid. T. | | $13^h\ 37^m\ 8^s.1$ | |
| M.T. | | 6 56 54 | |
| | | 20 34 2 .1 | |
| ☾'s R.A. | | −4 42 0 .4 | |
| | | 15 52 1 .7 W. | |
| Hour-angle, | | 8 7 58 .3 E. | |

Ex. 2. Feb. 11th, 1878, long 87° 6′ W., at $4^h\ 46^m\ 48^s$ A.M. M.T.: find the Hour-angle of Mars.

Green. Date, Feb. $10^d\ 22^h\ 35^m\ 12^s$.

| | | | |
|---|---|---|---|
| Sid. T. Mean Noon, 10th | | | $21^h\ 21^m\ 43^s.0$ |
| Accel. $22^h$ | | | 3 36 .8 |
| $35^m$ | | | 5 .8 |
| Red. Sid. T. | | | 21 25 25 .6 |
| Mars' R.A. 10th | $2^h\ 15^m\ 57^s.0$ | | |
| 11th, | 2 18 22 .2 | | |
| Daily Var. | 2 25 .2 | | |
| $22^h\ 35^m$ var. $2^m\ 25^s$ gives | | | 2 17 .1 |
| R.A. 10th | | | 2 15 57 .0 |
| Red. R.A. | | | 2 18 14 .1 |
| Red. Sid. T. | | $21^h\ 25^m\ 25^s.6$ | |
| M.T. | | 4 46 48 .0 | |
| | | 26 12 13 .6 | |
| Mars' R.A. | | −2 18 14 .1 | |
| | | 23 53 59 .5 W. | |
| Hour-angle, | | 0 6 0 .5 E. | |

## 2. *To find the Hour-angle, the Altitude being given.*

613. *By Inspection.* See Explan. of Table 5.

614. *By Computation.* Add together the alt., lat., and pol. dist., take half the sum, and from it subtract the alt.

Add together the log. sec. of the lat., the log. cosec. of the pol. dist., the log. cos. of the half sum, and the log. sine of the remainder; the sum (rejecting tens) is the log. sine square of the Hour-angle.*

*Note.*—When the Hour-angle is less than $2^h$, four places of the logarithms give it to the nearest second of time.

Ex. 1. Alt. 37° 51′, lat. 51° 10′ N., pol. dist. 70° 33′, or decl. 19° 27′ N.: find the Hour-angle. See Ex. 1, of No. 615.

| | | | |
|---|---|---|---|
| Alt. | 37° 51′ | | |
| Lat. | 51 10 | .. sec. | 0.20269 |
| Pol. dist. | 70 33 | ... cosec. | 0.02552 |
| Sum | 159 34 | | |
| Half | 79 47 | ... cos. | 9.24888 |
| Rem. | 41 56 | ... sin. | 9.82495 |
| Hour-angle | $3^h\ 32^m\ 47^s$ | sin. sq. | 9.30204 |

Ex. 2. Alt. 21° 19′ 5″, lat. 51° 9′ 26″ N. decl. 11° 14′ 44″ S.: find the Hour-angle.

| | | | | |
|---|---|---|---|---|
| Alt. | 21° 19′ 5″ | | | Pts. for ″ |
| Lat. | 51 9 26 | ... sec. | 0.202536, | + 78 |
| P. dist. | 101 14 44 | ... cosec. | 0.008414, | + 6 |
| | 173 43 15 | | | |
| | 86 51 37 | ... cos. | 8.738820, | −277 |
| | 65 32 32 | ... sin. | 9.959167, | + 2 |
| | | | 8.908937 | |
| | | | −201 | |
| | | * sin. sq. | 8.908736 | |
| | | $2^h\ 12^m\ 19^s$ | 707 | |
| | | .3 | 29 | |
| Hour-angle | 2 12 19.3 | | | |

Ex. 3. Lat. 30° 11′ 24″ N. Decl. 14° 2′ 46″ N. Alt. 61° 9′ 17″. Hour-angle $1^h\ 43^m\ 52^s$.

When both the lat. and decl. are 0, the zenith distance in time is the measure of the Hour-angle.

At sea it is near enough to take the alt., lat., and pol. dist., to the nearest minute; but if the sum is *odd* and greater that 170°, take the cos. and sin. to 30″, because the neglect of this may make a sensible error in the Hour-angle.

* Log. sine square, Table 69, is the same as the log. haversine of Inman's Tables.

[1.] *Errors of the Hour-Angle.*

**615.** The following rules give, very nearly, the effect of 1′ error in the alt., lat., and pol. dist., and therefore for any small number of min. or sec. in the like proportion :—

(1.) Error of hour-angle, or time, due to 1′ error of alt.* Add together the parts for 30″ of the cos. and sine: the sum, divided by the parts for 1ˢ (Tab. 69), gives the error required.

When the alt. is too *small*, the hour-angle is too *great;* when the alt. is too *great*, the hour-angle is too *small.*

(2.) Error of hour-angle, or time, due to 1′ error of lat.† Multiply the parts for 30″ of the sec. by 2, and add the parts for the sine; under the sum put the parts for 30″ of the cos., and take the diff.; divide this diff. by the parts for 1ˢ.

When the lat. and true bearing are of the *same* names, the errors of the hour-angle and lat. are of the *same* kind; when of *contrary* names, of *contrary* kinds.

Ex. In N. Lat., if the sun is to the N. of E. or W., and the Lat. employed is too *great*, the computed hour-angle will be too *great;* if the sun is to the S., in the same case, too *small.*

(3.) Error of time, or hour-angle, due to 1′ error of pol. dist. Multiply the parts for 30″ of the cosec. by 2, and add the parts for 30″ of the cos.; under the sum put the parts for 30″ of the sine; take the diff., and divide it by the parts for 1ˢ.

When the parts for 30″ of the sine are *less* than the sum over them, the error of the hour-angle is of the *contrary* kind to that of the pol. dist.; when *greater*, of the *same* kind.

Ex. See Ex. 1, of No. 614.

| Parts for 30″. | Error 1 of Alt. | Error 1′ of Lat. | Error 1 of Pol. Dist. |
|---|---|---|---|
| 51° 10′ sec. 78 | Cos. 354 | Sec. 78 | Cosec. 22 |
| 70 33 cosec. 22 | Sin. 71 | ×2 | ×2 |
| 79 47 cos. 354 | (Sum) 425 | 156 | 44 |
| 41 56 sin. 71 | Error of Time | Sin. 71 | Cos. 354 |
| Parts for | $=\frac{425}{64}=7^s$ | (Sum) 227 | (Sum) 398 |
| 1ˢ table 69 p. 830 } 64 | | Cos. 354 | Sin. 71 |
| | | (Diff.) 127 | (Diff.) 327 |
| | | Error of Time | Error of Time |
| | | $=\frac{127}{64}=2^s$ | $=\frac{327}{64}=5^s$ |

The error of the hour-angle may, possibly, be made up of the *sum* of these three errors, but in most cases they will partially compensate.

---

* To find, approximately, the small interval of time corresponding to a small change of alt. by means of the Azimuth :—Add together the log. sine of the change of alt., the log. cosec. of the azim., and the log. sec. of the lat.: the sum (rejecting tens) is the log. sine of the interval required.

To find the same, by means of the Hour-angle :—Add together the log. sine of the change of alt., the log. sec. of the lat. and declin., the log. cos. of the alt., and the log. cosec. of the hour-angle: the sum is the log. sine, as above.

One of these processes may, on some occasions, be convenient.

† To find this error by means of the Azimuth :—Add together the log. cot. of the azim., the log. sec. of the alt., and the log. sine of the error of lat.: the sum is the log. sine of the error required.

### 3. *To find the Hour-angle, the Azimuth being given.*

616. Add together the log. sine of the azimuth, the log. cos. of the lat., and the log. sec. of the decl.; the sum (rejecting tens) is the log. sine of the angle A.*

Under A put the azimuth, reckoned from the elevated pole, and take half the sum.

Take half the sum of the pol. dist. and colat., and half the diff.

Add together the log. tan. of the half sum of A and the azim., the log. cos. of the half sum of the p. dist. and colat., and the log. sec. of the half diff.; the sum (rejecting tens) is the log. cot. of an arc.

When each half sum is less, or greater, than 90°, twice this arc is the Hour-angle required; but if one only of the half sums exceed 90°, twice the suppl. of the arc is the Hour-angle.

Ex. Lat. 51° 30′ N., decl. 20° 2′ N., azim. N. 110° 21′ W.: find the Hour-angle.

| | | | |
|---|---|---|---|
| Az. | 110° 21′ | sin. | 9·97201 |
| Lat. | 51 30 | cos. | 9·79415 |
| Decl. | 20 2 | sec. | 0·02711 |
| A | 38 25 | sin. | 9·79327 |
| Az. | 110 21 | | |
| Sum | 148 46, half 74° 23′ | | |

| | | | | | |
|---|---|---|---|---|---|
| P. Dist. | 69° 58′ | | | | |
| Colat. | 38 30 | | 74° 23′ | tan. | 0·55359 |
| Sum | 108 28 | half | 54 14 | cos. | 9·76677 |
| Diff. | 31 28 | do. | 15 44 | sec. | 0·01658 |
| | | | 1ʰ 38ᵐ 52ˢ | cot. | 0·33694 |
| | | | 2 | | |
| | | Hour-angle, | 3 17 44 | | |

### 4. *To find the Hour-angle, the Altitude and Azimuth being given.*

617. Add together the log. sine of the azim., the log. cos. of the alt., and the log. sec. of the decl.; the sum (rejecting tens) is the log. sine of the Hour-angle.

Ex. Alt. 40° 25′, azim. 69° 39′, decl. 20° 2′: required the Hour-angle.

| | | | |
|---|---|---|---|
| Az. | 69° 39′ | sin. | 9·97201 |
| Alt. | 40 25 | cos. | 9·88158 |
| Decl. | 20 2 | sec. | 0·02711 |
| Hour-angle, | $3^h\ 17^m\ 48^s$ | sin. | 9·88070 |

### 5. *To find the Hour-angle on the Prime Vertical.*

618. *By Inspection.* See Table 29.

619. *By Computation.* Add together the log. cot. of the lat. and the log. tan. of the decl.; the sum (rejecting tens) is the log. cos. of the Hour-angle.

Ex. Lat. 31° 28′, Decl. 14° 11′ of the same name: find the Hour-angle of a celestial body on the prime vertical.

| | | | |
|---|---|---|---|
| Lat. | 31° 28′ | cot. | 0·21325 |
| Decl. | 14 11 | tan. | 9·40266 |
| Hour-angle, | $4^h\ 22^m\ 26^s$ | cos. | 9·61591 |

### 6. *To find the Hour-angle at Rising or Setting.*

620. *By Inspection.* When the decl. is less than 24°, take out of

* This angle A is the angle at the body contained between its pol. dist. and zen. dist., or the angle P A Z, fig. p. 162.

Table 26 the *time of setting*; this is the Hour-angle required. It is called also the Semidiurnal arc.

When the decl. exceeds 24°, see No. 621, or Explan. of Table 5.

621. *By Computation.* Add together the log. tangents of the lat. and decl.; the sum (rejecting tens) is the log. cos. of the Hour-angle at rising or setting, or its supplement.

When the lat. and declin. are of the *same* name, take the *supplement*; when of *contrary* names the Hour-angle is that taken out.

Ex. 1. Lat. 48° 42′ N. decl. 20° 11′ N.: find the Hour-angle at rising or setting.

| | | |
|---|---|---|
| Lat. 48° 42′ | tan. 0·0562 | |
| Decl. 20 11 | tan. 9·5654 | |
| $4^h\ 21^m\ 4^s$ | cos. 9·6216 | |
| HOUR-ANGLE, 7 38 56 | | |

Ex. 2. Lat. 31° 10′ N. decl. 11° 14′ S.: find the Hour-angle at rising or setting.

| | | |
|---|---|---|
| Lat. 31° 10′ | tan. 9·7816 | |
| Decl. 11 14 | tan. 9·2980 | |
| HOUR-ANGLE, $5^h\ 32^m\ 24^s$ | cos. 9·0796 | |

### 7. *To find the Hour-angle near the Meridian, by the observed Change of Altitude.*

622. The alts. must be on the same side of the meridian.

Correct the diff. of alts. and the interval by adding the correction in the following table:—

| TIME. | | | | ARC. | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 12m | 0s | 43m | 15s | 1° 0′ | 0′ 0″ | 6° 15′ | 0′ 44″ | 10° 45′ | 3′ 51″ |
| 13 | 1 | 44 | 16 | 30 | 0 1 | 30 | 0 50 | 11 0 | 4 7 |
| 20 | 1 | 45 | 18 | 2 0 | 0 2 | 45 | 0 56 | 15 | 4 25 |
| 23 | 2 | 46 | 19 | 30 | 0 3 | 7 0 | 1 3 | 30 | 4 43 |
| 25 | 3 | 47 | 20 | 45 | 0 4 | 15 | 1 10 | 45 | 5 2 |
| 26 | 3 | 48 | 21 | 3 0 | 0 5 | 30 | 1 17 | 12 0 | 5 21 |
| 28 | 4 | 49 | 23 | 15 | 0 6 | 45 | 1 25 | 15 | 5 42 |
| 30 | 5 | 50 | 24 | 30 | 0 8 | 8 0 | 1 34 | 30 | 6 4 |
| 32 | 6 | 51 | 26 | 45 | 0 10 | 15 | 1 44 | 45 | 6 27 |
| 33 | 7 | 52 | 27 | 4 0 | 0 12 | 30 | 1 53 | 13 0 | 6 51 |
| 34 | 7 | 53 | 29 | 15 | 0 14 | 45 | 2 3 | 15 | 7 15 |
| 35 | 8 | 54 | 31 | 30 | 0 17 | 9 0 | 2 14 | 30 | 7 41 |
| 36 | 9 | 55 | 32 | 45 | 0 20 | 15 | 2 26 | 45 | 8 8 |
| 37 | 10 | 56 | 34 | 5 0 | 0 23 | 30 | 2 39 | 14 0 | 8 36 |
| 38 | 11 | 57 | 36 | 15 | 0 27 | 45 | 2 52 | 15 | 9 4 |
| 40 | 12 | 58 | 38 | 30 | 0 31 | 10 0 | 3 16 | 30 | 9 34 |
| 41 | 13 | 59 | 40 | 45 | 0 35 | 15 | 3 20 | 45 | 10 5 |
| 42 | 14 | 60 | 42 | 6 0 | 0 39 | 30 | 3 34 | 15 0 | 10 37 |

Add together the log. sin. of the diff. alts. (thus corrected), the log. cosec. of the interval (corrected), the log. sec. of the declin., the log. cos. of the mean of the two alts., and the log. sec. of the lat.: the sum (rejecting tens) is the log. sine of the hour-angle at the middle of the interval, nearly.

To find the hour-angle for the alt. *nearest* the meridian, *subtract* half the interval from this hour-angle. To find the hour-angle for the alt. *furthest* from the meridian, *add* half the interval to the hour-angle found.

*Note.*—If the alts. are not measured, the merid. alt., deduced from the lat. by acc. figures No. 452, may be employed, recollecting that this alt. is always somewhat *too great*, except when below the pole, when it is too small.

Ex. 1. Lat. 51° 30′ N., decl. 22° 20′ N., obtained tr. alts. 60° 27′ 52″ and 60° 34′ 35″, or diff. alts. 6′ 43″ at an interval of 4ᵐ: find the Hour-angle at the time of the alt. nearest the meridian.

| | | | |
|---|---|---|---|
| D. Alt. 6′ 43″ | (no corr.) | sin. | 7·2909 |
| Int. 4ᵐ | (do) | cosec. | 1·7581 |
| Decl. | 22° 20′ | sec. | 0·0339 |
| Mean Alt. | 60 31 | cos. | 9·6921 |
| Lat. | 51 30 | sec. | 0·2058 |
| Mid. Int. | 0ʰ 21ᵐ 58ˢ | sin. | 8·9808 |
| ½ Int. | −2 | | |
| Hour-angle | 19 58 | | |

Ex. 2. Lat 40° N., decl 20° N., obtained tr. alts. 69° 58′ and 67° 0′, or diff. alt. 2° 58′, with interv. of 47ᵐ 39ˢ: find the Hour-angle at the time of the alt. furthest from the meridian.

| | | | |
|---|---|---|---|
| D. Alt. | 2° 58′ 0″ | Int. | 47ᵐ 39ˢ |
| Corr. | +5 | Corr. | +21 |
| | 2 58 5 | | 48 0 |
| D. Alt. | 2° 58′ 5″ | sin. | 8·7142 |
| Int. | 48ᵐ 0ˢ | cosec. | 0·6821 |
| Decl. | 20° 0′ | sec. | 0·0270 |
| Mean Alt. | 68 29 | cos. | 9·5644 |
| Lat. | 40 0 | sec. | 0·1157 |
| Mid. T. | 29ᵐ 10ˢ | sin. | 9·1034 |
| ½ Int. | +23 49 | | |
| Hour-angle | 52 59 | (only 2ˢ too small.) | |

The degree of dependence is chiefly to be estimated from the effect produced by a small change in the diff. alts.

For finding by an easy operation the apparent local time from an observed altitude, Davis's "Chronometer" Tables (J. D. Potter, London, 10*s*. 6*d*) will be found of service; they also make clear the effect and direction of any small error in the observer's latitude.

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## V. Times of certain Phenomena.

### 1. *Time of Passing the Meridian.*

#### [1.] *Meridian Passage of the Sun.*

623. The *Apparent Time* of the sun's meridian passage is 0ʰ 0ᵐ 0ˢ except below the pole, when it is 12ʰ 0ᵐ 0ˢ.

624. To find the *Mean Time* of the meridian passage:—

Take the Eq. of T. from page I. of the Nautical Almanac, or from Table 62; reduce it for the long. as the Green. Date. Then, if the reduced Eq. of T. is *additive* to A.T., it is the time P.M. of the sun's meridian passage. If the Eq. of T. be *subtractive* from A.T., *subtract* it from 12ʰ: the remainder is the M.T. of passage.

Ex. 1. March 31st, 1902, long. 140° W.: find Mean Time of Sun's meridian passage.

| | | |
|---|---|---|
| Eq. T. 31st, | | +4ᵐ 28ˢ·3 |
| 32d, | | +4 10 ·1 |
| Daily Var. | | 18 ·2 |
| Long. 9ʰ 20ᵐ, var. 18ˢ·2 | | −7 ·0 |
| | | 4 28 ·3 |
| Red. Eq. T. *add* to A.T. | | 4 21 ·3 |
| M.T. of M. Pass. 12ʰ 4ᵐ 21ˢ 3. | | |

Ex. 2. Dec. 1st, 1902, long. 93° E.: find Mean Time of Sun's meridian passage.

| | |
|---|---|
| Green. Date, Nov, 30ᵈ 17ʰ 48ᵐ. | |
| Eq. T. 30th, | −11ᵐ 29ˢ·1 |
| 31st, | −11 7 ·3 |
| Daily Var. | 21 ·8 |
| 17ʰ 48ᵐ, var. 21ˢ·8 | −16 ·4 |
| | 11 29 ·1 |
| Red. Eq. T. | −11 12 ·7 |
| M.T. of Pass. 11ʰ 48ᵐ 47ˢ·3. | |

#### [2.] *Meridian Passage of a Star.*

625. To find the *Apparent Time* of a star's meridian passage:—
*At Sea.*—See Table 27, and Explanation.

Or, from the R.A. of the star (adding $24^h$ if necessary) subtract the R.A. of the sun at noon, Nautical Almanac, page I., or deduced from Sidereal Time in Table 61 (*see* Note, page 211); the remainder is the A.T. required.

Ex. 1. Oct. 17, 1902: find A.T. of the Mer. Pass. of Sirius.

| By Table 27. | | By Sun's R.A. | |
|---|---|---|---|
| Oct. 1st, | $18^h\ 14^m$ | R.A. Sirius | $6^h\ 41^m$ |
| For 17 days | 59 | Oct. 17th. ☉'s R.A. | 13 26 |
| Mer. Pass. | 17 15 P.M. | Mer. Pass. | 17 15 P.M. |
| Or 18th, | 5 13 A.M. | Or 18th, | 5 13 A.M. |

Ex. 2. Find the A.T. of the Mer. Pass. of $\alpha$ Urs. Maj., above and below the Pole, on Feb. 11th, 1902. Ans. $1^h\ 19^m$ A.M.; $1^h\ 17^m$ P.M.

Ex. 3. Find A.T. of Mer. Pass. of Capella on July 20th, 1902. Ans. $9^h\ 11^m$ A.M.; $9^h\ 9^m$ P.M.

626. To find the *Mean Time* of a star's meridian passage:—

*Accurately.*—From the R.A. of the star (increased, if necessary, by $24^h$) subtract the Sid. T. at mean noon on the day: the remainder is the approx. M.T. of transit.

Subtract from this the Retardation, Table 24.

In W. Long. *subtract* from this result the Acceleration for the Long. In E. Long. *add* the Acceleration.

The result is the M.T. of meridian passage.

Ex. 1. Jan. 1st, 1902, long. 1° 25′ W.: find M.T. of Mer. Pass. of Aldebaran.

| | | | |
|---|---|---|---|
| R.A. Aldebaran | | | $4^h\ 30^m\ 17^s{\cdot}8$ |
| Sid. T. Mean Noon | | | $-18\ 40\ 48\cdot5$ |
| | | | $9\ 49\ 29\cdot3$ |
| Ret. $9^h$ | $1^m\ 28^s{\cdot}7$ | | |
| $49^m$ | $8\cdot0$ | | $-1\ 36\cdot8$ |
| $29^s$ | $\cdot1$ | | |
| 1° 25′ W., or $5^m\ 40^s$ | | | $-\cdot9$ |
| M.T. Mer. Pass. | | | $9\ 47\ 51\cdot6$ |

Ex. 2. May 22d, 1902, long. 131° 11′ E.: find M.T. of Mer. Pass. of Spica.

| | |
|---|---|
| R.A. Spica | $13^h\ 20^m\ 4^s{\cdot}6$ |
| Sid. T. Mean Noon | $3\ 56\ 42\cdot6$ |
| | $9\ 23\ 22\ 0$ |
| Ret. $9^h\ 23^m\ 22^s$ | $-1\ 32\cdot6$ |
| | $9\ 21\ 49\cdot4$ |
| Long. $8^h\ 44^m\ 44^s$ | $+1\ 26\cdot2$ |
| M.T. of Pass. | $9\ 23\ 15\ 6$ |

Ex. 3. Aug. 8th, 1902, long. 90° 15′ E.: find M.T. of Mer Pass. of Altair. Ans. $10^h\ 41^m\ 3^s{\cdot}4$.

Ex 4. Feb. 1st, 1902, long. 172° 34′ W.: find M.T. of Mer. Pass. of Regulus. Ans. $13^h\ 16^m\ 5^s{\cdot}0$.

Ex. 5. Oct. 1st, 1902, long. 90° 48′ E.: find M.T. Mer. Pass. of Markab. Ans. $10^h\ 22^m\ 6^s{\cdot}1$.

[3.] *Meridian Passage of the Moon.*

627. This is required only approximately.

In W. Long. take from the Naut. Almanac the diff. between the Mer. Pass. of the proposed day and the next (given in *mean time* to $0^m\cdot1$). In E. Long. take the diff. between that for the proposed day and the day before. The diff. is the daily variation.

Take from Table 28 the correction corresponding to the daily variation and longitude. In W. Long. add this corr. to the time of

mer. pass. on the given day; in E. Long. subtract it; the result is the time required.

When one mer. pass. has 23h, and the next 0h, 24h must be added to the latter in finding the Daily Variation.

Ex. 1. Find Mer. Pass. of ☾ Jan. 16th, 1878, long. 46° W.

| | |
|---|---|
| Mer. Pass. 16th, | 10h 9m·1 |
| 17th, | 11 11 ·6 |
| Daily Var. | 1 2 ·5 |
| 46° W. var. 62m·5 | +7 ·6 |
| | 10 9 ·1 |
| Mer. Pass. | 10 16 ·7 |

Jan. 16th, at 10h 16m·7 P.M.

Ex. 2. July 24th, 1878, long. 130° E.: find the Mer. Pass. of the Moon.

| | |
|---|---|
| Mer. Pass. | 23d 19h 1m·8 |
| | 22 18 14 ·1 |
| Daily Var. | 47 ·7 |
| 130° E. var. 47m·7 | −16 ·8 |
| | 23 19 1 ·8 |
| Mer. Pass. | 23 18 45 ·0 |

July 24th, at 6h 45m A.M.

628. As the lunar day, or the interval between the moon's mer. pass. and her return to the same meridian again, exceeds 24 hours or a mean solar day, an entire day passes at certain intervals without a lunar transit. For ex.:—

The moon passes the meridian on the 3d, at 23h 50m, or 10m before the noon concluding the 3d. The lunar day being, at least, 40m longer than the mean solar day, the moon will not have reached the merid. by about 30m at next noon, or that concluding the 4th; she accordingly passes the merid. about 0h 30m on the 5th, having skipped the 4th altogether

There may thus be no mer. pass. on the day proposed.*

Ex. 1. March 3rd, 1878, long. 21° W.: find the Moon's Mer. Pass.

| | |
|---|---|
| Mer. Pass. | 2d 23h 44m·1 |
| | 3 * * |
| | 4 0 23 ·5 |
| Daily Var. | 39 ·4 |
| Long. 21° W. var. 39m·4 | +2 ·0 |
| | 2 23 44 ·1 |
| Mer. Pass. | 2 23 46 ·1 |

March 3rd at 11h 46m·1 A.M.

Ex. 2. October 26th, 1878, long. 38° E.: find the Moon's Mer. Pass.

| | |
|---|---|
| Mer. Pass. | 26d 0h 7m·7 |
| | 25 * * |
| | 24 23 10 ·2 |
| Daily Var. | 57 ·5 |
| Long. 38° E., var. 57m·5 | 5 ·7 |
| | 26 0 7 ·7 |
| Mer. Pass. | 26 0 2 ·0 |

October 26th, at 0h 2m P.M.

In W. Long., when the sum of the corr. and mer. pass. exceeds 24h, subtract 24h, and reckon the time on the next day. In E. long., when the corr. exceeds the time of mer. pass., add 24h to the latter, and reckon the time on the day before.

Ex. 1. Suppose Ex. 1 above, the long. to be 170° W.

| | |
|---|---|
| Long. 170° W. var. 39m·4 | +18m·0 |
| | 2d 23 44 ·1 |
| Mer. Pass. | 3 0 2 ·1 |

March 3rd, at 0h 2m·1 P.M.

Ex. 2. Suppose Ex. 2 above, the long to be 90° E.

| | |
|---|---|
| Long. 90° E., var. 57m·5 | −13m·7 |
| | 26d 0h 7 ·7 |
| Mer. Pass. | 25 23 54 |

October 26th, at 11h 54m A.M.

---

* This occurs about the time of conjunction with the sun, and the day skipped is marked ☌ in the Nautical Almanac. In like manner a day is skipped at the *lower* transit (under the pole) at opposition.

[4.] *Meridian Passage of a Planet.*

629. The meridian passages of the planets, like those of the moon, are given in the Nautical Almanac to $0^{m}\cdot1$ of mean time.

A planet, of which the R.A. increases faster than that of the sun, skips a day at conjunction, as observed in No. 628 of the moon. On the other hand, when the R.A. diminishes, or the motion of the planet among the stars is reversed, two transits occur within the limits of the mean solar day.

As the greatest daily variation of meridian passage of Venus amounts to $6^{m}$ only, the mer. passages of the planets may be taken at once from the Nautical Almanac for all practical purposes.

## 2. *Time of Passage of the Prime Vertical.*

[1.] *Of the Sun.*

630. *Approximately.* Find the Hour-angle by Table 29: this is the App. Time, approximately, of the afternoon passage; the supplement to $12^{h}$ is the Approx. Appar. Time of the forenoon passage.

Ex. 1. Jan. 20th, 1878, lat. 39° S.: find the times of the Sun's Passage of the Prime Vertical.

Jan. 20th, Sun's Decl. 20° 5′ S., Table 29, lat. 39° and decl. 20°, give Hour-angle $4^{h}\ 13^{m}$. The A.T. of the W. transit is $4^{h}\ 13^{m}$ P.M., that of the E. is $12^{h} - 4^{h}\ 13^{m}$, or $7^{h}\ 47^{m}$ A.M.

Ex. 2. June 20th, 1878, lat. 55° N.: find the A.M. and P.M. transits of the Prime Vertical.

Lat. 55° decl. 23° 27′ N., or $23\frac{1}{2}$°, Hour-angle $4^{h}\ 52^{m}$, which is P.M. transit: the other passage is at $7^{h}\ 8^{m}$ A.M.

631. *Accurately.* Having found the Approx. App. Time as above (No. 630), apply to it the long. in time; this gives the Green. Date in App. Time.

To this reduce the sun's declination, and compute the hour-angle by No. 619.

Ex. 1. Aug. 29th, 1878, required the App. Time of Passage P.M. at Tenby, in lat. 51° 40 20″ N., long. 4° 41′ W.

| | | | |
|---|---|---|---|
| Lat. $51\frac{1}{2}$° decl. $9\frac{1}{2}$° Table 29 gives | | $5^{h}\ 30^{m}$ | |
| 4° 41′ W. | | + 19 | |
| Green. Date, 29th, | | 5 49 | |
| Decl. 29th, | 9° 19 33″·8 N. | | |
| 30th, | 8 58 6 ·1 N. | | |
| | 21 27 ·7 | | 0485 |
| | 5 49 | | 6155 |
| | 5 12 | | 6640 |
| | 9 19 33 ·8 | | |
| Red. Decl | 9 14 21 ·8 N. | | |

| | | Parts for′ |
|---|---|---|
| 51° 40′ 20″ cot. | 9·898010 | − 86 |
| 9 14 22 tan. | 9·211018 | + 295 |
| | 9·109028 | |
| | + 209 | |
| Cos. | 9·109237 | |

Pass. P. Vertical, $5^{h}\ 30^{m}\ 27^{s}$

Ex. 2. May 13th, 1878, find the Time of Passage A.M. at South Shields, lat. 55° 0′ 50″ N., long. 1° 25′ W.

Green. Date, May $12^{d}\ 19^{h}\ 0^{m}$

Red. Declin. 18° 22′ 16″ N.

App. Time Pass. $6^{h}\ 53^{m}\ 45^{s}$ A.M.

[2.] *Of a Star.*

632. Find the A.T. of meridian passage. When the time of the *east* transit is required, *subtract* the Hour-angle (Table 29) from

this A.T. (increased if necessary by $24^h$); for the time of *west* transit, *add* the Hour-angle.

Ex. 1. Find the Times of Eastern and Western Transits of Prime Vertical of Aldebaran at So. Shields, on Jan. 1st, 1878.

| | | | |
|---|---|---|---|
| App. Time Mer. Pass. Tab. 27 | $9^h\ 41^m$ | | $9^h\ 41^m$ |
| Decl. 16° lat. 55° | $-5\ \ 14$ | | $5\ \ 14$ |
| APP. TIME OF. E. TRANSIT, | $4\ \ 27$ P.M. | | $14\ \ 55$ |
| | | W. TRANSIT OF 2D, | $2\ \ 55$ A.M. |

Ex. 2. July 11th, 1878, lat. 51° 30′ N.: find Times of E. and W. Transits of Prime Vertical of $\alpha$ Lyræ. *Ans.* APP. T. OF PASS. E. $7^h\ 50^m$ P.M.; W. $2^h\ 30^m$ A.M.

Ex. 3. Dec. 4th, 1878, lat. 40° 10′ S.: find Times of E. and W. Transits of Prime Vertical of Antares. *Ans.* APP. T. OF PASS. E $8^h 1^m$ A.M.; W. $3^h\ 17^m$ P.M.

Ex. 4. Aug. 17th, 1878. lat. 56° 3′ N.: find Time of E. Transit of Prime Vertical of Altair. *Ans.* APP. T. OF PASS. E. $4^h\ 22^m$ P.M.

[3.] *Of the Moon.*

633. *Approximately.* Proceed as for a star, using M.T. for A.T., because the time of her mer. pass. is given in M.T.

634. *More Accurately.* Find the approximate time as for a star; find the Green. Date, and reduce to it the declination. Find the Hour-angle by No. 619. This Hour-angle, with the correct time of mer. passage, gives the time more nearly. Correct the declination and repeat the computation. For extreme precision, a correction would be required for the oblateness of the earth.

[4.] *Of a Planet.*

635. Find the M.T. of the Meridian Passage of the planet, in the Nautical Almanac, and apply the Hour-angle as directed for a star; the result is in M.T.

Ex. 1. Jan. 19th, 1878, lat. 54° 33′ S.: find the time of W. Transit of Prime Vertical of Venus.

| | |
|---|---|
| M.T. Mer. Pass, 19th page 224 N.A. | $2^h\ 39^m$ |
| Lat 54° S., Decl. 6° S. | $+5\ \ 42$ |
| M.T. OF PASS. | $8\ \ 21$ P.M. |

Ex. 2. Aug. 9th, 1878, lat. 49° 56′ S.: find the Time of E. Transit of Prime Vertical of Jupiter.

| | |
|---|---|
| M.T. Mer. Pass. 9th page 254 N.A. | $10^h\ 57^m$ |
| Lat. 50° S., Decl 21° S. | $-4\ \ 10$ |
| M.T. OF PASS. | $6\ \ 47$ P.M. |

3 *Times of Rising and Setting.*

These are required approximately only.

[1.] *Of the Sun.*

636. See Table 26, and Explanation.

[2.] *Of a Star, the Moon, or a Planet.*

637. Find the A.T. (or M.T., according as required) of the meridian passage, No. 625, &c. Find the Hour-angle at rising or setting, No. 620.

To find the time of *rising, subtract* this Hour-angle from the time of mer. passage (increased if necessary by $24^h$); to find the Time of *setting, add* them together, rejecting $24^h$ if the sum exceed $24^h$.

Ex. Jan. 1st, 1878, lat. 50° N.: find A.T. of rising and setting of Aldebaran.

| | |
|---|---|
| A.T. Mer. Pass., Table 27 | $9^h\ 41^m$ |
| 55° N., Decl. 16° N. | $-7\ 37$ |
| A.T. OF RISING | 2 4 P.M. |

| | |
|---|---|
| A.T. Mer. Pass. | $9^h\ 41^m$ |
| | 7 37 |
| A.T. OF SETTING | 17 18 |

Or at $5^h\ 18^m$ A.M. on 2d.

638. To find the change in the time of apparent rising or setting due to the horizontal refraction and the height of the spectator, No. 446 (1) and (2).

*By Computation.* Add together the log. secants of the latitude and declination, the log. cosec. of the hour-angle at rising or setting, and the log. sine of 34′+depr. for the height of the eye, Table 8; the sum is the log. sine of the portion of time required, nearly.

Ex. 1. Find the difference of times of Sunset to an eye at the level of the sea, and on the summit of the Peak of Teneriffe, on May 4th.

Hour-angle at setting (No. 621), $6^h\ 35^m\ 52^s$.

| | | | |
|---|---|---|---|
| Lat. | 28° 16′ | sec. | 0·0551 |
| Decl. | 16 10 | sec. | 0·0175 |
| H.-Ang. | $6^h\ 36^m$ | cosec. | 0·0054 |
| 34′ + 117′ = 2° 31′ | | sin. | 8·6426 |
| TIME REQ. $12^m\ 3^s$ | | sin. | 8·7206 |

Ex. 2. Lat. 28° 16′ N., declin. 16° 10′ N.: required the difference in the times of Sunset to the eye at the level of the sea, and elevated 16 feet above it.

Hour-angle at level of the sea, $6^h\ 35^m\ 52^s$.

| | | |
|---|---|---|
| Lat. | sec. | 0·0551 |
| Decl. | sec. | 0·0175 |
| Hour-angle | cosec. | 0·0054 |
| 34′ + 4′, | sin. | 8·0435 |
| TIME REQ. $3^m\ 2^s$ | sin. | 8·1215 |

This process is very nearly correct in low latitudes, but in high latitudes, where the body, instead of rapidly passing the horizon, partly skims along it, the result, when the dip is large, is too small.

Thus, for the above depression, 117′, in lat. 50° (and declination above), the time comes out $17^m\ 23^s$, it should be $17^m\ 38^s$; and in lat. 60°, the result, $24^m\ 17^s$, should be $25^m\ 4^s$.

639. More accurately, find the Hour-angle of the given celestial body when below the horizon 34′+depression due to the observer's height, by No. 642; this is effected by using 34′+depr., instead of 18°. The Diff. between this Hour-angle and that found by No. 621 is the portion of time required.*

640. Since the moon's parallax exceeds the refraction, Nos. 433 and 436, she always appears below her true place, and therefore rises later, and sets earlier, than a more distant body of the same declination. Accordingly, in the preceding rule we must use, instead of 34′, the diff. between the hor. par. and 34′, and the difference instead of the sum of the latter and the depression. If the depression is the greater, the rising is accelerated, otherwise retarded. For the hor. par. 61′, these effects neutralise each other at the height of 650 feet; for 53′, at 320 feet; that is, to the eye placed at these heights the moon in these cases rises and sets nearly at her true time.

* In strictness, however, some correction (subtractive) is due to the refraction itself when the body is seen at a considerable depression.

### 4. *Times of the Beginning and End of Twilight.*

641. *By Inspection.* See Explanation of Table 5.

642. *By Computation.* Add together 18°, the lat., and the pol. dist., take half the sum, and from it subtract 18°, or the upper term.

Add together the log. sec. of the lat., the log. cosec. of the pol. dist., the log. sine of the half sum, and the log. cos. of the remainder; the sum (rejecting tens) is the log. sine square of the sun's hour-angle when 18° below the horizon.

This Hour-angle is the App. time of the *end* of twilight, P.M.; and the *supplement* to $12^h$ is the App. time of the *beginning*, A.M.

NOTE.—The declination at noon, and 4, or even 3, places in the logs. are enough for this purpose.

Ex. 1. April 22d, 1878, lat. 51° 46′ N.: find the Beginning and End of Twilight.

| | | | |
|---|---|---|---|
| Const. | 18° 0 | | |
| Lat. | 51 46 | sec. | 0·2084 |
| P.D. | 77 45 | cosec. | 0·0100 |
| | 147 31 | | |
| | 73 45 | sine | 9·9823 |
| | 55 45 | cosine | 9·7504 |
| END | $9^h\ 28^m$ | sine sq. | 9·9511 |
| BEG. | 2 32 | | |

Ex. 2. Dec. 21st, 1878, lat. 55° 1′ N.: find the Beginning and End of Twilight.

| | | | |
|---|---|---|---|
| Const. | 18° 0′ | | |
| Lat. | 55 1 | sec. | 0·2416 |
| P.D. | 113 27 | cosec. | 0·0374 |
| | 186 28 | | |
| | 93 14 | sine | 9·9993 |
| | 75 14 | cosine | 9·4063 |
| END | $5^h\ 52^m$ | sine sq. | 9·6846 |
| BEG. | 6 8 | | |

Ex. 3. March 3d, 1878, lat. 60° 47′ S. Twilight begins $2^h\ 8^m$ A.M., ends $9^h\ 52^m$ P.M.

Ex. 4. Jan. 2d, 1878, lat. 70° 1′ N., Twilight begins, $6^h\ 42^m$ A.M., ends $5^h\ 18^m$ P.M., the sun not appearing above the horizon.

643. The *duration* of twilight, or the interval between the beginning of twilight and the sun's rising, or between sunset and darkness, is found by taking the differences of these times. Thus, in Ex. 1, it is $9^h\ 28^m - 7^h\ 3^m$ (setting, Table 26), or $4^h\ 57^m$ (rising) $- 2^h\ 32^m$, which is $2^h\ 25^m$. In Ex. 2, it is $5^h\ 52^m - 3^h\ 27^m$, or $2^h\ 25^m$.

The shortest duration is at the equator, when the sun moves through 18° in $1^h\ 12^m$; at the poles it continues several months.

When the lat. (of the same name with the decl.) exceeds the compl. of 18° + decl., the sun is less than 18° below the horizon at midnight, or twilight lasts all night, as for ex. with lat. 58° N., decl. 21° N.

## VI. ALTITUDES.

### 1. *Correction of the Observed Altitudes.*

644. The corrections necessary to reduce an altitude observed from the sea-horizon with a sextant or circle to the *true* altitude, consists of the Index Correction, the Dip, the Correction of Altitude (or the joint effect of refraction and parallax, No. 438,) and, in certain cases, the Semidiameter.

When one of the instruments, No. 522 or 523 is used, the Dip is omitted; the constant correction should be applied the first thing.

645. The *apparent* alt. is deduced from the *observed* alt. by applying all the above corrections except refraction and parallax.

646. When the altitude is less than 10°, the mean refraction in Table 31 may be in error more than 1′, and should be corrected by Tables 32 and 33 if a barometer and thermometer are at hand. For precision, this is necessary in all cases.

[1.] *To Correct the Sun's Altitude.*

647. *At Sea.* Apply the Ind. Corr.; subtract the dip corresponding to the height of the eye, Table 30; subtract the refraction for this alt., Table 31, to the nearest minute.

When the *lower* limb is observed, *add* 16′ to this reduced alt.; when the *upper* limb is observed, *subtract* 16′; the result is the true or corrected alt. of the sun's centre.

Ex. 1. Obs. alt. of ⨀ 28° 54′, ind. corr. +3′, height of the eye 16 feet: required True Alt. of the centre.

| | |
|---|---|
| Obs. Alt. | 28° 54′ |
| Ind. Corr. | + 3 |
| | 28 57 |
| Dip | − 4 |
| | 28 53 |
| Refr. (for 29°) | − 2 |
| | 28 51 |
| Semid. (*low. l.*) | + 16 |
| True Alt. | 29 7 |

Ex. 2. Obs. alt. of ⨀̄ 42° 11′, ind. corr. −17′, height of the eye 30 feet: required True Alt. of the centre.

| | |
|---|---|
| Obs. Alt. | 42° 11′ |
| Ind. Corr. | − 17 |
| | 41 54 |
| Dip | − 5 |
| | 41 49 |
| Refr. (for 42°) | − 1 |
| | 41 48 |
| Semid. (*upper l.*) | − 16 |
| True Alt. | 41 32 |

Ex. 3. Obs. alt. ⨀ 10° 4′, ind. corr. + 2′, height of eye 18 feet: required the True Alt. of Sun's centre. True Alt. 10° 13

Ex. 4. Obs. alt. ⨀̄ 42° 11′, ind. corr. −17′, height of eye 30 feet: required the True Alt. of the centre. True Alt. 41° 32′.

648. In the open sea, where an error of 2′ or 3′ of lat., and a corresponding error of long., are of no great consequence, the corr. of alt. for the sun (when the *lower* limb is observed), may be taken from Table 38, in which it is given to the nearest minute.

Ex. 1. (Ex. 1 above.)

| | |
|---|---|
| Obs. Alt. ⨀ | 28° 54 |
| Ind. Corr. | + 3 |
| | 28 57 |
| Ht. 16 f., Alt. 29° Corr. | + 11 |
| True Alt. | 29 8 |

Ex. 2. (Ex. 3 above.)

| | |
|---|---|
| Obs. Alt. ⨀ | 10° 4 |
| Ind. Corr. | + 2 |
| | 10 6 |
| Ht. 18 f., Alt. 10°, Corr. | + 7 |
| True Alt. | 10 13 |

If the upper limb has been observed, proceed as above, and deduct 32′.

Ex. Obs. Alt. ⨀̄ 88° 40′, Ht. of Eye 30 f., Ind. Corr. −5, True Alt. 88° 14′.

649. *Accurately.* Apply the ind. corr. and (at sea) the dip; correct the refr. by Tables 32, 33; take the semid. and parallax from the Nautical Almanac; and subtract the parallax in alt., Table 34.

Minute accuracy in alt. at sea can rarely be worth the trouble

bestowed upon it, from the uncertain state of the sea-horizon. The examples, No. 651, will serve, supplying the dip.

650. When the altitude of either limb of the sun is observed, and the altitude of the other limb (which will appear the same in the instrument) is observed from the opposite point of the horizon (No. 535), take half the diff. of these angles and *add* to it the correction of alt.; the sum is the true zen. dist.

Ex. 1. Obs. Alt. $\underline{\odot}$ S. 63° 49′ 20″, $\underline{\odot}$ N. 115° 46′ 20″: required the true Zenith Distance.

| | |
|---|---|
| $\underline{\odot}$ N. | 115° 46′ 20″ |
| S. | 63 49 20 |
| 2) | 51 57 0 |
| App. Zen. Dist. | 25 58 30 |
| Refr. | + 29 |
| True Z. Dist. | 25 58 59 N. |

Ex. 2. Obs. Alt. $\underline{\odot}$ N. 81° 59′ 0″, $\underline{\odot}$ S. 97° 40′ 30″: required the true Zenith Distance.

| | |
|---|---|
| $\underline{\odot}$ S. | 97° 40′ 30″ |
| N. | 81 59 0 |
| 2) | 15 41 30 |
| App. Zen. Dist. | 7 50 45 |
| Refr. | + 8 |
| True Z. Dist. | 7 50 53 S. |

651. *On Shore.* When the alt. is observed from the quicksilver, apply the ind. corr. at once; halve the result, and proceed as in No. 649, omitting the dip.

Ex. 1. Jan. 1st, 1878, alt. $\underline{\odot}$ in the quicksilver 17° 24′ 0″, ind. corr. − 4′ 50″, bar. 30·6 inch, therm. 44°: find the True Alt.

| | | | |
|---|---|---|---|
| | | Obs. Alt. $\underline{\odot}$ | 17° 24′ 0″ |
| | | Ind. Corr. | − 4 50 |
| M. Refr. | 6′ 6″ | 2) | 17 19 10 |
| Therm. | + 5 | | 8 39 35 |
| Bar. | + 7 | | |
| | 6 18 | Corr. of Alt. | − 6 9 |
| Par. | − 9 | | |
| Corr. of Alt. | 6 9 | | 8 33 26 |
| | | Semid. | + 16 18 |
| | | True Alt. | 8 49 44 |

Ex. 2. July 1st, 1878, alt. $\overline{\odot}$ 60° 11′ 40″, ind. corr. + 2′ 35″, bar. 29·2, therm. 76°, find the True Alt.

| | | | |
|---|---|---|---|
| | | Obs. Alt. $\overline{\odot}$ | 60° 11′ 40″ |
| | | Ind. Corr. | + 2 35 |
| M. Refr. | 1′ 41″ | 2) | 60 14 15 |
| Therm. | − 5 | | 30 7 7 |
| Bar. | − 3 | | |
| | 1 33 | | |
| Par. | − 7 | | |
| Corr. of Alt. | 1 26 | Corr. of Alt. | − 1 26 |
| | | Semid. | − 15 46 |
| | | True Alt. | 29 49 55 |

Ex. 3. May 3d, 1878, obs. alt. $\underline{\odot}$ in the quicksilver 116° 14′ 0″, ind. corr. + 2′ 0″, bar. 29·2, therm. 58°: required the True Altitude. True Alt. 58° 23′ 23″.

Ex. 4. July 9th, 1878, obs. alt. $\underline{\odot}$ in the quicksilver 120° 17′ 50″, ind. cor. + 54″, bar. 29·8, therm. 62°: required the True Altitude. True Alt. 60° 24′ 39″.

### [2.] *To Correct a Star or a Planet's Altitude.*

652. *At Sea.* Apply the index corr.; subtract the dip and refraction.

Ex. 1. Obs. alt. of a star 10° 28′, ind. corr. + 2′, height of eye 16 feet: required the True Alt.

| | |
|---|---|
| | 10° 28′ |
| | + 2 |
| | 10 30 |
| Dip 4 and Refr. 5′ | − 9 |
| True Alt. | 10 21 |

Ex. 2. Obs. alt. of a star 46° 12′, ind. corr. − 3′, height of eye 16 feet: required the True Alt.

| | |
|---|---|
| | 46° 12 |
| Sub. 3′, 4′, and 1′ | 8 |
| True Alt. | 46 4 |

Or, having corrected for index error, subtract the corr. in Table 38.

Ex. 3. Obs. alt. of the planet Venus 30° 14′, ind. corr. + 3′, height of eye 12 feet: required the True Alt.

| | |
|---|---|
| Obs. Alt. | 30° 14′ |
| Ind. Corr. + 3′ ; Table 38, − 5 | − 2 |
| TRUE ALT. | 30 12 |

Ex. 4. Obs. alt. of the planet Mars 78° 57′, ind. corr. + 7, height of eye 30 feet: required the True Alt.

| | |
|---|---|
| Obs. Alt. | 78° 57 |
| Ind. Corr. + 7′ ; Table 38, − 5 | + 2 |
| TRUE ALT. | 78 59 |

653. *Accurately*. Proceed as for the sun, No. 649, omitting semidiameter.

A star's corr. of alt. is the refraction alone, No. 438, p. 147.

For a planet, find the hor. par. in the Nautical Almanac; find the par. in alt. corresponding, in Table 45, and deduct it from the refraction.

Ex. 1. Obs. Alt. of Sirius in the quicksilver 37° 9′ 35″, ind. corr. − 7′ 30″, bar. 30·2, therm. 42°: required the True Alt.

| | | |
|---|---|---|
| ✱ Obs. Alt. | | 37° 9′ 35″ |
| Ind. Corr. | | − 7 30 |
| | 2) | 37 2 5 |
| | | 18 31 2 |
| M. Refr. | 2′ 53″ | |
| Therm. | + 3 | |
| Bar. | + 1 | − 2 57 |
| Corr. | − 2 57 | |
| TRUE ALT. | | 18 28 5 |

Ex. 2. Obs. alt. of α Polaris in the mercury 102° 38′ 30″, ind. corr. + 1′ 30″, therm. 62°, bar. 30 inch.

| | | |
|---|---|---|
| ✱ Obs. Alt. | | 102° 38′ 30″ |
| Ind. Corr. | | + 1 30 |
| | 2) | 102 40 0 |
| | | 51 20 0 |
| M. Refr. | 0′ 46″·8 | |
| Therm. | − 1 ·2 | − 0 46 |
| Corr. | 0 45 ·6 | |
| TRUE ALT. | | 51 19 14 |

Ex. 3. Dec. 21st, 1878, obs. alt. Venus in the quicksilver 116° 48′ 40″, ind. corr. + 1′ 40″, bar. 29·8, therm. 62°: required the True Alt.

Venus' H.P., p. 277, N.A. 5″·2

| | | |
|---|---|---|
| Obs. Alt. | | 116° 48′ 40″ |
| Ind. Corr. | | + 1 40 |
| | 2) | 116 15 20 |
| | | 58 25 10 |
| M. Refr. | 0′ 35″·9 | |
| Therm. | − 0 ·9 | |
| Bar. | − 0 ·2 | |
| | 0 34 ·8 | − 0 32 |
| Par. | − 2 ·6 | |
| Corr. of Alt. | 0 32 ·2 | |
| TRUE ALT. | | 58 24 38 |

Ex. 4. Feb. 6th, 1878, obs. alt. Mars in the quicksilver, 41° 49′ 30″, ind. corr. + 1′ 20″, bar. 29·2, therm. 58°: required the True Alt.

Mars' H.P., p. 278, N.A. 5″·5

| | | |
|---|---|---|
| Obs. Alt. | | 41° 49′ 30″ |
| Ind. Corr. | | + 1 20 |
| | 2) | 41 50 50 |
| | | 20 55 25 |
| M. Refr. | 2′ 31″·8 | |
| Therm. | − 3 | |
| Bar. | − 4 | |
| | 2 24 ·8 | − 2 20 |
| Par. | − 5 ·1 | |
| Corr. of Alt. | 2 19 ·7 | |
| TRUE ALT. | | 20 53 5 |

[3.] *To Correct the Moon's Altitude.*

654. *At Sea.* Find the Green. Date roughly, and take out of the Nautical Almanac the hor. par. and semid. to the nearest noon or midnight.

Apply the ind. corr. to the alt., subtract the dip; when the *lower* limb is observed, *add* the semid.; when the *upper* limb is observed, *subtract* it; the result is the *app. alt.* of the centre.

With the A. alt. and hor. par. find, in Table 39, the moon's corr. of alt., which *add*. The result is the true or corrected alt. of the moon's centre, approximately.

Ex. 1.* May 13th, 1878, long. 52° W., at $8^h$ $42^m$ P.M., obs. alt., ☽ 37° 10′, ind. corr. + 3′, height of eye 14 feet: required the True Alt.

The Gr. Date is 13th, $12^h$ $10^m$, H.P. at midnight 60′, semid. 16′.

| | | ☽ 37° 10′ |
|---|---|---|
| Ind. Corr. | + 3′ | |
| Dip | − 4 | + 15 |
| Semid. | + 16 | |
| | | 37 25 |
| 37° 25′, H.P. 60′ | | + 46 |
| True Alt. | | 38 11 |

Ex. 2. Sept. 18th, 1878, long. 160° E., at $2^h$ A.M., obs. alt. ☽ 61° 20′, height of eye 16 feet, ind. corr. − 3′: find the True Alt.

The Gr. Date 17th, $3^h$ $20^m$, H.P. at noon, 55. semid. 15′.

| | | ☽ 61° 20′ |
|---|---|---|
| Ind. Corr. | − 3′ | |
| Dip | − 4 | − 22 |
| Semid. | − 15 | |
| | | 60 58 |
| 61° 0′, H.P. 55′ | | + 26 |
| True Alt. | | 61 24 |

Ex. 3. Jan. 3d, 1878, long. 159° E., at $9^h$ $10^m$ P.M ☽ 85° 42′, height of eye 20 feet, ind. corr. + 3′ True Alt. 86° 1′.

Ex. 4. July 5th, 1878, long. 172° W., at $3^h$ A.M. ☽ 14° 28′, ind. corr. 0′, height of eye 18 feet. True Alt. 15° 1′.

655. *Accurately.* (1.) Reduce the hor. par. to the Gr. Date, and find the semid. Table 40. Reduce the par. by Table 41, and augment the semid. Table 42.

(2.) Take out the refraction for the limb observed, correct it for barom. and therm.; subtract this corrected refraction from the alt. and apply the augmented semidiameter.

(3.) To the log. sec. of the alt. thus reduced add the prop. log. of the reduced hor. parallax; the sum is the prop. log. of the parallax in alt. This par. added to the reduced alt. gives the true alt. of the centre.

As, however, the degree of precision obtained by these precepts will rarely be required, we shall, in the following example, employ Table 39.

Ex. 1. July 30th, 1878. lat. 42° S., long. 42° 13′ W., at $5^h$ $24^m$ $38^s$ M.T. obs. alt. ☽ 36° 39′ 50″, ind. corr. + 2′ 17″, height of eye 22 feet; therm. 72°, bar. 29·1: required the True Alt.

| | |
|---|---|
| The Gr. Date, 30th, $8^h$ $13^m$ $30^s$ | |
| H.P. 30th, Noon | 59′ 55″·6 |
| 30th, Midn. | 60 6 ·2 |
| 12-hourly Var. | + 10 ·6 |
| $8^h$ $14^m$, var. 10″·6 | + 7 ·2 |
| | 59 55 6 |
| Equat. H.P. | 60 2 ·8 |
| Red. for Lat. | − 5 ·2 |
| Red. H.P. | 59 57 6 |
| Semid. corresp. to 59′ 58″ | 16′ 21 |
| Augment. | 10 |
| Aug. Semid. | 16 31 |

| | | | |
|---|---|---|---|
| Obs. Alt. | | | 36° 39′ 50″ |
| Ind. Corr. | + 2′ 17″ | | − 2 13 |
| Dip. | − 4 30 | | |
| | | | 36 37 37 |
| Aug. Semid. | | | + 16 31 |
| | | | 36 54 8 |
| 36° 50′ and 59′ | | 45 56″ | |
| 4 | | − 2 | |
| 58″ | | + 47 | |
| | | 46 41 | |
| Therm. 72°, sub. 3″ | | + 5 | |
| Bar. 29·1 sub. 2 | | | |
| | | 46 46 | + 46 46 |
| True Alt. | | | 37 40 54 |

656. When the moon is referred to the opposite point of the horizon, No. 535, half the diff. of the alt. and its supplement is the zenith distance of the illuminated limb, to which the augmented

* The examples being given merely in illustration of the rules, no regard has been paid to the visibility of the moon at the time and place specified.

semid. is to be applied the contrary way to that directed for the alt. In certain cases both limbs can thus be observed, No. 540, and the semidiameter avoided.

## 2. *To Reduce the True to the Apparent Altitude.*

### [1.] *For the Sun, a Star, or a Planet.*

657. Take out the refraction to the true alt. as if for the app. alt., correcting it, when necessary, for the barom. and therm.; *subtract* the parallax in alt., add the remainder to the true alt., and subtract the correction in Table 43.

### [2.] *For the Moon.*

658. Find her corr. of alt. for the true alt., as if for the app. alt., and apply the corr., Table 44.

| | | |
|---|---|---|
| Ex. ☽'s Hor. Par. 59', True Alt. | | 48° 41' 12" |
| 48° 41', and 59', — 38' 6" | } | — 38 34 |
| Corr. Table 44, — 28 | | |
| App. Alt. | | 48 2 38 |

659. To reduce the app. alt. to the observed alt. for a particular instrument and given height of the eye, apply the ind. corr. the *opposite* way, and *add* the dip.

## 3. *Reduction of Two Altitudes to an Intermediate Point of Time.*

660. Two altitudes observed at periods of time not distant, afford, by simple proportion, the altitude at an intermediate time.

(1.) Find the interval between the time of the 1st alt. and the time proposed, and call it the partial interval.

(2.) To the prop. log. of the partial interval add the ar. co. prop. log. of the whole interval, and the prop. log. of the diff. of alts.; the sum is the prop. log. of the change of alt. in the partial interval.

(3.) When the 1st alt. is the *lesser*, *add* this change; when it is the *greater*, *subtract* the change.

Ex. 1. At $10^h\ 18^m\ 4^s$ by watch, obs. an alt. 54° 56'; at $10^h\ 29^m\ 11^s$ obs. a second alt. 55° 12': required the Alt. at $10^h\ 23^m\ 6^s$.

| | | | | | |
|---|---|---|---|---|---|
| Alt. 54° 56' | time $10^h\ 18^m\ 4^s$ | | | | |
| | 10 23 6 | } | $5^m\ 2^s$ | pr. log. | 1·553 |
| 55 12 | 10 29 11 | | 11 7 | ar. co. p. log. | 8·791 |
| Diff. 16 | ............................................ | | | pr. log. | 1·051 |
| | Change of Alt. | | 7' | pr. log. | 1·395 |
| | | | 54 56 | | |
| | Alt. req. | | 55 3 | | |

Ex. 2. At $12^h\ 57^m\ 24^s$ by watch, obs. an alt. 39° 2'; and at $1^h\ 8^m\ 18^s$ obs. a second alt 36° 42: required the Alt. at $1^h\ 1^m\ 29^s$. Change of Alt. —0° 53', and Alt. req. 38° 9'.

Ex. 3. At $c^h\ 58^m\ 36^s$ by watch, obs. an alt. 47° 33', and at $1^h\ 5^m\ 47^s$, obs. a second alt. 47° 52': required the Alt. at $1^h\ 1^m\ 29^s$. Change of Alt. + 8', and Alt. req. 47° 41'.

The altitude thus deduced differs from the true alt. by a proportional part of the 2d diff. of alt. upon the interval, No. 558. The

method serves very well when the azimuth is large, or the object 60° or more from the meridian, or less if the interval be small; but in cases near the meridian the result will be sensibly in error, unless the interval is very small. The error arising from the neglect of the 2d diff. will be less as the intermediate time is nearer to the beginning or end of the interval.

### 4. *Reduction of an Altitude to another Place of Observation.*

**661.** The run of the ship in the interval between the taking of the two altitudes which constitute certain observations, renders it necessary to reduce one to the place of the other.

When the ship approaches the sun directly she raises him 1 for each mile of distance made good. When the sun bears obliquely (as for ex. 3 points) from the course made good, if we consider the angle between this last course and the sun's bearing (or 3 points) as a course, the space by which the ship approaches the sun is the D. Lat. corresponding to her Dist. made good.*

When the sun's bearing is at right angles to the course made good, the ship neither approaches nor recedes from him; when the bearing is abaft this line, she drops the sun.

When it is required to reduce an alt. observed at 1 o'clock (for ex.) to what it would have been if observed at the place where the ship is at 2 o'clock, the ship having approached the sun, we have merely to add to the alt. observed at 1 o'clock the portion of space or arc by which the ship would have raised the sun in $1^h$, if he had preserved his bearing at 1 o'clock unaltered. Hence the following rules.

To reduce the 1st alt. to the second place of observation.

(1.) Take the diff. between the bearing of the body at the first observation and the ship's course, as a Course, and the dist. run as a Distance; the D. Lat. corresponding is the reduction for run.

(2.) When this course is *less* than 90° or 8 points, *add* the red. to the first alt.; when the said course exceeds 90° or 8 points, *subtract* the red.; the result is the alt. reduced to what it would have been if observed at the second place of the spectator.

If the ship does not preserve the same course, the course made good must be employed.

As it is *difference* only of bearing or azimuth that enters into this question, the variation (supposed the same at both observations) is not considered; but if the ship's course changes, the deviation should be attended to.

Ex. 1. Observed the sun's alt., the sun bearing S.E. by E. ½ E., the course E. by N. ½ N. (by compass). Sailed for $1^h\ 15^m$ at the rate of 7½ knots: required the Reduction of the Alt. for Run.

From S.E. by E. ½ E. to E. is 2¾ pts.; from E. to E. by N. ½ N. is 1½ pts. The course 4¼ points, and dist. 9·4, give D. Lat. 6′·3 the REDUCTION to be *added* to the Alt.

---

* As the distance is described upon a spherical surface, in strictness a correction is necessary; also the dist. made good on the spiral rhumb should be reduced to that on a great circle; but these refinements are generally inconsistent with the rude *data* of the question.

Ex. 2. Sun South, alt. 55° 30'·5, course E. by N., rate 6·8 knots, interval 12ᵐ: reduce the Alt. for the Run.

The suppl. of 9 pts., or 7 pts., and dist. 1·4, give D. Lat. 0·27, or 0'·3, which *subtracted* from 55° 30'·5, gives 55° 30'·2, the ALT. required.

Ex. 3. Obs. sun's alt., sun bearing N.E. ½ E., course N.W. ½ N, sailed for 36ᵐ 10ˢ at the rate of 10·2 knots: required the Reduction for Run. The REDUCTION is 0'·0.

Ex. 4. Obs. a star's alt. 37° 18 40", bearing S.E. by E. ½ E., course N.W. by W. ½ W., rate 5·8 knots, interval 2ʰ 24ᵐ: reduce the Alt. for Run.

The REDUCTION is 13'·9 to *sub.*; the ALT. 37° 4'·8.

When the course at the 1st observation is *directly towards* the sun, the dist. run in the interval is the correction, and is to be *added* to the 1st alt.; when *directly from* the sun, to be subtracted.

Ex. Obs. sun's alt. 29° 7' 30", bearing E.S.E., course E.S.E., rate 5·4 knots, interval 3ʰ 6ᵐ: reduce the Alt. for Run.

The REDUCTION is 16'·7 to *add*; the ALT. 29° 24'·2.

662. To reduce the 2d alt. to the first place of observation.

Take the bearing at the last observation; find the reduction of the alt. as above, and apply it to the 2d alt. the contrary way to that directed in (2) above.

Ex. 1. Observed the sun's alt., sailed S.S.W. for 48ᵐ at the rate of 3½ knots, when the 2d alt. was taken, the sun bearing W.S.W.: required the Correction of the Alt. for Run.

From S.S.W. to W.S.W. is 4 pts. The course 4 pts., and Dist. 2·8, give the D. Lat. 2·0 to be *subtracted* from the 2d Alt.

Ex. 2. Course N.W. by N., observed the sun's alt. After sailing for 1ʰ 36ᵐ at 8·2 knots, observed the 2d alt. 39° 44', the sun bearing E.S.E.

From N.W. by N. to E.S.E. is 13 pts.; then the course 3 pts., and Dist. 13·1, give D. Lat. 10·9, which *added* to 39° 44' gives 39° 54'·9, the Alt. reduced.

When the course at the 2d observation is *directly towards* the sun, the dist. run is the correction, and is to be *subtracted* from the second alt.; when *directly from* the sun, it is to be *added.*

### 5. *To find the Altitude.*

[1.] *On the Meridian.*

663. For the sun, the moon, or a planet, find the time of Mer. Pass., No. 623, &c., and reduce the declin., No. 579, &c. Find the colat. When the lat. and decl. are of the same name take the sum of the colat. and decl.; when of different names, their diff.; the result is the mer. alt. If the sum exceeds 90° take its complement.

Below the Pole. Find the pol. dist., and subtract it from the latitude.

[2.] *On the Prime Vertical.*

664. *By Inspection.* See Table 29, and Explan. of Table 5.

665. *By Computation.* (1.) Find the approx. time of Passage, No. 630; to this reduce the declin., in the case of the sun, moon, or a planet

(2.) Add together the log. sine of the declin., and the log. cosec. of the lat; the sum is the log. sine of the true alt. required.

Ex. 1. July 12th, 1878, lat. 51° 48′ N., long. 4° 56′ W.: find the Sun's Alt. on the Prime Vertical, W.

| | |
|---|---|
| Table 29, Lat. 52°, Decl. 22°, Hour-angle, or App. Time | 4ʰ 46ᵐ |
| Long. 4° 56′ W. | + 20 |
| Green. Date 12th, | 5 6 |
| ☉ Decl. 12th, | 21° 58′ N. |
| 13th, | 21 50 N. |
| Daily Var. | 8 |

Daily Var. 8′ and 5ʰ gives 2′, whence Red. Decl. is 21° 56′

| | | |
|---|---|---|
| Decl. 21° 56′ | sine | 9·57232 |
| Lat. 51 48 | cosec. | 0·10466 |
| Alt. 28 23 | sine | 9·67698 |

Ex. 2. Lat. 50° 48′ N: find the Alt. of α Lyræ on the Prime Vertical.

| | | |
|---|---|---|
| Decl. 38° 40′ | sine | 9·79573 |
| Lat. 50 48 | cosec | 0·11073 |
| Alt. 53 44 | sine | 9·90646 |

Ex 3. Lat. 46° 14′ N.: find the Alt of Capella on the Prime Vertical.

| | | |
|---|---|---|
| Decl. 45° 52′ | sine | 9·85596 |
| Lat. 46 14 | cosec. | 0·14136 |
| Alt. 83 38 | sine | 9·99732 |

[3.] *To find the Altitude, the Hour-angle being given.*

666. *By Inspection.* See Explan. of Table 5.

667. *By Computation.* Having (in the case of the sun, moon, or planet) found the Gr. Date and the declination.

Take the suppl. of the hour-angle to 12ʰ; add together the pol. dist. and colat.

Add together the log. sine square of the suppl. of the hour-angle, and the log. sines of the pol. dist. and colat.; the sum (rejecting tens) is the log. sine square of an auxiliary arc $x$

Write $x$ under the sum of the pol. dist. and colat. and take the sum and diff, and half the sum and half the diff.

Add together the log. sines of the last two terms; the sum (rejecting tens) is the log. sine square of the zen. dist.

Ex. 1. Lat. 22° 15′ N., decl. 2° 49′ S., hour-angle 2ʰ 14ᵐ 36ˢ: required the Alt. (working to the nearest minute).

| | | | |
|---|---|---|---|
| Hour-angle | 2ʰ 14ᵐ 36ˢ | | |
| Suppl. | 9 45 24 | sin. sq. | 9·96200 |
| P. Dist. | 92 49′ | sine | 9·99947 |
| Colat. | 67 45 | sine | 9·96639 |
| Sum | 160 34 | | |
| Arc $x$ | 133 57 | sin. sq. | 9·92786 |
| Sum | 294 31 | | |
| Diff. | 26 37 | | |
| ½ S. | 147 15 | sine | 9·73318 |
| ½ D. | 13 18 | sine | 9·36182 |
| Zen. Dist. | 41° 19′ | sin. sq. | 9·09500 |
| Alt. | 48 41 | | |

Ex. 2. Lat. 35° 15′ N., decl. 20° 0′ N., hour-angle 4ʰ 53ᵐ 19ˢ. Alt. 24° 41′.

Ex. 3. Lat. 19° 20′ S., decl. 19° 20′ S., hour-angle 1ʰ 18ᵐ 10ˢ. Alt. 71° 35′.

When the lat. is 0, we may use either N. or S. pol. dist. When the declin. is 0, the pol. dist. is 90°. When both lat. and declin. are 0, the z. d. is the hour-angle converted into arc.

Ex. 1. Lat. 0, decl. 23° 27′ N., hour-angle 4ʰ 30ᵐ 14ˢ. Alt. 20° 30′.

Ex. 2 Lat. 30° 0 N., decl. 0, hour-angle 3ʰ 38ᵐ 30ˢ Alt. 30° 5′.

[4.] *To find the Altitude, the Azimuth being given.*

668. Add together the log. sine of the azim., the log. cosine of the lat., and the log. sec. of the decl.; the sum (rejecting tens) is the log. sine of an angle A (see note to No. 616), p. 222.

Under A put the azim. reckoned from the elevated pole; take half the sum and half the diff.

Take half the sum of the pol. dist. and colat.

Add together the log. tan. of this half sum, the log. cos. of the half sum of the azim. and A, and the log. sec. of their half diff.; the sum (rejecting tens) is the log. tan. of half the zen. dist.

Ex. Lat. 51° 30′ N., decl. 20° 2′ N., azimuth S. 69° 39′ W., that is N. 110° 21′ W.: required the Alt.

| | | | | |
|---|---|---|---|---|
| Az. | 69° 39′ | sin. | 9·97201 | |
| Lat. | 51 30 | cos. | 9·79415 | |
| Decl. | 20 2 | sec. | 0·02711 | |
| A = | 38° 25′ | sin. | 9·79327 | |
| Az. | 110 21 | | | |
| Sum | 148 46, | ½ S. | 74° 23′ | |
| Diff. | 71 56, | ½ D. | 35 58 | |

| | | | | | |
|---|---|---|---|---|---|
| Colat. | 38° 30 | | | | |
| P. Dist. | 69 58 | | | | |
| Sum | 108 28, | ½ S. | 54° 14 | tan. | 0·14246 |
| | | | 74 23 | cos. | 9·43007 |
| | | | 35 58 | sec. | 0·09186 |
| | | | 24° 47′ | tan. | 9·66439 |
| | | | 2 | | |
| | | Zen. Dist. | 49 34 | | |
| | | Alt. | 40 26 | | |

For other Examples reverse those in No. 674.

## 6 *To find the Change of Altitude in a Small Interval of Time.*

[1.] *The Hour-angle and Altitude being given.*

669. (1.) When the body is to the E. of the meridian, ***subtract*** half the interval from the hour-angle; when to the W. of the meridian, ***add*** half the interval: call the result the reduced hour-angle.

(2.) Add together the log. cosines of the lat. and declin., the log. sine of the red. hour-angle, the log. sec. of the alt. and the log. sine of the interval; the sum (rejecting tens) is the log. sine of the change of alt.*

(3.) When the body is to the E. of the meridian, *add* this change to the alt.; when to the W., *subtract* it: the result is the alt. required.

Ex. 1. Lat. 51° 30′, decl. 22° 20′, true alt 44° 47′ 36″, hour-angle 3ʰ 0ᵐ 0ˢ to the E. of the meridian: required the Alt. 10ᵐ afterwards.

| | | | |
|---|---|---|---|
| Hour-angle | 3ʰ 0ᵐ 0ˢ E. | lat. cos. | 9·7942 |
| Half-int. | − 5 0 | decl. cos. | 9·9661 |
| Red.H.ang. | 2 55 0 | sine | 9·8398 |
| | 44° 47′ 36″ | sec. | 0·1490 |
| | | int. sin. | 8·6397 |
| Change | 1 24 1 | sin. | 8·3888 |
| Alt. | 46 11 37 | | |

The true alt. is 46° 12′ 48″, or the process is here 1′ 11″ in defect.

Ex. 2. Lat. 51° 30′, decl. 22° 20′, true alt. 44° 47′ 36″, hour-angle 3ʰ 0ᵐ 0ˢ to the W.: find the Alt. 20ᵐ afterwards.

| | | | |
|---|---|---|---|
| | 3ʰ 0ᵐ 0ˢ W. | lat. cos. | 9·7942 |
| | + 10 0 | decl. cos. | 9·9661 |
| | 3 10 0 | sine | 9·8676 |
| | 44° 47′ 36″ | sec. | 0·1490 |
| | | int. sine | 8·9403 |
| | 2 59 20 | sin. | 8·7172 |
| Alt. | 41 48 16 | | |

The true alt. is 41° 52′ 24″, or the error is 4′ 8″ in consequence of the length of the interval.

* The prop. logs. may be used for the sines of the small arc and the interval, provided that the arithmetical complements of all the other quantities be employed, and the const. 8·8239 added. The proper logarithm for the purpose is the log. of the small arc or the interval in seconds of arc (″). The inaccuracy attending the use of the sine, instead of its arc, in these computations is insensible, as the sine of 1° falls short of its arc by only 0″·2, the sine of 2° by 1″·5, and that of 3° by 2″·9, or 0ˢ·19 of time.

The method is more accurate as the object is more nearly E. or W.

The proper alt. to employ in this computation is the middle alt. between those at the beginning and end of the interval; for greater accuracy, therefore, the work should be repeated with a new alt. thus deduced.

[2.] *The Azimuth being given.*

670. *By Inspection.* Multiply the change of alt. in $1^m$ of time, Table 46, by the interval, both being in min. and decimals.

Ex. Lat. 52°, azim. 72°: find the change in Alt. in $3^m\ 12^s$.
The change of alt. in $1^m$ is about 8'·7, which multiplied by 3·2 gives 28', the CHANGE required.

671. *By Computation.* Add together the log. sine of the azimuth (reckoned either from N. or S.), the log. cos. of the lat., and the log. sine of the interval of time; the sum (rejecting tens) is the log. sine of the change of altitude.

It is more correct to use the azimuth corresponding to the middle of the interval of time.*

Ex. Lat. 51° 49', azimuth of Arcturus 72°: find the change of Alt. in $3^m\ 12^s$, and also in $2^m\ 51^s$.

| | | | | | |
|---|---|---|---|---|---|
| Az. | 72° | sine 9·9782 | | | 9·9782 |
| Lat. | 51 49' | cos. 9·7911 | | | 9·7911 |
| Int. | $3^m\ 12^s$ | sine 8·1450 | Int. | $2^m\ 51^s$ | 8·0946 |
| CHANGE req. | 28' 13" | sine 7·9143 | CHANGE req. | 25' 8" | sine 7·8639 |

672. All bodies on the same or opposite azimuths change their altitudes at the same rate, whatever be their declinations.

---

## VII. AZIMUTHS.

### 1. *To find the Azimuth, the Altitude being given.*

673. *By Inspection.* See Explanation of Table 5.

674. *By Computation.* Add together the pol. dist., the lat., and the alt., take half the sum,† and take the diff. between this half sum and the pol. dist.

Add together the log. sec. of the lat., the log. sec. of the alt., the log. cosines of the half sum and remainder; the sum (rejecting tens) is the log. sine square of the azimuth,‡ to be reckoned from the S. in N. lat., and from the N. in S. lat.

---

* The above rules, Nos. 669, &c., relate to the change of the *true* altitude. To compare the change of alt. as shewn by an instrument with the true difference, in a given interval of time, a small correction would, in general, be necessary, on account of the change of refraction, and in the case of the moon, for the change also in her parallax in altitude.

† The learner will observe that in this formula the pol. dist., lat., and alt., occur in the *reverse* order of that in No. 614, in which last their initials form the word *alp*. The 2d and 3d terms take secants; the last two, cosines.

‡ The angle obtained is the *supplement* of the angle P Z A in fig. 1, p. 162

Ex. 1. Lat. 51° 30′ N., alt. 40° 25′ to the W., decl. 20° 2′ N.: required the Azimuth.

| | | | |
|---|---|---|---|
| Pol. Dist. | 69° 58′ | | |
| Lat. | 51 30 | sec. | 0·20585 |
| Alt. | 40 25 | sec. | 0·11842 |
| | 161 53 | | |
| | 80 56½ | cos. | 9·19711 |
| | 10 58½ | cos. | 9·79198 |
| Azimuth, S. 69° 39′ W. | | sin. sq. | 9·51336 |

Ex. 2. Lat. 40° 8′ S., decl. 11° 0′ N., alt. 38° 11′ to the Eastward: required the Azim.

| | | | |
|---|---|---|---|
| P Dist. | 101° 0′ | | |
| Lat. | 40 8 | sec. | 0·1106 |
| Alt. | 38 11 | sec. | 0·1046 |
| | 179 19 | | |
| | 89 39½ | cos. | 7·7755 |
| | 11 20½ | cos. | 9·9914 |
| Azimuth, N. 11° 19′ E. | | sin. sq. | 7·9881 |

When the lat. is 0, if the declin. is N. the azimuth is to be reckoned from the south; if it is S. from the north.

When the declin. is 0, the azimuth is reckoned from the N. in S. lat., and from the S. in N. lat.

Ex. 1. Lat. 0°, decl. 23° 27′ S., alt. 41° 2′ W. Azim. N. 121° 50′ W., or S. 58° 10′ W.

Ex. 2. Lat. 11° 12′ N., decl. 0°, alt. 54° 30′, to the East. Azim. S. 73° 53′ E.

When both the lat. and decl. are 0, the object moves on the prime vertical.

## 2. *To find the Azimuth, the Hour-angle being given.*

675. (1.) Take half the sum of the pol. dist. and colat., and half the difference.

(2.) Add together the log. cot. of half the hour-angle, the log. sec. of the half sum, and log. cos. of the half diff.: the sum (rejecting tens) is the log. tan. of half the sum of the azimuth and another angle A.

When the half sum of the pol. dist. and colat. exceeds 90°, take the suppl. of the resulting arc for the half sum required.

To the log. cot. already employed add the log. cosec. of the half sum, and the log. sine of the half diff.; the sum (rejecting tens) is the log. tan. of half the diff. of the same two angles.

(3.) The *sum* of the resulting half sum and half diff. is the *greater* of the said two angles; the *difference* is the *lesser*.

When the pol. dist. exceeds the colat. the greater of the two angles is the azimuth required; when the pol. dist. is *less* than the colat., the *lesser* of the angles is the azimuth required

Ex. 1. Lat. 10° 20′ N., decl. 22° 14′ S., hour-angle $1^h\,44^m\,17^s$ W.: required the Azimuth.

| | | | | | |
|---|---|---|---|---|---|
| H. Angle | $1^h\,44^m\,17^s$ | | | | |
| Half | 0 52 8 | cot. | 0·63548 | cot. | 3·63548 |
| P Dist. | 112° 14′ | | | | |
| Colat. | 79 40 | | | | |
| Sum | 191 54 | | | | |
| Diff. | 32 34 | | | | |
| ½ S. | 95 57 | sec. | 0·98439 | cosec. | 0·00235 |
| ½ D. | 16 17 | cos. | 0·98222 | sin. | 9·44776 |
| | 88° 34′ | tan. | 1·60209 | 50° 37′ tan. | 0·08559 |
| | 91 26 (suppl.) | | | | |
| | 50 37 | | | | |
| Sum N. | 142 3 W. Azimuth (p. dist. exceeds col.) | | | | |
| Diff. | 40 49 the other Angle, or A. | | | | |

Ex. 2. Lat. 47° 11′ S., decl. 11° 18′ S., hour-angle $5^h\,11^m\,20^s$: the Azimuth 91° 6′, the other angle, or A, 43° 52′.

Ex. 3. Lat. 13° 52′ N., decl. 46° 8′ N., hour-angle $1^h\,21^m\,11^s$ E. of Mer.

Azim. 33° 49½′ E.

### 3. *To find the Azimuth, the Hour-angle and Altitude being given.*

676. Add together the log. sine of the pol. dist. (or log. cos. of the declin.), the log. sine of the hour-angle, and the log. sec. of the alt.; the sum rejecting tens is the log. sine of the azimuth.

Ex. 1. Hour-angle $1^h\ 19^m\ 19^s$, alt. $58°\ 40'$, pol. dist. $104°\ 24'$: required the Azimuth.

| | | |
|---|---|---|
| Pol. Dist. sin. | | 9·9861 |
| Hour-angle sine | | 9·5305 |
| Alt. sec. | | 0·2840 |
| AZIM. 39° 11′ | sin. | 9·8006 |

Ex. 2. Hour-angle $0^h\ 46^m\ 39^s$, alt. $63°\ 0'$, decl. $14°\ 24'$ (N. or S.): required the Azimuth.

| | | |
|---|---|---|
| Decl. cos. | | 9·9861 |
| Hour-angle sin. | | 9·3057 |
| Alt. sec. | | 0·3430 |
| AZIM. 25° 33′ | sin. | 9·6348 |

This method cannot shew whether the body is to the N. or S. of the prime vertical; for this purpose see No. 673, &c.

### 4. *To find the Azimuth, not far from the Meridian, by the observed change of Altitude in a small Interval of Time.*

677. *By Inspection.* Divide the given change of alt. by the interval, in min. and decimals; the quotient is the change of alt. in $1^m$.

With this change and the lat. enter Table 46, and take out the azimuth, which corresponds approximately to the middle of the interval.

Ex. Lat. 35°; the change of alt. in $20^m\ 12^s$ is 59′: find the Azimuth.

59 divided by 20·2 gives 2·9, the change of alt. in $1^m$, which gives the AZIM. about 14°.

678. *By Computation.* Add together the log. sine of the change of alt., the log. cosec. of the interval, and the log. sec. of the lat.; the sum is the log. sine of the azimuth about the middle of the interval.

Ex. 1. Lat. 51° 26′; in $5^m\ 20^s$ observed 22′ change of alt.: required the Azimuth.

| | | |
|---|---|---|
| D. Alt. 22′ | sine | 7·8061 |
| Int. $5^m\ 20^s$ | cosec. | 1·6332 |
| Lat. 51° 26′ | sec. | 0·2052 |
| AZIM. 26° 10′ | sine | 9·6445 |

At about $3^m$ after the 1st observation.

Ex. 2. Lat. 34° 40′; in $20^m\ 12^s$ observed 59′ 6″ change of alt.: required the Azimuth.

| | | |
|---|---|---|
| D. Alt. 59′ 6″ | sine | 8·2353 |
| Int. $20^m\ 12^s$ | cosec. | 1·0554 |
| Lat. 34° 40′ | sec. | 0·0849 |
| AZIM. 13° 44′ | sine | 9·3756 |

At about $10^m$ after the 1st observation.

679. This method will sometimes be useful, as for determining the variation, but it must be employed with caution; the interval should not be very small, the body should not be far from the meridian, and both alts. must of course be observed on the same side.

The degree of dependance is easily estimated by changing the diff. of alts. by the amount of probable error, as about 1′ or 2′: Thus, 1′ error of diff. alts. produces in Ex. 1 an error of 1°¼, while in Ex. 2 it produces an error of only 14′. *

* The work of finding the Azimuth is much lessened by the use of suitable tables. Burdwood and Davis's Azimuth tables and Star Azimuth tables extend from the equator to 60° latitude, and are published in a convenient form by J. D. Potter, 145 Minories, London, E. Such tables are indispensable for the navigation of iron ships. *See* also Lecky's "Wrinkles," for stars.

# CHAPTER V.

## FINDING THE LATITUDE.

I. BY THE MERIDIAN ALTITUDE. II. BY THE REDUCTION TO THE MERIDIAN. III. BY DOUBLE ALTITUDE OF THE SAME BODY. IV. BY DOUBLE ALTITUDE OF DIFFERENT BODIES. V. BY THE ALTITUDE OF THE POLE STAR.*

680. The pole remains always in the same absolute fixed position from whatever point of the earth's surface it is viewed; its altitude at any particular place is, therefore, always the same. The position of the equator, which is 90° from the pole, is also always the same at the same place, and is determined by reference to the celestial bodies, whose declinations are measured from it. The latitude of the place may, therefore, be determined directly by observation, and independently of the latitude of any other place.

When the body observed is on the meridian (at which time its altitude ceases to change) the time is not noted; but if it is not on the meridian, either the absolute time must be given, or a second altitude must be obtained after a measured interval.

## I. BY THE MERIDIAN ALTITUDE.

681. The simplest, and in general the most satisfactory, method of determining the latitude, is by observation of the altitude of a celestial body when on the meridian of the place.†

* The several methods of latitude which are given in this work under the heads enumerated above, and which may be considered as distinct methods, of which the solution depends on circumstances as elsewhere described, amount to eight. The seaman, who will remember the adage, "lead, latitude, and look-out," scarcely needs to be reminded that the latitude is often the only element necessary,—that headlands on vast tracts of coast are approached, and numerous passages or channels taken, by reference to latitude alone,—and that the time, and therefore the longitude itself, depends on the latitude. In these days, also, when such great and continued velocity is attained, in steam-vessels, increased facilities are demanded for determining the place of the ship from time to time; the seaman accordingly should be furnished with a method of finding the latitude (provided it be convenient and satisfactory) adapted to every occasion that may present itself by day and by night.

† The manner of deducing the latitude from the mer. alt. and declin. is fully described in No. 452.

## 1 *Meridian Altitude of the Sun.*

682. *The Observation.* When the sun is near the meridian, continue to observe the altitude till it is found to decrease; the *greatest* alt. reached is the mer. alt.*

In latitudes above 66°½ the sun, being above the horizon the whole 24 hours during part of the summer months, may often be observed below the pole at midnight; in this case the *smallest* altitude is the mer. alt.†

When accuracy is required, note the barom. and therm.

683. *The Computation. At Sea.* (1.) Take the sun's decl. from the Nautical Almanac, page I., or Table 60, for the noon of the day, and reduce it by Table 19 for the longitude by account.

(2.) Correct the alt. for index error, dip, semidiameter, and refraction, No. 647; subtract it from 90°, the remainder is the zenith distance.

(3.) When the observer is to the N. of the sun, call the zen. dist. *north;* when he is to the S. of the sun, call it *south.*

When the zen. dist. and decl. are of the *same* name, take their *sum;* when of *contrary* names, take their *difference:* the result is the lat.

When the decl. and zen. dist. are of the *same name*, the lat. is also of *that name;* when the decl. and zen. dist. are of *different* names, the lat. takes the name of the *greater*.‡

Ex. 1. May 3d, 1902, long. 38° W., obs. Mer. Alt. ⊙ 56° 10′ to the southward, ind. corr. + 2′, height of eye 20 feet: required the Latitude.

| | | | |
|---|---|---|---|
| Decl. 3d, Table 60, | | | 15° 29′ N. |
| Corr. for 38° W. | | | + 2 |
| Red. Declin. | | | 15 31 N. |
| Obs. Alt. ⊙ | | 56° 10 | |
| Ind. Corr. | + 2′ | } − 2 | |
| Dip | − 4 | | |
| App. Alt. ⊙ | | 56 8 | |
| Refr. | − 1′ | } + 15 | |
| Semid. | + 16 | | |
| True Alt. | | 56 23 | |
| Zen. Dist. | | 33 37 | 33 37 N. |
| Latitude | | | 49 8 N. |

Ex. 2. July 4th, 1902, long. 101° E.; obs. Mer. Alt. ⊙ 81° 59′ bearing north, ind. corr. 0, height of eye, 16 feet: required the Latitude.

| | | |
|---|---|---|
| Decl. 4th, | | 22° 57′ N. |
| Corr. for 101° E. | | + 1 |
| Red. Declin. | | 22 58 N. |
| Obs. Alt. | 81° 59 | |
| Table 38, | + 12 | |
| True Alt. | 82 11 | |
| Zen. Dist. | 7 49 | 7 49 S. |
| Latitude | | 15 9 N. |

* At sea it is usual to keep advancing the index till the sun has *dipped*, but it is better to take separate altitudes.

† Since the sun, moon, and planets, change their declinations, the mer. alt. is not always the *maximum* or *minimum* altitude. Near the equator the difference, which is as the tangent of the latitude nearly, is very minute. In lat. 60° the sun's alt. will be maximum, in the extreme case, at half a min. from the meridian, and the altitudes will differ only 0″·4; in the same latitude these quantities will be, for the moon, 7′ and 2′ respectively. As 0″·4 is inappreciable by ordinary instruments, and as the moon can be employed for approximation only, it is not necessary to tabulate this correction.

‡ A ship, on board which the declination had been applied the wrong way, made the Orkney Islands, in coming from the westward, instead of the Channel. A few years ago a ship bound homewards from Australia round C. Horn got too far to the southward; a similar

**When the declin. is 0, the zen. dist. is the latitude; and when the zen. dist. is 0, the declin. is the latitude.**

Ex. 3. March 21st, 1902, long. 15° W.; obs. mer. alt. ☉ 48° 16′ bearing N., index error − 5′, eye 16 feet. find the Latitude.

| | |
|---|---|
| Decl. 21st | 0° 1′ S. |
| Corr. for long. 15° W. | − 1 |
| Red. Decl. | 0 0 |
| Obs. Alt. ☉ | 48° 16′ |
| Index − 5′; Semi. − 16; Dip − 4; Ref. − 1 | − 26 |
| True Alt. | 47 50 |
| Zen. Dist. | 42 10 S. |
| Decl. | 0 0 |
| Latitude | 42 10 S. |

Ex. 4. July 13th, 1902, long. 49° W.; obs. mer. alt. ☉ 89° 44′ N., index error + 4′, eye 18 feet: find the Latitude.

| | |
|---|---|
| Decl. 13th | 21° 56 N. |
| Corr. for long. 49° W. | − 1 |
| Red. Decl. | 21 55 N. |
| Obs. Alt. ☉ | 89° 44′ |
| Index + 4′; Table 38 + 12 | + 16 |
| True Alt. | 90 0 |
| Zen. Dist. | 0 0 |
| Decl. | 21 55 N. |
| Latitude | 21 55 N. |

Ex. 5. March 21st, 1902, long. 60° E., obs. mer. alt. ☉ 56° 26′ N., index error + 2′, eye 20 feet: required the Latitude. Red. decl. 0° 5′ S. True alt. 33° 21′. Lat. 33° 26′ S.

Ex. 6. Aug. 5th, 1902, long. 47° W., obs. mer. alt. ☉ 72° 47′ N., index error + 2′, eye 16 feet. Red. decl. 17° 8′ N. True alt. 73° 1′. Lat. 0° 9′ N.

Ex. 7. March 20th, 1902, long. 90° W., obs. mer. alt. ☉ 89° 48′ S., index error − 1′, eye 12 feet. Red. decl. 0° 19′ S. True alt. 90°. Lat. 0° 19′ S.

Ex. 8. Jan. 1st, 1902, long. 138° W., obs. mer. alt. ☉ 89° 55′ S., index error + 2′, eye 12 feet. Red. decl. 23° 3′ S. True alt. 90° 10′. Lat. 23° 13′ S.

Ex. 9. June 20th, 1902, long. 172° W., obs. mer. alt. ☉ 52° 18′ S., index error − 2′, eye 60 feet (the top). Red. decl. 23° 27′ N. True alt. 52° 23′. Lat. 61° 4′ N.

Ex. 10. Feb. 18th, 1902, long. 71° E., obs. alt ☉'s centre (by bisecting the cloudy disc, No. 539), 48° 22′ S., eye 18 feet. Decl. 11° 55′ S. True alt. 48° 17′. Lat. 29° 48′ N.

Ex. 11. Dec. 20th, 1902, long. 160° E, obs. mer. alt. ☉ 28° 18′ S., above the sea horizon 2½ miles distant, eye 20 feet. Red. decl. 23° 25′ S. True alt. 28° 26′. Lat. 38° 9′ N.

**684. When the sun is observed below the pole (at midnight), instead of subtracting the true alt. from 90°, add 90° to it; the lat. will be of the same name as the declin.**

Ex. 1. June 5th, 1902, long. 29° E. at $12^h$ P.M., obs. mer. alt. ☉ below the pole 3° 38′ N., ind. corr. + 2′, height of eye 20 feet: required the Latitude.

| | |
|---|---|
| Red. Declin. No. 579 (2), | 22° 31′ N. |
| Obs. Alt. ☉ | 3° 38′ |
| Ind. Corr. + 2′; Dip. − 4 | − 2 |
| | 3 36 |
| Refr. − 13′; Semid. + 16 | + 3 |
| True Alt. | 3 39 |
| Supp. Zen. Dist. | 93 39 |
| Decl. | 22 31 N. |
| Latitude | 71 8 N. |

Ex. 2. Nov. 13th, 1902, long. 98° W. at $12^h$ P.M., obs. mer. alt. ☉ below the pole 5° 37′ S., ind. corr. − 2′, height of eye 30 feet.

| | |
|---|---|
| Declin. Noon | 17° 48′ S. |
| Corr. for $12^h$ *add* 8′; 98° W. *add* 4 | 12 |
| Red. Declin. | 18 0 S. |
| Obs. Alt. | 5° 37′ |
| Ind. Corr. − 2′; Table 38 + 2 | 0 |
| True Alt. | 5 37 |
| Supp. Zen. Dist. | 95 37 |
| Decl. | 18 0 S. |
| Latitude | 77 37 S. |

blunder was discovered to have been made, but the existence of an error in the latitude was suspected only from the circumstance of the ship being beset with ice.

In crossing the meridian of 180°, when the long. changes from W. to E., or from E. to W., care must be taken to change the application of the corr. of the declin accordingly. The neglect of this precaution has been a fertile source of mistakes.

685. *Accurately.* Reduce the declin. to the nearest second for the long., correct the refraction for the barom. and therm. and add the sun's parallax.

As the sun passes the meridian at $0^h\ 0^m\ 0^s$ App. Time, the Greenwich Date may be deduced in App. Time by means of the long. in time, No. 576 (3). Or it may be taken at once from the chronometer, in which case it will be in Mean Time, as is supposed in Ex. 1, following.

Ex. 1. March 20th, 1878, long, 1° 25′ W., obs. mer. alt. ☉ in the mercury 69° 8′ 10″ bearing S., time by chron. $20^d\ 0^h\ 13^m\ 12^s$, index error + 1′ 10″, bar. 29·5 inches, therm. 40°.

| | |
|---|---|
| ☉'s Decl. 20th | 0° 5′ 38″·7 S. |
| 21st | 0 18 2·4 N. |
| Daily Var. | 23 41·1 |
| $13^m\ 12^s$, var. 23′ 41″ | −12·6 |
| | 0 5 38·7 S. |
| Red. Decl. | 0 5 26·1 S. |
| Obs. Alt. | 69° 8′ 10″ |
| | +1 10 |
| | 2)69 9 20 |
| | 34 34 40 |
| Ref. −1′ 25″; Ther. + 2; Bar. − 1 | −1 24 |
| | 34 33 16 |
| Semid. | +16 5 |
| Par. | + 7 |
| True Alt. | 34 49 28 |
| Zen. Dist. | 55 10 32 N. |
| Decl. | 0 5 26 S. |
| LAT. | 55 5 6 N. |

Ex. 2. June 20, 1878, long. 26° 5′ E., at midnight, obs. mer. alt. ☉ in the quicksilver 26° 26′ 20″, index 0′, bar. 29·8 inches, therm. 34°.

| | |
|---|---|
| Green. Date, A.T. June | $20^d\ 10^h\ 15^m\ 40^s$ |
| Reduced Decl. | 23° 27′ 16″ N. |
| Obs. Alt. | 26° 26′ 20″ |
| | 13 13 10 |
| Ref. −4′ 4″; Ther. + 8; Bar. − 1 | −3 57 |
| | 13 9 13 |
| Semidiam. | +15 46 |
| Par. | + 8 |
| True Alt. | 13 25 7 |
| Supp. Zen. Dist. | 103 25 7 |
| Decl. | 23 27 16 N. |
| LAT. | 79 57 51 N. |

Ex. 3. July 27th, 1878, long. 2° W., obs. mer. alt. ☉ in the quicksilver 116° 2′ 30″, zenith N. ind. corr. + 2′ 15″. bar. 30·0 inch., therm. 60°: required the Latitude.

Green. Date (A.T.), $27^d\ 0^h\ 8^m$; Red. Decl. 19° 12′ 17″ N.; True Alt. 57° 46′ 4″ 2 LAT. 51° 26′ 13″ N.

686. When the altitude of either limb of the sun is observed, and the alt. of the other limb (which will appear the *same* in the instrument) is observed from the opposite point of the horizon (No. 535), take half the diff. of these angles and *add* to it the correction of alt.; the sum is the true zen. dist.

Ex. 1. Aug. 5th, 1878, long. 25° W.

| | |
|---|---|
| Obs. Alt. ☉ N. | 115° 46′·3 |
| S. | 63 49·3 |
| Diff. | 51 57 |
| | 25 58·5 N. |
| Corr. of Alt. | +·4 |
| Zen. Dist. | 25 58·9 N. |
| Red. Decl. | 16 56·3 N. |
| LAT. | 42 55·2 N. |

Ex. 2. Oct. 20th, 1878, long. 1° W.

| | |
|---|---|
| Obs. alt. ☉ N. | 105° 5′ |
| S. | 74 32·2 |
| Diff. | 30 32·8 |
| | 15 16·4 N. |
| Corr. of Alt. | +·2 |
| Zen. Dist. | 15 16·6 N. |
| Red. Decl. | 10 23·9 S. |
| LAT. | 4 52·7 N. |

Thus it appears that this observation, which is the most efficient in practice, is also the shortest in computation.

Ex. 3. July 15th, 1878, alt. ☉ N. 93° 58′, S. 85° 38′, long. 71° W. LAT. 25° 39′·7 N.

Ex. 4. July 4th, 1878, alt. ☉ N. 81° 59′, S. 97° 40′, long. 83° E. LAT. 15° 3′·7 N.

## 2. Meridian Altitude of a Star or a Planet.*

687. *The Observation* is the same as for the sun, but it is still more necessary to take separate altitudes of a star in order to avoid straining the eye to perceive its small rise or fall when near the meridian. See No. 542.

688. *The Computation. At Sea.* (1.) Take the decl. either from the Nautical Almanac, or, in the case of a star, from Table 63.

(2.) Correct the alt. for index-error, dip, and refraction, No. 652. Find the zenith dist. and proceed as for the sun.

Ex. 1. May 15th, 1878, obs. mer. alt. of Spica 33° 17′ S. index error + 1′ 20″, eye 30 feet.

| | | |
|---|---|---|
| Obs. Alt. | | 33° 17′ S. |
| Index err. | + 1′ | |
| Dip | − 5 | − 5 |
| Ref. | − 1 | |
| True Alt. | | 33 12 S. |
| Zen. Dist. | | 56 48 N. |
| Star's Decl. | | 10 32 S. |
| LAT. | | 46 16 N. |

Ex. 2. April 9th, 1878, P.M. long. 126° W., obs. alt. of Mars 49° 20 N., index corr. + 3′, eye 16 feet.

In N. A. page 244, the M.T. of mer. pass. of Mars is Aug. 9ᵈ 3ʰ 36ᵐ. The Green. Date is Aug. 9ᵈ 12ʰ 0ᵐ, and the Red. Decl. is 23° 39′ N.

| | | |
|---|---|---|
| Obs. Alt. | | 49° 20′ N. |
| Index Corr. | + 3′ | |
| Dip | − 4 | − 2 |
| Ref. | − 1 | |
| True Alt. | | 49 18 |
| Zen. Dist. | | 40 42 S. |
| Red. Decl. | | 23 39 N. |
| LAT. | | 17 3 S. |

Ex. 3. Dec. 21st, 1878, obs. mer. alt. Aldebaran 50° 27′ N.; height of eye 20 feet; required the Latitude. LAT. 23° 22′ S.

Ex. 4. Jan. 1st, 1878, obs. mer. alt. Sirius 81° 13′ S., ind. corr. − 4′, height of eye 18 feet: required the Latitude. LAT. 7° 38′ S.

Ex. 5. Feb. 18th, 1878, obs. mer. alt. Canopus 37° 25′ S., ind. corr. + 2′, height of eye 16 feet: required the Latitude. LAT. 0° 0′

Ex. 6. Feb. 1st, 1878, obs. mer. alt. Arcturus 80° 12′ N., ind. corr. + 4′, height of eye 18 feet: required the Latitude. LAT. 10° 1′ S.

Ex. 7. Feb. 18th, 1878, obs. mer. alt. α Lyræ, below the pole, 12° 30′, ind. corr. + 2′, height of eye 18 feet: required the Latitude. LAT. 63° 44′ N.

Ex. 8. Oct. 6th, 1878, long. 87° W., obs. mer. alt. Mars 57° 45′ S., index corr. − 2′, height of eye 18 feet. LAT. 30° 15′ N.

Ex. 9. July 6th, 1878, long. 178° E., obs. mer. alt. Jupiter 57° 50′ S., index corr. + 3′, height of eye 20 feet. LAT. 13° 2′ N.

Ex. 10. Jan. 6th, 1878, long. 169° W., obs. mer. alt. Venus 69° 54′ S., index corr. − 1′, height of eye 15 feet. LAT. 9° 15′ N.

689. *Accurately.* Take the decl. from the Nautical Almanac. For a planet find the Gr. Date, and reduce its hor. par. and decl. Correct the refraction for the thermometer and barometer.

690. Stars which never set at the place may be observed both above and below the pole. In this case the latitude is half the sum of the altitudes corrected for refraction.

691. If two stars are observed on the meridian, on different sides of the zenith, and at equal altitudes, the result is independent of the refraction, unless it changes in the interval of the observations. If the altitudes are not equal, the result involves only the difference of the refractions proper to each.

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* Venus may often be observed by daylight, even in high latitudes.

### 3. *Meridian Altitude of the Moon.*

692. *The Observation.* The same as for the sun. See No. 540.

693. *The Computation. At Sea.* (1.) Find the Green. Date by means of the time at ship; or, if this time is uncertain several minutes, find the M.T. of the moon's mer. pass., No. 627, &c. Reduce thereto the moon's decl., No. 589, her hor. par., and take the corresponding semid. from Table 40, all to the nearest minute.

(2.) Correct the observed alt., No. 654, and proceed as for the sun, No. 683 (3).

Ex. 1. Nov. 3d, 1878, long 150° 15′ E., at $7^h\ 7^m$ P.M. mean time at ship, obs. alt. ☽ 45° 13′ S., height of eye 16 feet.

| | |
|---|---|
| M.T.S. Nov. | $3^d\ 7^h\ 7^m$ |
| Long. in time | −10 1 E. |
| M.T.G. Nov. | 2 21 6 |
| ☽'s Decl. at $21^h$ | 14° 47′ 45″ S. |
| $6^m$, var. 119″ | −1 11 |
| Red. Decl. | 14 46 34 S. |
| Hor. Par. | 54′ 50″ |
| Semid. | 14 58 |
| Obs. Alt. ☽ | 45° 13 |
| Dip −4, Semid. +15 | +11 |
| | 45 24 |
| 45° 20′, and H.P. 55′ | +38 |
| True Alt. | 46 2 |
| Zen. Dist. | 43 58 N. |
| Decl. | 14 47 S. |
| LAT. | 29 11 N. |

Ex. 2. May 20th, 1878, A.M. long. 114° W., obs. mer. alt. ☽ 48° 48′ S., height of eye 18 feet.

| | |
|---|---|
| Moon's Mer. Pass. | $19^d\ 15^h\ 12^m$ |
| Corr. for Long. | +16 |
| M.T. Mer. Pass. at ship | 19 15 28 |
| Long. in time | 7 36 |
| M.T.G. May | 19 23 4 |
| ☽'s Decl. at $23^h$ | 24° 34′ 22″ S |
| $4^m$, var. 69″ | −8 |
| Red. Decl. | 24 34 14 S. |
| Hor. Par. | 56′ 33″ |
| Semid | 15 26 |
| Obs. alt. ☽ | 48° 48 |
| Dip −4′, Semid. −16 | −20 |
| | 48 28 |
| 48° 30′ and H.P. 57′ | +37 |
| True Alt. | 49 5 |
| Zen. Dist. | 40 55 N. |
| Decl. | 24 34 S. |
| LAT. | 16 21 N. |

Ex. 3. Dec. 21st, 1878, A.M. long. 149° W., obs. mer. alt. ☽ 84° 9′ N. index corr. + 2′, height of eye 14 feet.
LAT. 31° 14′ S.

Ex. 4. Aug. 10th, 1878, P.M. long. 134° E., obs. mer. alt. ☽ 59° 44′ N., index corr. − 1′, height of eye 18 feet.
LAT. 53° 48′ S.

It will in general be loss of time to work nearer than to minutes, because the moon's declination cannot be found to seconds unless the Greenwich time is known with precision.*

694. When both the upper and lower limbs are well defined, the suppl. of the alt. can be observed, and the precept No. 683 applied. When only one limb can be observed, the semi-diameter must be applied.

695. *Degree of Dependance.* The error of the resulting lat. is obviously the sum or difference of the errors of alt. and decl. The lat. by the sun at sea may be depended upon within 2′ or less, that by the moon not so nearly, and the lat by a single star in a dark night perhaps not within 3′ or 4′.

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* Also as the moon at certain times changes her declination very rapidly, or 17′ an hour, her mer. alt. may differ considerably from the maximum alt.; and an interval of several minutes may occur between these two altitudes. See note †, p 244.

Errors of observation or of the instrument may be removed b employing celestial bodies of nearly equal altitudes N. and S. of the zenith.* (See No. 999.)

It may in general be considered that the lat. by mer. alt. is not decisively determined unless alts. on both sides of the zenith have been employed.

## II. By the Reduction to the Meridian.

696. When the sky is cloudy, or the weather variable, the sun or any other celestial body, though obscured when exactly on the meridian, frequently appears, for short intervals of time, both before and after the meridian passage.†

When the body is near the meridian, the change of alt. in a small portion of time is very small; and though the altitude near the meridian changes at a different rate in different latitudes, yet the *change of altitude* in a given small interval is not sensibly affected by a change of several miles in the latitude, and therefore it may be computed with tolerable accuracy, even when the lat. by account (which is used in the computation) is considerably in error. If, accordingly, at the time of observing an alt. near the meridian, we know the hour-angle, we may find very nearly, by computation, the difference of alt. by which to reduce the observed alt. to the mer. alt., and which is thence called the *Reduction to the Meridian.*

This method is, in point of simplicity, but little inferior to the meridian altitude, to which it is next in importance; and it particularly demands the attention of seamen, because, when the latitude by observation is left, as it too generally is, to the casualty of obtaining the merid. alt., it is frequently lost for the day.

697. The term "near the meridian" implies a meridian distance limited according to the lat., the decl., and also the degree of precision with which the time is known. The Limits are given in Table 47 See also Explan. of the Table.

698. Since the lat. by acc. is employed in computing the Reduction, it may be necessary, when this lat. has been found to be much in error, to repeat the work.

* Though the lat. by a single star may not be very correct, yet the error will in general be much less than that of the D.R. The altitude of a star also affords a certain check against the mistake of applying the sun's declination the wrong way; and it may be remarked, that a single observation of the kind would have prevented all the delay, wear and tear, and danger incurred in the cases mentioned in the note p. 244, from the ships being so far out of their proper latitudes.

† Capt. Sir Richard Grant remarks that in H.M.S. Cornwallis, alts. of the sun and stars were rarely to be obtained while within the limits of the Gulf Stream, but they had a momentary glimpse of the sun near noon once in two or three days.—Nautical Magazine, 1838, p. 437.

## 1. *Reduction to the Meridian at Sea.*

### [1.] *By the Sun.*

699. *The Observation.* When the sun is within the limits in Table 47, observe two or three altitudes,* quickly, noting the times.

When the alts. are not observed very close together, either a separate result should be obtained from each alt. with its corresponding time, or the case should be solved by No. 727.

700. *The Computation.* (1.) Take the mean of the alts. and the mean of the times.

(2.) Find the sun's hour-angle, or the time from noon, thus:

1. When the App. Time has been lately *determined by observation.* If the ship has since made *westing*, *subtract* the diff. long. made good from the A.T. found; if she has made *easting*, *add* the diff. long. to the A.T.: the result is the A.T. required.

2. When the A.T. has *not* been lately determined by observation. Find A.T. by the chron. and the long. by acc., thus: To the G.M.T. (found by applying to the chron. the gain or loss up to the time) reduce the Eq. of T. and apply it to the G.M.T., as directed page II. of the Nautical Almanac, or the *contrary* way to that directed in Table 62: the result is A.T at Greenwich. In W. long. *subtract* the long in time from this Gr. T. (increased, if necessary, by $24^h$); in E. long., *add* it: the result (rejecting $24^h$ if it exceed $24^h$) is A.T. *at ship.*

When the A.T. of observation is P.M., it is the hour-angle required; when it is A.M., subtract it from $24^h$: the rem. is the hour-angle.

If A.T. is near $12^h$, subtract it from $12^h$; if it exceed $12^h$, reject $12^h$: the rem. is the hour-angle from midnight.

Find the sun's decl., No. 579.

(3.) Correct the alt., No. 647.

(4.) Add together the logarithm from Table 70 and the log. sine square of the hour-angle: the sum is the log. sine of the Reduction.

(5.) *Add* the reduction to the true alt., unless the observation is near midnight, when *subtract* it: the result is the mer. alt. at the place where the alt. was observed; and the resulting lat. is the lat. of the ship at the time of observation (not at noon).

Having the mer. alt., proceed by No. 683 (3).

Ex. 1. Aug. 5th, 1826. H.M.S. Leven, lat. by acc. 47° N.; long. by acc. 25° W. at $11^m 48^s$ before noon; obtained true alt. ☉ 63° 54′ to the southward: required the lat. The reduced decl. was 17° 4′ N.

| | | | | |
|---|---|---|---|---|
| Lat. 47°, decl. 17° (*same* name) | 0·416 | | Mer. alt. | 64° 0′ |
| $11^m 48^s$ sine sq. | 6·821 | | Zen. dist. | 26 0 N. |
| Red. 0° 6′ sin. | 7·237 | | Red. decl. | 17 4 N. |
| 63 54 | | | LAT. | 43 4 N. |
| Mer. alt. 64 0 | | | Repeating the work gives 43° 3′ | |

* As more than one altitude would, for greater security, always be obtained when possible, we shall, to avoid repetition, consider the term "altitude" in the subsequent rules and examples, as implying the mean of two or more altitudes corresponding to the mean of the times.

Ex. 2. Lat. 55° 6′ N., ☉'s decl. 20° 4′ S., at $0^h\ 54^m\ 12^s$ P.M., sun's true alt. 14 1′ S.: required the Latitude.

The Red. is 0° 54′, mer. alt 14° 55′, and the LATITUDE 55° 1′ N.

Ex. 3. Feb. 23d, 1878, lat. by acc. 40° 5′ S., long. 132° E., at $11^h\ 45^m\ 20^s$ A.M., obs. alt ☉ 59° 40′ N., index corr. −2′, eye 20 feet: find the Latitude.

Red. decl. 9° 54′ S., true alt. 59° 49′, Red. 11′, LAT. 39° 54′ S.

Ex. 4. Dec. 12th, 1878, lat. by acc. 0° 0′, long. 162° W., at $0^h\ 11^m\ 52^s$ P.M., obs. alt. ☉ 66° 34′ S., index corr. −5′, eye 16 feet: required the Latitude.

Red. decl. 23° 7′ S., true alt. 66° 41′, Red. 11′, LAT. 0° 1′ N.

Ex. 5. June 21st, 1878, lat. by acc. 42° 18′ S., long 53° E., obs. alt. ☉ 23° 41′ N. index corr. −1′, eye 14 feet; time by watch $0^h\ 50^m\ 53^s$ P.M., fast on A. T. $14^m\ 28^s$, diff. long made since 20′ E.: find the Latitude.

Red. decl. 23° 27′ N., true alt. 23° 50′, Red. 35′, LAT. 42° 8′ S.

**701. When the number of minutes of arc, in the Reduction, exceeds the number of minutes of time from the meridian, it is proper to refer to Table 48, to ascertain if it be necessary to employ the *Second Reduction*.**

**Ex. 1. (The preceding.) The number of min. in the Reduction, or 6, being less than the number of min. of time, or 11, it is not necessary to refer to the Table.**

*To Compute the 2d Red.* Double the log. sine of the Red.; add to it the log. tan. of the mer. alt. found, and the constant 9·6990: the sum (rejecting tens) is the log. sine of the 2d Red.

This is to be *subtracted* from the 1st Red. (above the Pole), that is applied to the alt. the *contrary way* to that of the 1st Red.

Ex. 2. May 5th, 1878, lat. acc. 5° 3 N., long. 71° 10′ E; time by watch $5^h\ 3^m\ 7^s$ P.M., fast on app. time at ship $4^h\ 47^m\ 27^s$: obs. alt. ☉ 77° 59′ N; height of eye 16 feet.

| | | | | |
|---|---|---|---|---|
| Time by Watch | $5^d$ | $5^h$ | $3^m$ | $7^s$ |
| Fast | | −4 | 47 | 27 |
| A.T.S. | 5 | 0 | 15 | 40 |
| Long. in Time | | −4 | 44 | 40 |
| A.T.G. | 4 | 19 | 31 | 0 |

| | | | |
|---|---|---|---|
| Decl. | 16° 1′ N. | Obs. Alt. | 77° 59′ |
| Corr. | + 14 | Table 38 | + 12 |
| Red. Decl. | 16 15 N. | True Alt. | 78 11 |

| | | | |
|---|---|---|---|
| Lat. 5°, Decl. 16¼° (*same name*) | | | 0·992 |
| $0^h\ 15^m\ 40^s$ | | sin sq. | 7·067 |
| | 39′ | sin. | 8·059 |
| True Alt. | 78 11 | | 2 |
| | | | 6·118 |
| | 78 50 | tang. | 0·705 |
| | | const. | 9·699 |
| | −1 | sin. | 6·522 |
| Mer. Alt. | 78 49 | | |
| Zen. Dist. | 11 11 S. | | |
| Decl. | 16 15 N. | | |
| LAT. | 5 4 N. | | |

Ex. 3. Jan. 6th 1878, A.M., lat. acc. 1° 10′ N., long. 58° E., at $8^h\ 4^m\ 53^s$ by watch, $3^h\ 36^m\ 28^s$ slow on A.T., long. made since 23′ W.; obs. alt. ☉ 65° 13′ S, height of eye 16 feet: required the Latitude.

Red. decl. 22° 30′ S., Red. 31′, 2d Red. 0′, LAT. 1° 34′ N

Ex. 4. Sept. 15th, 1878, lat. acc. 4° 58′ S., long. 110° W., at $0^h\ 11^m\ 19^s$ P.M. A.T. obs. alt. ☉ 81° 33′ N., index error −2′, eye 16 feet: find the Latitude.

Red. decl. 2° 52′ N., Red. 30′, 2d Red. 1′, LAT. 4° 6′ S

702. If a second altitude, some time after the first, do not confirm the lat., the time is probably in error. In such cases the mean latitude is *not* to be taken as the true latitude, because that result which is nearest to the meridian is the best.

If the time only is in error, it will be easy to find, by trial, that time from noon which will make the two results agree; and thus this observation may serve to correct, approximately, the error of the watch. When the interval, however, between the alts. amounts to $6^m$ or $8^m$, the case should be solved as a *Short Double Altitude*, No. 720.

[2.] *By a Star, a Planet, or the Moon.*

703. Compute the hour-angle: this must be done by means of the time at ship, by No. 611 or 612. But in general it will be better to observe the alt. of a star nearly E. or W., and to deduce its hour-angle, as directed in No. 737.

In other respects proceed as above directed. When the decl. exceeds 24°, the log., Table 70, must be computed.

704. *Degree of Dependance.* The error of the result is composed of that of the mer. alt., No. 695, together with that of the computed Red., which latter, when well within the limits of Table 47, will rarely be worth notice.

## 2. *Circummeridional Altitudes.*

705. On shore, when the time is accurately known, or even at sea under favourable circumstances, the result of several altitudes may be obtained by a computation which is the same in principle as the preceding, and is of much greater value than that of any single observation on or near the meridian.

[1.] *By the Sun.*

706. *The Observation.* When the sun is within the limits in Table 47, observe altitudes as fast as convenient, noting accurately the times by watch, of which the error on Apparent Time must be known or found as soon as possible afterwards.

When precision is required, note the barometer and thermometer.

707. *The Computation.* (1.) Find the Green. Date for noon at the place, in app. time, and reduce the decl. If the error of the watch is given on M.T., reduce also the Eq. of Time.

(2.) By means of the error of the watch obtain A.T. at each altitude. To these App. Times take out the Reduction in seconds from Table 49. Take the mean of the Reductions.

(3.) Find the mean of the alts., and correct it, No. 649 or 650. If the meridian alt. is not observed nearly, deduce it, No. 663, &c.

(4.) Add together the log. of the mean Reduction, the log. cos. of the lat. by acc., the log. cos. of the decl., and log. sec. of the mer. alt.: the sum is the log. of the Reduction.

(5.) At *noon*, *add* the Reduction to the mean alt.; at *midnight*, *subtract* it: the result is the mer. alt.

Ex. 1. July 9th, 1836, lat. by acc. 51° 49′ N.; long. $0^h\ 3^m$ W.; obs. alts. of the sun's lower limb, near noon, by a sextant.

| Times, by Watch. | Double Alt. ☉ |
|---|---|
| $11^h\ 58^m\ 21^s$ | 120° 28′ 0″ |
| 0 0 47 | 120 30 30 |
| 0 3 40 | 120 32 37 |
| 0 25 46 | 120 7 0 |
| 0 30 39 | 119 51 40 |

At $11^h\ 55^m\ 1^s$ by watch the watch was $2^m\ 10^s{\cdot}9$ fast on M.T., and at $0^h\ 44^m\ 51^s$ it was $2^m\ 8^s{\cdot}7$ fast.

Ind. corr. + 54″, barom. 29·8 inches, therm. 66°.

The observation being at noon in long. $0^h\ 3^m$ W., the Gr. Date is July 9th, $0^h\ 3^m$, app. time.

The reduced Eq. of T. is $4^m\ 49^s{\cdot}4$, *subtr.* from M.T.; red. decl. 22° 21′ 11″ N.

| Error on App. T. | |
|---|---|
| T. by W. | $11^h\ 55^m\ 1^s$ |
| Fast | 2 11 |
| M.T. | 11 52 50 |
| Eq. of T. | − 4 49 |
| App. T. | 11 48 1 |
| T. by watch | 11 55 1 |
| W. fast on A.T. | 7 0 |
| | |
| Sum of Alts. | 601° 29′ 47″ |
| | 120 17 57 |
| | + 54 |
| 2) | 120 18 51 |
| | 60 9 25 |
| | + 15 45 |
| Mean Alt. | 60 25 10 |
| Approx. Mer. Alt. | 60 32 |

| App. Times | Reductions |
|---|---|
| $11^h\ 51^m\ 21^s$ ......... | 146″·9 |
| 11 53 47 ......... | 75 ·9 |
| 11 56 40 ......... | 21 ·8 |
| 0 18 46 ......... | 691 ·1 |
| 0 23 39 ......... | 1097 ·2 |
| 5) | 2032 ·9 |
| | 406 ·6 |
| 60° Refr. | 33″ |
| Par. | − 4 |
| Mean Corr. | 29 |
| Th. 61°, Alt. 60°, −0″·9; Bar. 29·8, −0 ·2 | − 1 |
| True Corr. | 28 |
| | 60 25 10 |
| True Alt. | 60 24 42 |

| | | |
|---|---|---|
| 406·6 log. .................. | | 2·6092 |
| Lat. | cos. | 9·7911 |
| Decl. | cos. | 9·9661 |
| M. Alt. | sec. | 0·3079 |
| 472″·4 log. | | 2·6743 |
| 472″ = | | 0° 7′ 52″ |
| | | 60 24 42 |
| Mer. Alt. | | 60 32 34 |
| Zen. Dist. | | 29 27 26 N. |
| Declin. | | 22 21 11 N. |
| LAT. | | 51 48 37 N. |

708. To compute the 2d Reduction.

Take from Table 50 the 2d Reductions (these will be sensible in the larger hour-angles only), and divide the sum by the whole number of altitudes.

To twice the sum of the three logs. used before (namely, lat., decl., and alt.) add the log. of the mean of the 2d Reductions; the sum is the log. of the 2d Red. required.

| Ex. (Ex. 1 preceding.) | | | | |
|---|---|---|---|---|
| $23^m\ 39^s$ | 2d R. | 2″·9 | 3 logs. | 0·0651 |
| 18 46 | | 1 ·1 | | 2 |
| | 5) | ·0 | | 0·1302 |
| | | 0 ·8 | log. | 9·9031 |
| | 2d RED. | 1″·08 | log. | 0·0333 |

Subtracting 1″·1 from 7′ 52″·4 gives the lat. omitting decimals, 51° 48′ 38″.

709. When the declin. changes considerably, take the difference between the sums of the Eastern and Western hour-angles, in decimals of an hour; multiply it by the hourly diff. of declin., and divide by the number of altitudes.

When the sun is *approaching* the elevated pole, if the E. sum is the *greater*, *add* this quotient to the Red.; if the *lesser*, *subtract* it. When the sun is *receding* from the elevated pole, the *contrary*.

Ex. 2. May 7th, 1847, lat. by acc. 55° 1′ N., long. $0^h$ $6^m$ W., obs. alt. of sun's alternate limbs in the quicksilver, near noon, with the circle; bar. 29·6 inch, therm. 52°.

| Times by W. |
|---|
| $11^h$ $38^m$ $24^s$ |
| 11 43 3 |
| 11 46 38 |
| 11 50 13 |
| 11 52 33 |
| 11 54 27 |
| 11 57 15 |
| 11 59 21 |
| 0 6 5 |
| 0 7 19 |
| 0 9 37 |
| 0 11 53 |
| 0 14 5 |
| 0 17 17 |
| 0 21 27 |
| 0 25 33 |

During the observation the angle was carried twice quite round the limb, and the final angle registered was

211° 59′ 30″ which
Increased by 1440 0 0 gives
Total Angle Measure } 1651 59 30

The error of watch at noon, as determined by equal alts., was $2^m$ $3^s$·0 *fast* on A. T.

The obs. being made at noon in long. $0^h$ $6^m$, the Green. Date is May 7th, $0^h$ $6^m$ in App. Time.

Sun's Decl. at Green. Date, 16° 43′ 1″ N.

To find Approx. Mer. Alt.

Decl. 16° 43′
90
106 43
Lat. − 55 1
Mer. Alt. 51 42

Sum of Alts. 16) 1651° 59′ 30″
2) 103 14 58
Obs. Alt. 51 37 29
True Alt. 51 36 49

| App. Times | Reductions | 2d Reds |
|---|---|---|
| $11^h$ $36^m$ $21^s$ ... | 1097·2 .................. | 2″·9 |
| 11 41 0 ... | 708·3 .................. | 1 ·2 |
| .................. | .................. | .................. |
| 0 23 30 ... | 1083·3 .................. | 2 ·8 |
| Sum | 5817·4 | 16) 9 ·6 |

To find the Effect of a Change of Declin.
The Sum of the E. H.-ang. is $97^m$ $30^s$
Do. Western do. 94 53
Diff. of E. and W. H.-ang. 2 37
Or ·$05^h$
Hourly Diff. 41·32
16) 2·0660
·13

Effect of Change, Decl. is 0″·13 only.

Do. ÷ 16 363·6 log. 2·5606 0 ·6 log. 9·7781
Lat. 55° 1′ cos. 9·7584 }
Decl. 16 43 cos. 9·9812 } 9·9474
Mer. Alt. 51 42 sec. 0·2078 } 2
322·2 log. 2·5080 9·8948 9·8948
322″ = 5′ 22″ 2d Red. 0·5 log. 9·6729
Alt. 51 36 49
Mer. Alt. 51 42 11, and Lat. 55° 0′ 50″

710. The rate of the watch must be allowed for in deducing each hour-angle. In the case of the sun the rate should be found upon A. T., but it is of course near enough for this purpose to employ M. T.

711. An error in the absolute time affects all the hour-angles alike, but it produces the greatest errors in the greater Reductions. The higher the altitude, the greater is the precision required in the time.

When the time is inaccurate the Reductions on one side of the meridian will be too great, and on the other too small; if, therefore, the altitudes P.M. be taken so as to correspond nearly with those A.M. the errors of the Reductions will very nearly compensate.

This distribution of the altitudes, by equalising the number of the hour-angles A.M. and P.M. has also the advantage of neutralising the effect of a change of declination. It is proper, moreover, to multiply the observations near the meridian, in order to weaken, by subdivision, the small errors to which the outer reductions may be liable

712. The effect of *irradiation*, or the increase of the sun's apparent diameter caused by the extreme brightness, and which may amount to 5″ or 6″ (Dr. Robinson on Irradiation, "Mem Roy. Ast. Soc." vol. iv.), is removed by observing both limbs.

[2.] *By a Star or a Planet.*

713 *The Observation* is the same as for the sun, No. 706.

714. *The Computation.* (1.) Having the error of the watch on M.T., find the Greenwich Date. Reduce thereto the Sidereal Time at mean noon, and also the R.A. and decl.; and for a planet, the hor. par.

(2.) Find the hour-angle at each alt. and proceed as for the sun.

When the watch shews Sid. Time, the hour-angles are obtained at once.

715. The stars near the poles, and especially the pole-star, are the best adapted to this observation; because, from the slowness of the motion in altitude, an error of time produces but little error in the Reduction.

716. Errors of altitude, of whatever kind, are removed by employing two bodies on opposite sides of the zenith, and at equal altitudes. A single result, even though obtained with the circle, and without the roof, cannot accordingly be considered definitive when extreme precision is required.

717. Therefore, in the northern hemisphere the best south stars to pair with Polaris are those whose meridian altitudes are about the same as the latitude of the place.

Similarly, in taking Lunars, stars lying at about equal distances, east and west of the moon, should be chosen. *See* No. 861.

## III. By Double Altitude of the *Same* Body.

718. Two altitudes, of the same or different celestial bodies, with the interval of time between them, constitute an observation which is called a Double Altitude.* The interval may extend from a few minutes to several hours. *See* **Sumner's Method**, No. 1009.

719. When a double altitude of the same body is taken, the precepts below will be convenient in directing the method of solution proper for the case.

Also, when a first altitude has been obtained, the observer will find, on referring to the numbers indicated, under the heads *Observation* and *Limits*, instructions how to complete the observation in the manner adapted to the circumstances.

Selection of the Method of Solution.

When *both alts.* are not far from the meridian, on the same side, No. 729; on different sides, No. 731; in a doubtful case, No. 728.

When *one alt.* is near the meridian, No. 737.

When *neither alt.* is near the meridian. If the lat. by acc. is not greatly in error, No. 746. If it is greatly in error, or if it is proposed to do without it, No. 757.

* This is the old-established term; it is, however, defective, inasmuch as the word *double* means *twice* the *same*. Since the process involves two altitudes used in combination with one another, the term which would naturally suggest itself is *Combined Altitudes*: we should then have, accordingly, combined altitudes of the same or different bodies, and of long or short intervals. This term, therefore, which is accurate as respects definition, would be clear and descriptive in use. All changes in nomenclature, in this subject, however, must be made with caution.

### 1. *Short Double Altitude.*

720. When the time is not known with some degree of precision, the Reduction to the meridian cannot be computed. In such cases recourse must be had to two altitudes separated by a short interval, and not very distant from the meridian.

721. The change of altitude in a small interval of time (No. 696) depends chiefly on the hour-angle or meridian distance, and is nearly the same for a considerable difference of latitude. Although altitudes at sea are always more or less uncertain, yet *difference* of alt. may often be obtained with much precision. If, therefore, the difference of alt. in a small interval of time be measured by an instrument, the hour-angle corresponding may be found by computation. The Reduction to the meridian being then computed for this hour-angle, the latitude is obtained by the method in the last section.

722. The error of the watch is immaterial, but its *rate* should be known nearly enough for measuring the interval without much error.

723. When the altitudes are observed at different places, it is necessary to allow for the ship's run in the interval.

724. Since the lat. by acc. is necessary in computing the Reduction, the work should be repeated when this lat. is found to be very erroneous.

725. *Limits.* When both alts. are taken on the *same* side of the merid., if the outer alt. fall near the limits in Table 47, the Interval should exceed one-fourth of the time of that alt. from noon, and should not be less than $5^m$. The observation may be comprised within double the mer. dist. implied in Table 48.

When the alts. are taken on *different* sides, the Interval may vary from $5^m$ to twice the limit in Table 47.

#### [1.] *By the Sun.*

726. *The Observation.* Observe an alt.* and note the time. Note the sun's bearing for the purpose of allowing for run. After the proper interval, No. 725, observe the second alt. and bearing, noting the time.

727. *The Computation.*† (1.) Subtract the first of the two times from the second (increased if necessary by $12^h$); the rem. is the In-

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* Two only, or at most three, altitudes taken in quick succession would be employed in observations with a short interval.

† The first work in which a method occurs of finding the latitude by two altitudes observed near the meridian (but restricted to the *same side*) with an interval of a few minutes, is the "Cours d'Observations Nautiques," by Ducom. The advantage which Admiral W. Owen acquainted me that he had derived from the practice of this method led me to give an account of it in the "United Service Journal," vol. x., together with a rule for adapting it to longer intervals. Soon after the account appeared, Commander Graves, commanding H. M. surveying-vessel Mastiff, was enabled, as he informed me, by this observation, to run direct for Malta before the coming on of a *grecale*, or N.E. gale, to which another of Her Majesty's ships was exposed.

terval. Reduce the decln. for the time of the alt. nearest the mer., No. 579; or to the middle of the interval (that is, to noon) when the alts. are equal.

(2.) Correct the altitudes, No 648 or 649. Also correct the Interval by watch for the rate, if this is very large.

When the sun is rising or falling at both observations, proceed by Case I., No. 729; when rising at one observation, and falling at the other, proceed by Case II., No. 731.

728. When sufficient time is not afforded to perceive the rising or falling of the sun, and when it is not known otherwise whether the altitudes are taken on the same or on different sides of the meridian, proceed thus:

Consider the interval* as a time from noon; and compute the Reduction to it; then,

If the Reduction is *less* than the diff. of alts., the observations are on the *same* side; if the Reduction is the *greater*, they are on *different* sides.

Hence, if the Reduction is *equal* to the diff. of alts., one of the alts. is the meridian altitude.

No great precision is to be expected, as the rules are only approximate. In a doubtful case use either.

729. Case I. The observations on the *same* side of the meridian.

(1.) When the alts. are both A.M. reduce the 1st to the place of the 2d, No. 661; when they are both P.M. reduce the 2d to the place of the 1st, No. 662.† Find the diff. of the alts. and their mean. Correct the diff. alts. and the interval by the Table, p. 223.

(2.) Add together the log. sine of the diff. of alts., the log. cosec. of the interval, the log. sec. of the lat., the log. sec. of the decl., and the log. cos. of the mean alt.: the sum (rejecting tens) is the log. sine of the hour-angle, approximately, at the middle time between the two observations.

(3.) From this time subtract half the interval: the remainder is the time from noon of the altitude nearest the meridian.

(4.) To this time compute the Reduction, which apply to the alt. nearest the meridian, and proceed by No. 700 (5): the result is the latitude at the time and place where the alt. nearest the meridian was observed.‡

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* It is proper to remark here, that the *interval* between two observations of the sun should, in strictness, be measured in *apparent time*, instead of mean time, which is shewn by the watch. To correct the interval on this account, find the change of the Eq. of T. for the interval. When the Eq. is *additive*, if it is *increasing*, *subtract* the change; if *decreasing*, *add* it; and the contrary when the Eq. is *subtractive*. In the short double alt., however, this correction is insensible, and in long intervals the result is of so inferior a kind that the trifling accuracy gained by this process can rarely be worth the trouble bestowed upon it.

† This reduction is of particular consequence in this observation, because the accuracy of the result depends on that of the difference of altitudes.

‡ This observation, which affords the latitude, the app. time near enough for common purposes, and thence an approximate long. by chronometer, with the azimuth (No. 678), and consequently the variation of the compass, will, it is presumed, be found one of the most useful observations that can be made at sea, especially in high latitudes.

Ex. 1 Oct. 9th, 1878, A.M., lat. acc. 34° 55′ N., long. 61° W., had following obs.: height of eye 16 feet, ind. corr. +3′.

| | | | | | | |
|---|---|---|---|---|---|---|
| T. by Watch | 11h 12m 52s | Alt. ☉ 46° 47′ 50″ | | | | 48° 11′ 0″ |
| Ditto | 11 43 4 | Ind. corr. + 3 | Alt. ☉ | 47° 57′ | | 47 1 50 |
| Interval | 30 12 | Table 38 + 11 | | + 3 | | 95 12 50 |
| Half Int. | 15 6 | 47 1 50 | | + 11 | Mean Alt. | 47 36 25 |
| | | | Greater Alt. | 48 11 | Diff. Alt. | 1 9 10 |
| Decl. noon | 6° 19′ S. | | | | | |
| Corr. 61° W. | + 4 | | | | | |
| Red. Decl. | 6 23 S. | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| D. Alts. | 1° 9′ 10″ | sine | 8·3036 | Lat. 35°, decl. 6½°, Table 70 | | | 0·391 |
| Int. | 30m 12s | cosec. | 0·8814 | | 14m 2s | sin. sq. | 6·972 |
| Lat. | 34° 55′ | sec. | 0·0862 | | 8′ | sin. | 7·363 |
| Decl. | 6 23 | sec. | 0·0027 | Greater Alt | 48 11 | | |
| Alt. mean | 47 36 | cos. | 9·8289 | Mer. Alt. | 48 19 | | |
| Mid. T. | 29m 8s | sine | 9·1028 | | 41 41 N. | | |
| ½ Int. | 15 6 | | | Red. Decl. | 6 23 S. | | |
| T. fr. noon | 14 2 (of the greater alt.) | | | Lat. | 35 18 N. | | |

(The Red. for the interval 30m 12s is 37′, which being *less* than 69′, shows the observations to be on the same side of the meridian, if this were doubtful. No. 728.)

The 2d Red. is not worth notice. Repeating the work gives 35° 18′ N.

Ex. 2. Aug. 4th, 1878, lat. acc. 41° 54′ N., long. 39° W., obtained true alt. ☉ 63° 57′·5; after 11m 12s true alt. 64° 32′·5 (allowing for run). Red. decl. 17° 12′ N.; mean alt. 64° 15′; diff. alts. 35′·0.

| | | | | | | |
|---|---|---|---|---|---|---|
| 35′ 0″ | sin. | 8·0078 | Lat. 42° N., decl. 17° N. | | 0·527 |
| 11m 12s | cosec. | 1·3111 | 23m 40s | sin. sq. | 7·425 |
| 41° 54′ | sec. | 0·1282 | 0° 31′ | sin. | 7·952 |
| 17 12 | sec. | 0·0199 | 64 33 | | |
| 64 15 | cos. | 9·6379 | 65 4 | | |
| Mid. T. 29m 16s | sin. | 9·1049 | Whence Lat. 42° 8′ N. | | |
| ½ Int. −5 36 | | | | | |
| 23 40 | | | The 2d Red. is not worth notice. | | |

(The Red. for 11m 12s is 6′·9, which is less than 35′·0. See No. 728.)

Ex. 3. Aug. 11th, 1826, A.M., lat. by acc. 47° N., long. 13° W., obtained true alt. ☉ 55° 41′·9, bearing S., course E. by N. 7 knots; after 12m 14s obtained true alt. ☉ 56° 37′·9 1st alt. corrected for run, 55° 41′·6, mean alt. 56° 11′, diff. alts. 56′·3, reduced decl. 15° 23′ N Corrections, p. 205, 0.

The mid. time from noon is 1h 0m 14s. Reduction 2° 0′, mer. alt. 58° 34½′. Lat. 46° 48½′ N.

The 2d Red. by Table 48, alt. 58°, is 1′ for Red. 1° S., and therefore for Red. 1° 54′ it exceeds 1′.

730. *Degree of Dependance.* The smaller the hour-angle, the less is the effect of error in the D. alts. As the interval may, from its smallness, be assumed to be correctly measured, the value of the result depends chiefly on the difference of alts., and may be estimated by finding the effect of an error of 1′ in the diff. of alts., which is easily done. Divide the middle time by the diff. of alts., both in minutes: the quotient is the number of minutes of error in the time from noon, caused by 1′ error in the diff. of alts.: the case now becomes that of an error in the Reduction itself, No. 704.*

Ex. In Ex. 3, above, 60m divided by 56′ gives 1m·1, which is the error in the time from noon, supposing 56′ to be 1′ in error. Now, by inspecting Table 47, lat. 47° and decl. 15°, (*same* name) give 27m as the limit, or time from noon at which 1m error of time causes 2

* When the lat. is found to have been very erroneous, repetition is very easily effected, as the sec. lat. is the only log. in 729 (2) that changes.

error in the reduction: hence $1^m \cdot 1$ error at $1^h$ from noon will cause about 5′ error in the Reduction, and therefore in the latitude.

This example is not an eligible one, since $12^m$ is only 1-5th of $1^h$, instead of being not less then 1-4th. See No. 725.

731. Case II. Observations on *different* sides of the meridian.

(1.) Reduce the alts. to the place of the alt. nearest the meridian, No. 661 or 662. Find the diff. of alts.; correct it and the half interval, when necessary, by the Table, p. 223.

(2.) To the arith. comp. of the log. in Tab. 70 add the log. sine of the diff. of alts. and the log. cosec. of half the interval: the sum is the log. sine of half the diff. of the times from noon corresponding to the two altitudes.

(3.) Subtract this half diff. from the half interval: the remainder is the time from noon (or merid. dist.) of the alt. nearest the meridian.

(4.) Compute the Reduction to this time, and apply it to the alt. nearest the meridian, and proceed as directed, No. 700. The result is the latitude at the time and place where the alt. nearest the meridian was observed.

Ex. 1. April 3d, 1828, lat. by acc. 46° 2′ N., long. 17° W., the true alts. of the sun to the southward, reduced to last place of observation as below. Red. decl. 5° 23′ N.

| | | | |
|---|---|---|---|
| Times by Watch | $2^h\ 0^m\ 54^s$ | | |
| | 2 35 52 | | |
| Interval | 34 58 | | |
| Lat. 46°, decl. 5°, | ar. co. log. | 9·676 | |
| Diff. alts. 13′ 23″ | sin. | 7·590 | |
| Half. int. $17^m\ 29^s$ | cosec. | 1·118 | |
| Half. diff. —5 33 | sin. | 8·384 | |
| T. fr. noon 11 56 (of greater alt.) | | | |

| | | |
|---|---|---|
| true alt. 49° 10′ 30″ A.M., or rising. | | |
| 49 23 53 P.M., or falling. | | |
| diff. alt. 13 23 | | |
| Lat. 46°, decl. 5°, | log. | 0·324 |
| $11^m\ 56^s$ | sin. sq. | 6·831 |
| Red. 0° 5′ | sin. | 7·155 |
| Gr. alt. 49 24 | | |
| Mer. alt. 49 29 | | |

which gives the LAT. 45° 54′ N.

Ex. 2. H.M.S. Leven, Aug. 10th, 1826, lat. by acc. 46° N., long. 15° W., obtained true alt. ☉ 59° 57′·2; after $28^m\ 42^s$ true alt. 59° 20′·5, the ship having little or no way. Reduced decl. at 1st alt. 15° 40′ N.

| | | | |
|---|---|---|---|
| 46° and 16°, | | ar. co. log. | 9·573 |
| Diff. alts. | 36′ 42″ | sin. | 8·028 |
| Half int. | $14^m\ 21^s$ | cosec. | 1·204 |
| Half diff. | 14 39 | sin. | 8·805 |

This small excess of the computed ½ diff. over the ½ interval (which should be the greater) is due to the error of the method itself, which becomes apparent in a long interval, and it shews that the alt. 59° 57′·2 is very nearly the mer. alt. This gives the LAT. 45° 43′ N.

Ex. 3. Dec. 23d, 1825, lat. by acc. 8° S., observed true alts. ☉ 74° 26′ A.M. and 74° 16′ P.M., with the interval $36^m\ 37^s$. Reduced decl. 23° 27′ S.

| | | |
|---|---|---|
| | Ar. co. log. | 9·168 |
| | 10′ sin. | 7·464 |
| $18^m\ 18^s$ | cosec. | 1·098 |
| —1 14 | sin. | 7·730 |
| 17 4 | | |

| | | |
|---|---|---|
| | | 0·832 |
| | $17^m\ 4^s$ | 7·142 |
| Red. | 0° 32′ | sin. 7·974 |
| | —1 | (Table 48.) |
| | 74 26 | |
| | 75 57 | |

The Lat. is 8° 24′ S. This Ex. is far without the limits, Table 47.

Ex. 4. Aug. 9th, 1826, lat. by acc. 45° N., long. 15° W., A.M., obtained true alt. ☉ 60° 29′·5. After $52^m\ 27^s$ obtained true alt. 60° 30′. The 1st alt. reduced for 1′ northing made good in the interval is 60° 28′·5.

The diff. alts. 1′·5 and a half interval $26^m\ 16^s$ give half diff. $19^s$; the Red. is 31′, and mer. alt 61° 1′, which, with reduced decl. 15° 57′ N., give LAT. 44° 56′ N.

**732. When the alts. are equal, the half interval is the time from noon.**

733. *Degree of Dependance.* It would not be easy to give a concise rule for this in long intervals. The rule No. 730 applies very nearly in short and moderate intervals, using, instead of the "middle time," the time from noon of the alt. nearest the meridian.

[2.] *Short Double Altitude of a Star.*

734. Increase the interval by $1^s$ for every $6^m$. Take the decl. from the Nautical Almanac, or Table 63. In other respects proceed as for the sun.

[3.] *Short Double Altitude of a Planet.*

735. Find the Greenwich Date for the middle of the interval, and reduce the decl. Find the daily variation of R.A., and deduce by Table 21 the change of R.A. for the interval. When the R.A. is *increasing*, *subtract* this change from the interval; when *decreasing*, *add* it. Increase the interval by the acceleration upon it. In other respects proceed as for the sun.

As the R.A. and decl. of a planet sometimes change very slowly, much of the above labour is not always necessary: particular rules for all such cases would, however, be superfluous.

[4.] *By the Moon.*

736. Find the Greenwich Date as nearly as possible at each observation, and compute the R.A. *Subtract* from the interval the change of R.A., and add to it the acceleration. Reduce the decl. to the middle of the interval, as also the hor. par. and semid. In other respects proceed as for the sun.

As a proper allowance for a considerable change of declination would complicate the rule, the moon can be employed satisfactorily in this observation only in cases of very short intervals, and when her declination changes slowly.

2. *Double Altitude, one Altitude being near the Meridian.*

737. When one of two altitudes is taken near the meridian, and the other when the body has a large azimuth, the *outer* hour-angle (or that corresponding to the altitude furthest from the meridian) may be computed nearly (No. 614), since it will not be much affected by an error in the latitude by account.* The difference of the hour-angles being afforded by the measured interval of time, the other, or *inner* hour-angle, is found; and the Reduction being computed thereto, the mer. alt. is deduced. See Nos. 722 and 723.

738. *Limits.* The inner alt. must be within the limits in Table 47, and the outer angle should be as nearly E. or W. as possible.

When the outer bearing is not near E. or W., the outer hour-

* The *latitude by account*, in cases in which the ship's change of place is considerable, refers of course, to the place to which the alts. are reduced.

angle may be sensibly affected by the error of the lat. by acc.; and if the inner hour-angle be not very small, the work may require to be repeated.

### [1.] *By the Sun.*

739. *The Observation.* Observe the sun's alt., noting the time and the bearing. After a sufficient interval (No. 738) observe the second altitude. See note to No. 726.

740. *The Computation.* (1.) Reduce the decl. at both observations, either by Table 19, No. 579, or by the Green. Date, No. 580, and find the outer pol. dist.

(2.) Correct the interval for the rate of the watch when large.

Correct the altitudes.

When both observations are A.M., reduce the 1st alt. to the 2d place of observation, No. 661. When both observations are P.M., reduce the 2d alt. to the place of the 1st, No 662. When one observation is A.M., and the other P.M., reduce the alts. to the place of the alt. nearest the meridian.

(3.) With the outer alt., the lat. by acc., and the outer pol. dist., compute the hour-angle, No. 614.

(4.) Take the diff. between this hour-angle and the interval: this is the *inner* hour-angle.

(5.) With this hour-angle compute the Reduction to the meridian and apply it (No. 700 (4) and (5)), to the alt. nearest the merid. The decl. which is to be applied to the mer. zen. dist. is that reduced to the time of the alt. nearest the meridian.

Ex. 1. July 23d, 1878, lat. by acc. 54° 57′ N., long. 1° 25′ W., at about $7^h\ 0^m$ A.M.; obs. alt. ⊙ 24° 30′, bearing E. by S. by compass; $4^h\ 30^m\ 12^s$ afterwards obs. alt. ⊙ 54° 26′, course S.S.E., rate 4·5 knots; ind. corr. + 2′, eye 18 feet: required the Lat. at 2d obs.

From S.S.E. to E. by S., or 5 pts., and dist. in interval 20′·3 give corr. of alt. + 11.

| | | | |
|---|---|---|---|
| Decl. $23^d$ at noon | 20° 4′ N. | | |
| Long. 1° − 0′ ; $5^h\ 0^m$ + 3 | + 3 | | |
| 1st Red. Decl. | 20 7 | | |
| Int. $4^h\ 30^m$ | − 2 | | |
| 2d Red Decl. | 20 5 | | |
| Obs. Alt. | 24° 30′, | Obs. Alt. | 54° 26′ |
| Ind. cor. + 2′ ; Tab. 38 + 10 | + 12 | + 2′ ; + 11 | + 13 |
| | 24 42 | 2d Alt. | 54 39 |
| Corr. for run | + 11 | | |
| 1st Alt. | 24 53 | | |

(The Alt. nearest Mer. is here the 2d.)

| | | | |
|---|---|---|---|
| Alt. | 24° 53 | | |
| Lat. | 54 57 | sec. | 0·24086 |
| P. Dist. | 69 53 | cosec. | 0·02734 |
| | 74 51 | cos. | 9·41722 |
| | 49 58 | sine | 9·88404 |
| Hour-an. | $5^h\ 0^m\ 14^s$ | sin sq. | 9·56946 |
| Interval | 4 30 12 | | |
| Inn. H.-an. | 30 2 | sin. sq. | 7·632 |
| Lat. 55° Decl. 20° (*same name*) | | | 0·274 |
| Red. | + 28′ | sin. | 7·906 |
| | 54 39 | | |
| Mer. Alt. | 55 7 | | |
| Zen. Dist. | 34 53 N. | | |
| Decl. | 20 5 N. | | |
| LAT. | 54 58 N. | | |

Ex. 2. April 3d, 1878, lat. by acc 46° 7′ N., long. 14° W. at about $8^h\ 10^m$ A.M. obs. alt. ⊙ 26° 10′, sun S.E.; $3^h\ 26^m\ 35^s$ afterwards (corrected for rate) obs. alt. ⊙ 49° 8′ to the southward; course W.; rate 6·8 knots; index −3′: eye 16 feet: find Lat. at 2d obs.

From W. to S.E. is 12 pts.; 4 pts. and dist. 23·1 give corr. of 1st alt. − 16′. The 1st

red decl. 5° 20′ N.; the 2d, 5° 23 N.; the 1st alt. (corr. for run), 26° 1′; 2d alt. 49° 16′.

Alt. 26° 1′, lat. 46° 7′, and P. dist. 84° 40′, give hour-angle $3^h$ $49^m$ $41^s$, hence inn. hour-angle $23^m$ $6^s$ and Red. + 18′, LAT. 45° 49′ N.

Ex. 3. Dec. 30th, 1825, lat. by acc. 8° S., long. 6° W., at about $4^h$ $8^m$ $16^s$ by watch, the mean of 3 alts. ☉ 49° 9′·4, bearing S. 44° E. magnetic, course W.N.W. 6 knots; at $6^h$ $18^m$ $52^s$ mean of 2 alts. ☉ 73° 39′, the watch losing $4^s$·5 an hour on the chron., and the chron. gaining $6^s$·6 a-day; height of eye, 16 feet; ind. corr. + 1′; reduced decl. 23° 11′ S.

In the interval, $2^h\frac{1}{4}$, the chron. gained about 1-10th of $6^s$·6 or $0^s$·7, and the watch lost $10^s$·1 on the chron.; the measured interval must therefore be increased by $9^s$·4, and becomes $2^h$ $10^m$ $45^s$.

From W.N.W. to S. 44° E. is 156°; course 24° and dist. 13 miles give D. Lat. 11′·9, to be *subtracted* from the 1st alt.

Alt. 49° 10′, lat. 8° 1′, and pol. dist. 66° 49′, give *outer* hour-angle $2^h$ $38^m$ $16^s$; the diff. of this and $2^h$ $10^m$ $45^s$, or $27^m$ $31^s$, is the *inner* hour-angle, which, with alt. 73° 52′, reduction 1° 27′, and 2d reduction 4′, give LAT. 8° 26′ S.

[2.] *Double Altitude of a Star, one Alt. near the Meridian.*

741. Increase the interval by $10^s$ for each hour. Take the decl. from the Nautical Almanac, or from Table 63. In other respects proceed as for the sun.

[3.] *Double Altitude of a Planet, one Alt. near the Meridian.*

742. Find the Green. Date at each observation, and reduce to it the R.A. and decl. Apply the change of R.A. to the interval, as directed No. 735, and add to the interval the acceleration upon it Proceed as for the sun.

[4.] *Double Altitude of the Moon, one Alt. near the Meridian.*

743. Proceed by No. 736 as far as adding the acceleration. Reduce the decl. to each Gr. Date, and the hor. par. and semid. to that nearest the meridian. Proceed as for the sun.

744. The moon may be advantageously employed for this purpose when the Greenwich Time can be nearly ascertained, and in all cases when near her maximum declination, because her polar distance may then be very nearly computed.

745. *Degree of Dependance.* The error of the inner hour-angle is the same as that of the outer one, which, when the body is near E. or W., will be very small, even when the lat. by acc. is considerably in error.

### 3. *Double Altitude, neither Altitude being near the Meridian.*

746. When neither altitude is near the meridian, the computation is different from those hitherto given, of which the object is to find the meridian altitude.

We shall give, 1st, an *approximate* method, the object of which is to find the *correction of the lat. by acc.*; and, 2d, the *rigorous* method, the object of which is to find the *latitude itself* directly, both in Ivory's form (suited to the case in which the decl. is the same at both observations) and in a general form.

747. The principle of the approximate method will easily be

understood. Suppose the time* to be computed at each observation, then, if the interval between these computed times agrees with that actually shewn by a good watch, the latitude by acc. (which is an element of the calculation of the time) is obviously correct, but if on the other hand, the computed interval does not agree with the interval by the watch, the disagreement indicates an error in the latitude by acc.,† the *amount* of which is to be computed.

748. When the correction of the lat. by acc. exceeds 10′ or 15′, it may, generally, be advisable to repeat the computation; but when it is less than 4′ or 5′ it may be considered rather as confirming the lat. by acc. within this limit, than as correcting it by so small a quantity.

See, also, Nos. 722 and 723, which apply to this observation.

749. *Limits.* An observation that is usually a substitute for a better, which the state of the weather has prevented, or seems likely to prevent, from being obtained, must be taken when it offers itself; but when there is a choice of observations, the limits are as follows:—

(1.) When the observations are on the *same* side of the meridian, the difference of bearing at the two observations should exceed the lesser true bearing.

(2.) When on *different* sides of the meridian, the *supplement* of the diff. of bearing should exceed the lesser true bearing.

The diff. of bearing should, when possible, be 90°.

750. The simplest case in computation. This will of course be selected when the weather allows a choice of observations.

In N. lat. both altitudes are to be taken to the southward of E. or W. (or the prime vertical); in S. lat. both are to be taken to the northward of E. or W.

When the lat. and decl. are of *contrary* names, the simple case is the only one that offers itself, and therefore applies to the sun during the six months which include the winter. When the lat. and decl. are of the *same* name, the hour-angle at each observation is to be *less* than the hour-angle in Table 29, or the altitude is to be *greater* than the alt. in that Table.

### [1.] *Double Altitude of the Sun.*

751. *The Observation.* Take the alt. (see note to No. 726), noting the time, and the true bearing. After the proper change of bearing take the other altitude, noting the time.

As waiting for the proper change of bearing may risk the loss of the 2d alt. it will be prudent to provide an altitude earlier to serve in case of accident.

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* As the hour-angles only are here concerned, the consideration of Time, as found by observation, will present no difficulty to a learner.

† Admiral Sir Edward Owen informed me, that when in the North Sea he made constant use of the method of finding the lat. by the discrepancy of the computed times, as he found it much more convenient in practice, in cases where it was necessary to profit by every opportunity of observation, than any solution of the Double Altitude as a question of latitude only. In Lynn's Tables the same problem is worked by trial and error. In Capt. Owen's journals the observation, solved upon the same principle as that here adopted, constantly occurs.

Note at each observation whether the sun is to the northward or to the southward of E. and W.

An example will shew how to select the simple case.

Ex. 1. Oct. 3d, lat. 25° N. The lat. is N. and declin. south, and it is the simple case.

Ex. 2. Sept. 1st, lat. 40° N. The decl. is 8° N.; hence (Table 29) the 1st alt. must be taken after $6^h\ 39^m$ A.M. (which is the suppl. to $12^h$ of the hour-angle $5^h\ 21^m$), and the 2d before $5^h\ 21^m$ P.M. (A. T.); or each alt. of the centre must exceed 12°·5.

752. *The Computation.* The *approximate* method.*

If the difference of azimuth is not considerable this method should not be employed. In low lats. it will accordingly be less serviceable than in high latitudes The proper limits for the solution will be seen on inspecting Table 71; cases outside the limits should be rejected, and those bordering on them employed with caution, especially if the error of the latitude by account is large.

(1.) Find the Green. Date at the first observation. Reduce the declin. to each time of observation. For the sun, it is immaterial whether app. time or mean time be used. In general at sea app. time will be preferable, because when the observation confirms the lat. by acc. the apparent time at ship is determined. Find the polar distances (No. 443).

(2.) If the rate of the watch is large, correct the interval for it. Correct the alts. and reduce the 1st alt. to the 2d place of observation.† No 661.

(3.) With the alt., lat. by acc., and pol. dist., compute the hour-angle at each observation, No. 614.

(4.) When the observations are on the *same* side of the meridian, take the *difference* of the hour-angles; when on *opposite* sides, their *sum*. If this diff. or sum agrees with the interval by watch within $10^s$, or even $20^s$, provided the difference of azimuth is considerable, the lat. is confirmed, and the time is also obtained, nearly enough in the open sea. If they do not agree, proceed thus:—

(5.) In N lat. if the body at both observations is to the *south*ward of E. or W., it is the simple case (No. 750); if the body is to the *north*ward of E. or W., mark such hour-angle V.

In S. lat., if the body at both observations is to the *north*ward of

* This method, besides affording the time when the lat. by acc. is not very erroneous, employs the azimuths, which in practice is a considerable advantage, since the azimuth is the means of determining the degree of dependance of the lat. by double altitude.

† As some misunderstanding has prevailed upon the necessity of correcting the *interval of time* for the *change of longitude* of the ship, the following illustration, which was given in answer to the question, in the Nautical Magazine, 1840, is here inserted:—

Suppose at a place A, at 10 A.M., the sun's alt. is observed 13° 18′, and $3^h\ 40^m$ afterwards a 2d alt. is observed. These two alts. with the interval $3^h\ 40^m$ afford the latitude of A.

Again, suppose at a place B an observer had obtained the alt. at 10 A.M., or exactly at the same instant the observer at A took his 1st alt., and $3^h\ 40^m$ afterwards he obtains his 2d alt. 14° 15′. These two alts. with the interval $3^h\ 40^m$ afford the lat. of B. Now suppose a ship had left A at 10 A.M., having obtained the 1st alt 13° 18′, and at the end of $3^h\ 40^m$ she arrives at B, where she obtains her 2d alt 14° 15′; then she has the given interval $3^h\ 40^m$ with the 2d alt. 14° 15′; and it is clear that by reducing the 1st alt. observed at A, or 13 18′, to what it would have been if observed at B (that is, in other words, correcting the 1st alt. for the mere *change of place*), she has precisely the elements for determining the lat. of B, which is required.

Thus, when the interval is measured by a watch, no correction for longitude appears.

E. or W., it is the simple case; if the body is to the *southward* of E. or W., mark such hour-angle V.

If the bearing has not been observed, or if it is doubtful, look in Table 29; then, if the computed hour-angle *exceeds* the hour-angle in the Table, mark it V; if the comp. hour-angle is the *lesser*, use no mark. If both hour-angles are less than in Table 29, it is the simple case.

(6.) For the Correction of the Lat. Compute the azimuths at each observation, No. 676.

(7.) When the observations are on the *same* side, both of the meridian and prime vertical, enter Table 71, Part I. with the azimuths. When the observations are on *different* sides, either of the meridian or prime vertical, enter Part II.

To the log. from Table 71 add the log. sec. of the lat. by acc., and the prop. log. of the error of the interval; the sum (rejecting tens) is the prop. log. of the correction of the lat. by acc.

(8.) In the simple case (No. 750), apply the correction to the lat. by acc. according to the following directions:—

| Observations on the *same* side of the Meridian | | Observations on *different* sides of the Meridian | |
|---|---|---|---|
| The Computed Interval being | | The Computed Interval being | |
| the greater | the lesser | the greater | the lesser |
| *sub.* | *add* | *add* | *sub.* |

In the case in which *one* or *both* hour-angles are marked V (No. (5) above), apply the correction according to the directions in the next Table.

| | Observations on the *same* side of the Meridian | | | | Observations on *different* sides of the Meridian | | | |
|---|---|---|---|---|---|---|---|---|
| | The Computed Interval being | | | | The Computed Interval being | | | |
| | the *greater* | | the *lesser* | | the *greater* | | the *lesser* | |
| Both observations on the *same* side of the Prime Vertical, and *both* marked V. | The *greater* Hour ∠ being with the | | The *greater* Hour ∠ being with the | | | | | |
| | *greater* Azim. | *lesser* Azim. | *greater* Azim. | *lesser* Azim. | | | | |
| | *add* | *sub.* | *sub.* | *add* | *sub.* | | *add* | |
| Observations on *different* sides of the Prime Vertical, or *one* marked V. | The Hour ∠ V being with the | | The Hour ∠ V being with the | | The Hour ∠ V being with the | | The Hour ∠ V being with the | |
| | *greater* Azim. | *lesser* Azim. | *greater* Azim. | *lesser* Azim. | *greater* Azim. | *lesser* Azim. | *greater* Azim. | *lesser* Azim. |
| | *sub.* | *add* | *add* | *sub.* | *add* | *sub.* | *sub.* | *add* |

*Note.* This second Table, which contains the remaining fourteen out of eighteen cases, may appear complicated in its general aspect. It is, however, easy of reference when the case is proposed. For ex.:—

1. Suppose the observations to be on *different* sides of the meridian; of this point, with a long interval, there can never be a doubt. Again,

2. Let them be on *different* sides of the prime vertical, of which there can rarely be any doubt.

3. Let the computed interval be the *greater*.

Then the precept *add* or *sub.* depends on the condition that the hour-angle marked V is with the *greater* or with the *lesser* azimuth.

Ex. 1. (Observ. *same* side both of Mer. and Pr. Vert.) May 20th, 1878, lat. by acc. 40° 12′ N., long. 62° W., at about $8^h\ 0^m\ 0^s$ A.M., obs. alt. ☉ 35° 32′, bearing E. by S.; at $11^h\ 8^m\ 32^s$ A.M., obs. alt. ☉ 66° 58′; index −3′, eye 16 feet: course during interval S.E. ½E.; rate 4 knots: required the Lat. at 2d observation.

From S.E.½E. to E. by S., or 2½ pts. and dist. 12·4, corr. of 1st Alt. +11′.

| | | | | | |
|---|---|---|---|---|---|
| Decl. noon, 20th, | 20° 1′ N. | Alt. ☉ | 35° 32′ | Alt. ☉ | 66° 58′ |
| $4^h$ −2′ ; 62° W. +2 | 0 | Ind. −3′ ; Table 38 +11 | +8 | −3′ ; +12 | +9 |
| 1st Red. Decl. | 20 1 | | 35 40 | 2d True Alt. | 67 7 |
| $3^h\ 9^m$ | +2 | Corr. run | +11 | | |
| 2d Red. Decl. | 20 3 | 1st True Alt. | 35 51 | | |

| 1st Hour-angle. | | | | 2d Hour-angle. | | | |
|---|---|---|---|---|---|---|---|
| Alt. | 35° 51′ | | | Alt. | 67° 7′ | | |
| Lat. | 40 12 | sec. | 0·11702 | Lat. | 40 12 | sec. | 0·11702 |
| P. Dist. | 69 59 | cosec. | 0·02706 | P. Dist. | 69 57 | cosec. | 0·02715 |
| | 146 2 | | | | 177 16 | | |
| | 73 1 | cos. | 9·46552 | | 88 38 | cos. | 8·37750 |
| | 37 10 | sin. | 9·78113 | | 21 31 | sin. | 9·56440 |
| 1st H.-angle | $3^h\ 57^m\ 49^s$ | sin. sq. | 9·39073 | 2d H.-angle | $0^h\ 50^m\ 43^s$ | sin. sq. | 8·08607 |
| | | | | 1st ditto | 3 57 49 | | |
| | | | | Comput. Int. | 3 7 6 | (the *lesser*) | |
| | | | | Interval | 3 8 32 | | |
| | | | | Error | 1 26 | | |

| 1st Azimuth. | | | | 2d Azimuth. | | | |
|---|---|---|---|---|---|---|---|
| | $3^h\ 57^m\ 48^s$ | sine | 9·9351 | | $0^h\ 50^m\ 43^s$ | sine | 9·3414 |
| Decl. | 20° 1 | cos. | 9·9729 | Decl. | 20° 3 | cos. | 9·9728 |
| Alt. | 35 51 | sec. | 0·0912 | Alt. | 67 7 | sec. | 0·4100 |
| Azim. | 87° | sin. | 9·9992 | Azim. | 32° | sin. | 9·7242 |

Correction of the Latitude.

| | | |
|---|---|---|
| Table 71, Part I., 32° and 87° | | 9·014 |
| | Lat. sec. (above) | 0·117 |
| | $1^m\ 26^s$ pro. log. | 2·099 |
| Corr. of Lat. 11′ | Pro. log. | 1·230 |

The lat. being N., and both observations to the southward, it is the simple case; the obs. being on the same side of the merid. and the computed interval the *lesser*, 11′ is to be added to 40° 12′, which gives Lat. 40° 23′ N.

Ex. 2. (*Different* sides of Mer.) Oct. 16th, 1878, lat. by acc. 41° 22′ S., long. 150° E., at about $10^h\ 45^m$ A.M. obs. alt. ☉ 53° 2′ 20″, bearing by compass S.E. by S.; time by chron. $6^h\ 29^m\ 19^s$; at $10^h\ 29^m\ 6^s$ by same chron. obs. alt. ☉ 41° 1′ 10″, ind. corr. −3′ 20″, height of eye 14 feet; chron. *gaining* 12ˢ·2 daily. Course S.E. by S.; rate 6 knots.

The course being exactly towards the sun, the run in $4^h$ gives 24 to be *added* to 1st alt. The pol. dists. 81° 14′ and 81° 10′; 1st alt. 53° 35′; 2d, 41° 9.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Alt. | 53° 35′ | | | Alt. | 41° 9′ | | |
| Lat. | 41 22 | sec. | 0·12465 | Lat. | 41 22 | sec. | 0·12465 |
| P Dist. | 81 14 | cosec. | 0·00508 | P. Dist. | 81 10 | cosec. | 0·00518 |
| | 176 11 | | | | 163 41 | | |
| | 88 5 | cos. | 8·52434 | | 81 50 | cos. | 9·15245 |
| | 34 30 | sine | 9·75313 | | 40 41 | sine | 9·8141 |
| 1st H.-angle | $1^h\ 13^m\ 34^s$ | sin. sq. | 8·40720 | 3d H.-angle | $2^h\ 45^m\ 33^s$ | sin. sq. | 9·0964 |
| | | | | 1st do. | 1 13 34 | | |
| | | | | | 3 59 7 (*the lesser*) | | |
| | | | | Interval | 3 59 47 | | |
| | | | | | 0 0 40 | | |

| 1st Azimuth. | | | | 2d Azimuth. | | | |
|---|---|---|---|---|---|---|---|
| | $1^h\ 13^m\ 34^s$ | sine | 9·499 | | $2^h\ 45^m\ 24^s$ | sine | 9·820 |
| Decl. | 8° 46′ | cos. | 9·995 | Decl. | 8° 50′ | cos. | 9·995 |
| Alt. | 53 35 | sec. | 0·226 | Alt. | 41 9 | sec. | 0·123 |
| Azim. | 31° | sin. | 9·720 | Azim. | 60° | sin. | 9·938 |

Correction of the Latitude.

| | |
|---|---|
| Table 71, Part II., 31° and 60° | 9·174 |
| Lat. sec. (above) | 0·125 |
| $0^m\ 40^s$ pro. log. | 2·431 |
| 3′ pro. log. | 1·730 |

The obs. on *different* sides of meridian and the computed interval the *lesser*, 3′ has to be subtracted from 41° 22′, which gives Lat. 41° 19′ S.

Ex. 3. (*different* sides of the pr. vert.) Feb. 19th, 1878, lat. by acc. 52° 55′ S., long. 11° E., at $1^h\ 40^m$ P.M. obs. alt. ☉ 43° 53′, bearing S.W. by S.; at $5^h\ 39^m\ 5^s$ P.M. obs. alt. ☉ 11° 55′. Course in int. N.E. by N., 3·5 knots an hour; height of eye 16 feet: required the LATITUDE at 2d observation.

1st Alt. (run allowed for) 43° 50′, 2d Alt. 12° 3′; 1st Pol. Dist. 78° 48′, 2d Pol. Dist. 78° 51′; 1st Hour-angle $1^h\ 38^m\ 46^s$, Az. 35°; 2d Hour angle $5^h\ 38^m\ 57^s$, V. Az. 87°; corr. of lat. 7′ to be subtracted, because the obs. are on the same side of mer., the computed int. *greater*, obs. on *different* sides of pr. vert., and the hour-angle V with greater azimuth. LAT. 52° 48′ S.

[2.] *Double Altitude of a Star.*

753. This is the same as for the sun, except that the interval by watch must be *increased* by $10^s$ an hour.

[3.] *Double Altitude of a Planet.*

754. Find the Green. Date at each obs., and reduce thereto the R.A. and decl. Apply the change of R.A. to the interval, as directed No. 735, and add to the interval the Acceleration upon it. In other respects proceed as for the sun.

[4.] *Double Altitude of the Moon.*

755. Find the Green. Date at each observation, and reduce the R.A and decl. *Subtract* the change of R.A. from the interval, and add to the interval the Acceleration upon it. In other respects proceed as for the sun.

756. For the *Degree of Dependance*, see No. 771.

## 4. *Ivory's Solution, for the same Body.*

757. Though this method applies, strictly, to a body which does not change its declination, yet it answers well enough, in common

practice, with the sun, by employing a mean between the pol. dists. proper to each observation. The same is true of the moon when near her greatest declination, N. or S., since at that period she changes her decl. about 1′ only in 6 hours.

(1.) With the sun, the moon, or a planet, find the Greenwich Date for the middle time between the observations, and reduce the decl. thereto.

Find the pol. dist. by means of the lat. by acc., N. or S.

Correct the altitudes, and reduce them to the 2d place of observation.

Find the polar angle. For the sun, this is the interval in app. time; or mean time, as shewn by the watch, is near enough. For a star, see No. 734. For a planet, see No. 735. For the moon, see No. 736. Take half the interval, and find half the sum and half the difference of the altitudes.

*Note.*—When the interval is rather small, more care is required in the work, which may then be carried to quarter minutes in Table 68, at sight.

(2.) For Arc 1. To the log. sine of the half interval add the log. cos. of the decl.: the sum is the log. sine of arc 1.

(3.) For Arc 2. Take the ar. comp. of the log. sine found, and add to it the log. cos. of the half sum of the alts., and the log. sine of their half diff.: the sum is the log. sine of arc 2.

(4.) For Arc 3. To the log. sine of the decl. add the log. sec. of arc 1: the sum is the log. cos. of arc 3.

When the lat. and decl. are of contrary names, or the pol. dist. exceeds 90°, take the suppl. of this arc.

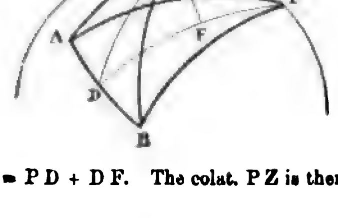
(5.) For Arc 4. Add together the log. sec. of arc 1, the log. sine of the half sum of the alts., the log. cos. of their half diff., and the log. sec. of arc 2: the sum is the log. cos. of arc 4.

(6.) For Arc 5. This is the diff. or sum of arcs 3 and 4.* When the observations are on *different* sides of the meridian; if the pol. dist. is *greater* than the colat. take the *diff.*; if *less*, the *sum*.

When the observations are on the *same* side of the merid., when the pol. dist. *exceeds* the colat., take the diff. When the pol. dist. is *equal* to or *less* than the colat., take out the log. sine of the lat. by acc.; then add together the log. sines of the decl. and mean of the

---

* This step is so near the end of the operation, that the computer may content himself with trying whether the sum or diff. gives the result in lat. nearest to the lat. by acc., as in all eligible cases the two results will differ greatly.




A and B are the places of the body at the two observations; P A, P B the polar distances; Z A, Z B the zen. dists.; A P B the polar angle or interval. P D is drawn perp. to A B, and dividing A P B into two equal parts; Z F is perp. to P D.

Then, Arc 1 is A D; Arc 2 is Z F; Arc 3 is P D. As P D is usually greater than A D, from which it is determined, if a small error occurs in A D, P D will be in error still more. Arc 4 is D F; Arc 5 is P F. P F here is P D − D F; but when the pol. dist. is much less than P Z, F may fall beyond D on P D produced, and then P F = P D + D F. The colat. P Z is then found from P F and Z F.

alts. (already employed). If this last sum is *less* than the sin. of the lat., take the *diff.*; if *greater*, the *sum*. One place in the logs. is enough, since, if the distinction is not strongly marked, the case should be rejected.

(7.) For the Latitude. To the log. sec. of arc 5 add the log sec of arc 2; the sum is the log. cosec. of the latitude.

*Note.*—To save reopening Table 68 at the same place, logs. taken out at the same opening, or repeated, are marked with the same letters.

Ex. 1. (Obs. *same* side.) Lat. by acc. 10° S., long. 7° E.; true alts. of the sun, 58° 40′, and 63° 0 reduced to the same place; interval, $32^m\ 54^s$: required the Latitude.

| Red. of Decl. in the Form, Ex. 1, p. 261. | | Correction of Alts. in the Form, Ex. 1, p. 266, then, | | | |
|---|---|---|---|---|---|
| Red. Decl. | 14° 24′ N. | 1st Alt. | 58° 40 | | |
| Pol. Dist. | 104 24 | 2d | 63 0 | | |
| | | Sum | 121 40 | Half Sum | 60° 50 |
| | | Diff. | 4 20 | Half Diff. | 2 10 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Int. | $32^m\ 54^s$ | | | | | |
| Half | 16 27 | sin. | 8·85605 | | | |
| Decl. | 14° 24′ | cos. | 9·98614 (*a*) | ........................ | sin. | 9·39566 (*a*) |
| Arc 1 | 3 59 | sin. | 8·84219 (*b*) | ........................ | sec. | 0·00105 (*b*) |
| | | | | (Suppl.) 75° 34′ | cos. | 9·39671 |
| | | | | Arc 3 104 26 | | |
| | | Ar. co. | 1·15781 | | sec. Arc 1 (rep.) | 0·00105 (*b*) |
| Half Sum | 60° 50′ | cos. | 9·68784 (*c*) | ......... ... | sin. | 9·94112 (*c*) |
| Half Diff. | 2 10 | sin. | 8·57757 (*d*) | ......... ... | cos. | 9·99969 (*a*) |
| Arc 2 | 15 22 | sin. | 9·42322 (*e*) | | sec. Arc 2 | 0·01581 (*e*) |
| | | | | Arc 4 24 53 | cos. | 9·95767 |
| | | | | Arc 5 79 33 | sec. | 0·74142 |
| Criterion for *Sum* or *Diff.* of Arcs 3 and 4. | | | | | Arc 2, sec. (rep.) | 0·01581 (*e*) |
| Pol. Dist. *exceeds* colat.-*diff.* | | | | LAT. 10° 4′ | cosec. | 0·75723 |

Ex. 2. (*same* side mer.) Lat by acc. 43° 10′ N.; alts. of Capella, reduced to the same place, 22° 58′ and 56° 14′; interval by chronometer, $3^h\ 34^m\ 17^s$: required the Lat.

Interval red. $3^h\ 34^m\ 53^s$; decl. 45° 50′ N.; arc 3, 40° 55′. Criterion, sin. lat. 9·8; sum of sines of decl. and mean alt. 9·6; take the *diff.* of arcs 3 and 4. LAT. 43° 29′ N.

Ex. 3. (obs. *different* sides.) Lat. by acc. 10° N.; alts. of Castor, 63° 16′ and 46° 12′; interval by a watch, $3^h\ 55^m\ 25^s$; decl. 32° 14′ N.: required the Lat.

Arc 1, 24° 33½′; Arc 2, 11° 54′; Arc 3, 54° 5½′; Arc 5, 78° 58′. LAT. 10° 47½′ N.

758. (1.) When the alts. are equal, this method is peculiarly convenient.

Compute arcs 1 and 3, as above. Arc 2 is 0.

For Arc 4. Add together the log. sine of the alt. and the log. sec. of arc 1: the sum is the log. cos. of arc 4.

When the pol. dist. exceeds the colat., the diff. of arcs 3 and 4 is the colat.; otherwise their sum.

Ex. Equal alts. 46° 51′; pol. dist. 66° 33; interval, $4^h\ 37^m\ 50^s$. LAT. by acc. 60°. Arc 1, 31° 30½′; Arc 3, 62° 10½′; Arc 4, 31° 9½′. LAT. 58° 59′.

(2.) When the declin. is 0, the half int. is arc 1, and arc 3 is 90°.

Ex. Lat. by acc. 60° N., decl. 0, int. $2^h\ 0^m\ 0^s$; true alts. 28° 53′ and 20° 42′. Arc 1 is 15° 0′; Arc 2, 14° 29½′; Arc 5, 26° 34′. LAT. 59° 59½′ N.

*Note.*—If the time also is required from the observation, with the outer alt., lat. found, and pol. dist. (red. to time of outer alt.), find the hour-angle, No. 614, and see No. 780 (4), p. 279. The sum of log. sec. lat. and log. sin. arc 2 is log. sin. mid. time between the obs.

## IV By Double Altitude of *Different* Bodies.

759. The forms of solution described in Nos. 737 and 747 for the cases of two altitudes of the same celestial body apply to the altitudes of different bodies, the difference of their right ascensions supplying in part, or entirely, the place of the measured interval.

Since the value of this observation, like the former, depends upon the difference of azimuth, the two bodies may often be so selected as to afford the best possible result under the circumstances, while in the case of a single body the necessary conditions are not, generally, matter of choice. Hence this method may be practised with equal convenience in all latitudes.

This observation is particularly convenient in the case of two stars, because, as the right ascensions of the stars change very slowly no reference to the absolute time is necessary.

760. When the two observations can be obtained at nearly the same time, this method has the advantage of being independent of the rate of the watch, and also of the errors of the ship's run; but when an interval elapses between the observations, allowance must be made both for the rate and the run.

### 1. *One of the Altitudes (of Two Bodies) being near the Meridian.*

761. *Limits.* These are the same as those given in No. 745. It must be remarked, that the rules for the limits apply to the bearings at the time the bodies are actually observed, whether there be an interval or not. For ex., if the sun be observed S.S.E., and the moon E. by S., the case is a good one; but if the observation of the moon were delayed till she bore S.E., the case would not be good.

762. *The Observation.* Take the alt. of the outer body, which should be observed as nearly E. or W. as possible. Then observe the alt. of the inner one; lastly, that of the outer one again, noting the times of each alt.

763. *The Computation.* (1.) For the sun, moon, or a planet. Find the Green. Date, and reduce thereto the R.A. and declination; and for the moon, her hor. par. and semid.

For a star. Take the R.A. and decl. from the Nautical Almanac, or from Table 63.

Call the diff. of R.A., or its suppl., *the polar angle.*

(2.) Reduce the alts. to the same instant, and correct them.

(3.) With the outer alt. and pol. dist. find the outer hour-angle, and proceed as in No. 740 (4), to the end.

Ex. 1. March 6th, 1878, at about $5^h\ 55^m$ P.M. M.T.; lat. acc. 40° 15′ S., long. 38° 52′ W., obs. alt. Saturn 11° 50′; also (reduced to the same instant) obs. alt. Aldebaran near meridian 33° 17′; ind. corr. + 1′, height of eye 18 feet: required the Latitude.

The Gr. Date is $6^d\ 8^h\ 30^m$.

| | | | |
|---|---|---|---|
| Saturn's Red. R.A. | $23^h$ | $34^m$ | $24^s$ |
| Aldebaran's R.A. + $24^h$ | 28 | 28 | 56 |
| Polar angle | 4 | 54 | 32 |
| The true Alt. of Sat. 11° 41′, lat. 40° 15′, pol. dist. 85° 6′ give Saturn's hour-angle | 5 | 15 | 19 |
| Aldebaran's hour-angle | | 20 | 47 |
| Saturn's Decl. 4° 54′ S. pol. dist. | 85° | | 6′ |

Aldebaran's decl. 16° 16′ N.

Aldebaran's obs. alt. 33° 17′, true alt. 33° 12

| | | | | |
|---|---|---|---|---|
| Lat. 40°, Decl. 16° (*contrary names*) | | | | 0·250 |
| | $20^m\ 47^s$ | | sin. sq. | 7·313 |
| | 0° | 13 | sin | 7·563 |
| | 33 | 12 | | |
| Mer. Alt. | 33 | 25 | | |
| Zen. Dist. | 56 | 35 S. | | |
| Decl. | 16 | 16 N | | |
| LAT. | 40 | 19 S. | | |

Ex. 2. Feb. 2d, 1878, lat. by acc. 54° 53′ N.; obs. alt. Regulus 15° 54′, and the alt. of Aldebaran (reduced to the same instant) 51° 17′; ind. corr. −3′; height of eye 20 feet: required the Latitude.

R.A. Regulus, $10^h\ 1^m\ 55^s$, decl. 12° 34′ N.; R.A. Aldebaran, $4^h\ 28^m\ 57^s$, decl. 16° 16′ N. Regulus' true alt. 15° 43′: Aldebaran's ditto, 51° 19′; hour angle of Regulus, $5^h\ 21^m\ 54^s$, hour-angle of Aldebaran, $11^m\ 4^s$; Red. +4′. LAT. 55° 3′ N.

**764.** When the change of alt. of one of the bodies is not given by the observation, its altitude cannot be reduced to the same instant as the other by No. 660; to compute it (No. 671), the azimuth is required, which, if not observed with some precision, must be computed. But this reference to the altitude may be avoided, thus:—

*Add* the interval of time, increased by $1^s$ for every $6^m$, to the R.A. of the body first observed, and subtract the R.A. of the body last observed; the rem. is the polar angle.

If the sum exceed $24^h$, reject $24^h$.

Ex. 1st. June 24th, 1878, lat. by acc. 40° N., long. 149° 52 W.; time by chron. $24^d\ 0^h\ 1^m$, obs. alt. of *a* Andromedæ 41° 53′, and $2^m\ 15^s$ afterwards obs. alt. of Jupiter 30° 29′ to the southward; height of eye 16 feet.

Red. R.A. of Jupiter $20^h\ 33^m\ 17^s$, Red. decl. 19° 22 S., *true* alt. 41° 48′.

| | | | |
|---|---|---|---|
| R.A. of *a* Andromedæ | $0^h$ | $2^m$ | $8^s$ |
| | | 2 | 15 |
| | 0 | 4 | 23 |
| Jupiter's R.A. | 20 | 33 | 17 |
| Polar Angle | 3 | 31 | 6 |

The hour-angle of *a* Andromedæ computed from alt. 41° 48′, lat. 40°, and p. d. dist. 61° 35′, is $3^h\ 50^m\ 33^s$.

The difference between the polar angle and the hour-angle of *a* Andromedæ leaves Jupiter's hour-angle $19^m\ 27^s$, which gives Red. + 10′, mer. alt. 30° 33′, and LAT. 40° 5′ N.

Ex. 2. Jan. 3d, 1878, lat. by acc. 54° 50′ N., obs. alt. Regulus 17° 21, and $3^m\ 40^s$ afterwards obs. alt. Rigel 26° 46′ S.; ind. corr. −5′; height of eye 16 feet: required the Latitude.

R.A. Regulus, $10^h\ 1^m\ 54^s$, decl. 12° 34′ N.; R.A. Rigel $5^h\ 8^m\ 42^s$, decl. 8° 21′ S.; polar angle $4^h\ 56^m\ 52^s$; true alt. Regulus, 17° 9′, hour-angle Regulus $5^h\ 11^m\ 57^s$; hour-angle Rigel $15^m\ 5^s$; Red. to this +5′. Lat. 54° 59′ N.

**765.** When the body nearest the meridian is observed below the pole, *add* the hour-angle of the other to the polar angle: the suppl. to $12^h$ of this sum is the inner hour-angle, to which compute the Reduction.

Ex. March 21st, 1831, off Cape Horn, lat. by acc. 56° 50′ S., long. 65° W., at night, obs. true alt. *a* Pavonis 24° 38′, not long past the mer. below the pole; and after $3^m\ 25^s$ obs. alt. *γ* Crucis 64° 47′; both stars rising, and both to the S. of E.

| | |
|---|---|
| α Pavo R.A. | 20ʰ 12ᵐ 17ˢ |
| ir.t. | + 3 23 |
| | 20 15 40 |
| γ Crux R A. | − 12 21 50 |
| Polar Angle | 7 53 50 |

The hour-angle of γ Crux, computed from alt. 64° 47′, lat. 56° 50′, and pol. dist. 33° 50′, is $3^h 6^m 18^s$.

This hour-angle, added to the polar angle, gives hour-angle of α Pavo $11^h 0^m 8^s$, or $59^m 52^s$ below the pole. The Red. to this is 38′, and the mer. alt. 24° 0′ gives Lat. 56° 44′ S. (Decl. of α Pavo, 57° 16′ S.)

## 2. *Neither of the Altitudes (of Two Bodies) being near the Meridian.*

766. *Limits.* These are the same as for No. 749.

767. *The Observation.* Take an alt. of the outer body, then of the inner one, and, lastly, of the outer one, noting the times. At each observation note whether the body is to the northward or southward of E. or W. (true).

768. *The Computation.* The approximate method.

(1.) Take out the right ascens. of the bodies from the Nautical Almanac, reducing them, if necessary, to the Green. Date. Take the diff. of R.A., or its suppl. to $12^h$, for the polar angle.

If the 2d alt. of the first body be lost, proceed by No. 763. The result is the polar angle.

(2.) Correct the altitudes.

(3.) Compute the hour-angle of each body.

When the bodies are on the *same* side of the meridian, take the *diff.* of the hour-angles; when on *opposite* sides, their *sum*, for the computed polar angle.

If this sum, or diff., agree tolerably well with the polar angle, the lat. by acc. is near enough; if not, proceed as in No. 752 (5) to find the corr. of lat.

Ex. 1. Feb. 25th, 1830. H.M.S. Eden, lat. by acc. 11° 45′ S., long. 19° W., took alts. of Canopus and Sirius as following, both stars to the E. of the mer., and both to the southward of the E. point.

| | Canopus. | | Sirius. | | Canopus. | |
|---|---|---|---|---|---|---|
| | 5ʰ 43ᵐ 11ˢ | 46° 58′·4 | 5ʰ 48ᵐ 0ˢ | 71° 47′·4 | 5ʰ 51ᵐ 4ˢ | 47° 27′·4 |
| | 5 45 25 | 47 7·2 | 5 50 0 | 72 14·6 | 5 54 0 | 47 33·4 |
| Means | 5 44 18 | 47 2·8 | 5 49 0 | 72 1·0 | 5 52 32 | 47 30·4 |

| | | | | | |
|---|---|---|---|---|---|
| Sirius R.A. | 6ʰ 37ᵐ 40ˢ | Decl. | 16° 29′·7 S. | Pol. Dist. | 73° 30′·3 |
| Canopus | 6 20 11 | | 52 36·5 S. | | 37 23·5 |
| Polar Angle | 17 29 | | | | |

Reducing the alt. of Canopus to the time $5^h 49^m$ gives alt. required, 47° 18′·4. The true alt. of Canopus, 47° 13′·6, and of Sirius, 71° 56′·7.

Hour-angle of Canopus $1^h 2^m 57^s$

| | |
|---|---|
| Hour-angle of Sirius | 1ʰ 11ᵐ 52ˢ |
| Ditto Canopus | 1 2 57 |
| Diff. or comput. Pol. Angle | 8 55 |
| Pol. Angle | 17 29 |
| Error | 8 34 |

| | | | |
|---|---|---|---|
| Hour-angle | 1ʰ 2ᵐ 57ˢ | sin. | 9·433 |
| Pol. Dist. | 37° 23′ | sin. | 9·783 |
| Alt. | 47 14 | sec. | 0·168 |
| | Azim. 14° | sin. | 9·384 |

| | | | |
|---|---|---|---|
| Hour-angle | 1ʰ 11ᵐ 52ˢ | sin. | 9·489 |
| Pol. Dist. | 73° 30′ | sin. | 9·982 |
| Alt. | 71 57 | sec. | 0·509 |
| | Azim. 73° | sin. | 9·980 |

| | | |
|---|---|---|
| Table 71, Part I., 14° and 73° | | 9·392 |
| | Lat. sec. | 0·009 |
| $8^m$ $34^s$ | pr. log. | 1·322 |
| Corr. of lat. 34′ | pr. log. | 0·723 |

The obs. are on the *same* side of the merid. and of the pr. vert.; both hour-angles are to be marked V; the comput. int. the *lesser*; the greater hour-angle is with the greater azimuth; 34′ is to be *subtracted* from 11° 45′, which gives the Lat. 11° 11′ S.

Ex. 2. (The Ex. No. 765.) The computed hour-angle of α Pavo is $11^h$ $5^m$ $0^s$; the diff of which, and $3^h$ $6^m$ $18^s$, is $7^h$ $58^m$ $42^s$, the computed polar angle, which is *greater* than $7^h$ $53^m$ $50^s$. The error is $4^m$ $52^s$.

The azim. of α Pavo is 8°, that of γ Crux 71½°; the corr. of lat. by Table 71, Part I., is 6′, which, since in this case the *greater* hour-angle $11^h$ $5^m$ $0^s$ is with the *lesser* azimuth, is to be *subtracted* from 56° 50′, and gives LAT. 56° 44′ S., as by the other solution.

Ex. 3. Dec. 1st, 1878, lat. by acc. 41° 28′ N.; obs. alt. of Markab, 59° 2′, and that of Altair, reduced to the same instant, 23° 38′; both bodies to the S. and E.; ind. corr. −2′; height of eye 16 feet: required the Latitude.

R.A. Markab, $22^h$ $58^m$ $45^s$, decl. 14° 33′ N.; R.A. Altair, $19^h$ $44^m$ $52^s$, decl. 8° 33′ N.; true alt. of Markab, 58° 55′; that of Altair, 23° 30′; polar angle, $3^h$ $13^m$ $52^s$; Markab's hour-angle, $1^h$ $11^m$ $44^s$; Altair's hour-angle, $4^h$ $24^m$ $26^s$. Then $4^h$ $24^m$ $26^s$ − $1^h$ $11^m$ $44^s$ = $3^h$ $12^m$ $42^s$. Azimuth of Markab, 35°; azimuth of Altair, 80°. Corr. of lat. 11′ to be added to 41° 28′. LATITUDE, 41° 39′ N.

Ex. 4. May 1st, 1878, lat. by acc. 29° 48′ S; obs. alt. of Altair, 26° 24′, and the obs. alt. of Arcturus, reduced to the same instant, 32° 23′; the bodies on different sides of the meridian, and to the north; ind. corr. +2′; height of eye 14 feet: required the Latitude.

R.A. of Altair, $19^h$ $44^m$ $52^s$, decl. 8° 33′ N.; R.A. of Arcturus, $14^h$ $10^m$ $9^s$; decl. 19° 49′ N.; polar angle, $5^h$ $34^m$ $42^s$; true alt. of Altair, 26° 20′; do. of Arcturus, 32° 20′; hour-angle of Altair, $3^h$ $31^m$ $43^s$; Arcturus' hour-angle, $2^h$ $2^m$ $3^s$; error, $0^m$ $56^s$; azimuths, 62° and 34°; corr. of lat. 6′ to *sub.* from 29° 48′. LATITUDE, 29° 42′ S.

769. The error of the correction of lat. is directly proportional to the error of the interval: hence, when the moon is employed, her R.A. should be computed for the actual time at Greenwich, as given by the chronometer, or found from observation of a lunar distance rather than by means of the erroneous long. by account.

Ex. April 7th, 1831, lat. by acc. 34° 40′ S., long. 42° W.; true alt. ☽ 38° 27′ to the N.W. At the same time, true alt. ☉ 47° 44′ to the NE-d; Gr. M.T. by lunar observation, $2^h$ $14^m$ $13^s$: required the Latitude.

☉ R.A. $1^h$ $2^m$ $41^s$, pol. dist. 96° 42′; ☽ R.A. $20^h$ $52^m$ $28^s$, pol. dist. 74° 10′; ☉'s hour-angle $0^h$ $36^m$ $45^s$ E.; ☽ ditto, $3^h$ $35^m$ $27^s$ W.; ☉'s az. 14°; ☽ ditto, 81°; suppl. of diff. of R.A. $4^h$ $10^m$ $13^s$. The error of the computed polar angle is $1^m$ $59^s$, corr. of lat. +6′, and LAT. 34° 46′ S.

This Ex. may be worked by No. 763 (3), thus: the ☽'s hour-angle, $3^h$ $35^m$ $27^s$, subtracted from $4^h$ $10^m$ $13^s$, gives the ☉'s hour-angle $34^m$ $46^s$. The Reduction to this is 49′, and LAT. 34° 45′ S.

### 3. *The General Solution, for the same, or different Bodies* *

770. (1.) Find the polar angle. This, for the sun, is properly an interval of A.T.; but mean time is near enough. For a star, see No. 753. For the moon or a planet, see Nos. 754, 755.

* Though this method is general, yet it is not well adapted to cases of short intervals (No. 727); because, in such cases, a small arithmetical inaccuracy in the process may produce a considerable error in the resulting latitude, as the reader may easily convince himself by working examples. This is the chief ground on which an approximate and indirect method is often superior, in practice, to the rigorous method.

In the figure in the note, p. 268, omitting the lines P D, Z D, and Z F, arc A is A B; A and B are the places of the same body at different times, or of different bodies; angle B

For different bodies, it is the diff. of their R.A.

Find the polar distances at each observation; in assigning these, one pole must necessarily be assumed as the elevated pole, whether the lat. be approximately known or not. Correct the altitudes, and reduce them to the second place of observation, and find the zenith distances.

(2.) For the Arc A. Take the suppl. of the polar angle; and add the pol. dists. together. Add together the log. sine square of the suppl. and the log. sines of the pol. dists.; the sum (rejecting tens) is the log. sine square of an arc $x$.

Put $x$ under the sum of the pol. dists.; take the sum and diff. and half the sum and half the diff. Add together the log. sines of the last two terms: the sum (rejecting tens) is the log. sine square of an arc A.

(3.) For the angle B. Add together the arc A and the two polar dists.; take half the sum, and from it subtract the arc A and the outer pol. dist., noting the two remainders. If the half sum is the lesser, subtract it from the other quantity.

Add together the log. cosec. of A, the log. cosec. of the outer pol. dist., and the log. sines of the remainders: the sum (rejecting tens) is the log. sine square of the angle B.

(4.) For the angle C. Add together the arc A and the two zenith dists., and from half the sum subtract A and the outer zen. dist.; note the two remainders. If the half sum is the lesser, subtract it from the other quantity.

Add together the log. cosec. of A, the log. cosec. of the outer zen. dist., and the log. sines of the two remainders: the sum (rejecting tens) is the log. sine square of the angle C.

(5.) For the angle D. This is the sum, or diff., of B and C, according to the following directions:—

In the case of the same body.

| Observations on the *same* side of the Meridian | | | Observations on *different* sides of the Meridian | | |
|---|---|---|---|---|---|
| Pol. Dist. *greater* than Colat. | Pol. Dist. *less* than Colat. *greater* Alt. with *lesser* Azim. | Pol. Dist. *less* than Colat. *greater* Alt. with *greater* Azim. | Pol. Dist. *greater* than Colat. | Pol. Dist. *less* than Colat. Interval *less* than $12^h$ | Pol. Dist. *less* than Colat. Interval *greater* than $12^h$ |
| *diff.* | *sum* | *diff.* | *diff.* | *sum* | *diff.* |

*Note.*—The difference of bearing in the interval must be *less* than 180°.

is PBA; angle C is ZBA; angle D is PBZ, which is PBA−ZBA. When PZ is larger and PA smaller, PBZ may be PBA+ZBA. Then the two sides PB, BZ, with the included angle PBZ, give PZ.

In the case of two stars, A and B are very nearly constant, and have accordingly been computed for certain pairs of stars, and inserted in tables, by which the computation is materially shortened.—*Tables for facilitating the Computation of Double Altitudes*, by Lieut. Shadwell, R.N. 1836.

(6.) For the Latitude. Take the supplement of D to 180° Take the sum of the outer polar and zenith distances.

Add together the log. sine square of the suppl. of D and the log. sines of the outer pol. and zen. dists.: the sum (rejecting tens) is the log. sine square of an auxiliary arc *y*.

Put this arc under the sum of the zen. and pol. dists.; take the sum and diff., and half sum and half diff.

Add together the log. sines of the last two terms: the sum (rejecting tens) is the log. sine square of the colatitude, reckoned from the same pole as the pol. dists.

**Ex. 1.** Interval, 32ᵐ 54ˢ; the 1st and *outer* alt., corrected and reduced to the 2d place, is 58° 39′ 42″; the 2d alt. 62° 59′ 36″; outer pol. dist. 104° 24′ 30″; the other, 104° 24′ 12″.

For the Arc A.

| | | | |
|---|---|---|---|
| Interval | 0ʰ 32ᵐ 54ˢ | | |
| Suppl. | 11 27 6 | sin. sq. | 9·997761 |
| Pol. Dist. | 104° 24′ 30″ | sin. | 9·986121 |
| Pol. Dist. | 104 24 12 | sin. | 9·986130 |
| Sum | 208 48 42 | | |
| Auxly. arc *x* | 150 3 42 | sin. sq. | 9·970012 |
| Sum | 358 52 24 | | |
| Diff. | 58 45 0 | | |
| Half Sum | 179 26 12 | sin. | 7·992640 |
| Half Diff. | 29 22 30 | sin. | 9·690660 |
| | Arc A 7° 57′ 52″ | sin. sq. | 7·683300 |

For the Angle B.

| | | | |
|---|---|---|---|
| Arc A | 7° 57′ 52″ | cosec. | 0·858367 |
| *Outer* p. d. | 104 24 30 | cosec. | 0·013879 |
| Inner p. d. | 104 24 12 | | |
| | 216 46 34 | | |
| | 108 23 17 | | |
| | 100 25 25 | sin. | 9·992773 |
| | 3 58 47 | sin. | 8·841384 |
| Angle B | 90° 59′ 20″ | sin. sq. | 9·706403 |

For the Angle C.

| | | | |
|---|---|---|---|
| Arc A | 7° 57′ 52″ | cosec. | 0·858367 |
| *Outer* z. d. | 31 20 18 | cosec. | 0·283921 |
| Inner z. d. | 27 0 24 | | |
| | 66 18 34 | | |
| | 33 9 17 | | |
| | 25 11 25 | sin. | 9·629028 |
| | 1 48 59 | sin. | 8·501014 |
| Angle C | 51° 16′ 31″ | sin. sq. | 9·272330 |

The observations are on the *same* side of the meridian, and the pol. dist. *greater* than the colat.: hence D is the *diff.* of B and C, and is therefore 39° 42′ 49″.*

For the Latitude.

| | | | |
|---|---|---|---|
| Arc D | 39° 42′ 49″ | | |
| Suppl. | 140 17 11 | sin. sq. | 9·946759 |
| *Outer* Pol. Dist. | 104 24 30 | sin. | 9·986121 |
| *Outer* Zen. Dist. | 31 20 18 | sin. | 9·716079 |
| | 135 44 48 | | |
| Auxly. Arc *y* | 83 45 20 | sin. sq. | 9·648959 |
| | 219 30 8 | | |
| | 51 59 28 | | |
| | 109 45 4 | sin. | 9·973668 |
| | 25 59 44 | sin. | 9·641773 |
| | 79° 55′ 24″ | sin. sq. | 9·615441 |
| Latitude | 10 4 36 S. | | |

* A general rule for assigning the sum or the diff. of B and C, in the case of different

This process is less troublesome than it appears. The 1st and 4th steps are of the same form, as are, also, the 2d and 3d.*

Ex. 2. Lat. by acc. 12° S.; true alt. of Sirius, 71° 56′ 42′, pol. dist. 73° 30′ 18″; true alt. of Canopus, 47° 13′ 36″, pol. dist. 37° 23′ 30″; diff. of R.A. $17^m 29^s$. Both stars to the eastward, and Sirius the *outer* one or easternmost.

The arc $x$ is 99° 22′ 15″; A is 36° 16′ 45″; angle B, 4° 30′ 10″; angle C, 100° 10′ 33″; the angle D, the *sum* of B and C, is 104° 40′ 43″. The arc $y$ is 38° 54′ 38″, and the LAT. 11° 13′ 27″ S.

771. *Degree of Dependance.* The lat. by double altitude is affected by the errors of altitudes, pol. dists., and interval, or polar angle. The effect is the same, whether by the approximate or rigorous process.

(1.) To find the error of lat. caused by 1′ error in one of the alts. To the log. 3·431 add the log. sine of the azimuth at that alt. and the log. from Table 71: the sum (rejecting tens) is the prop. log. of the error required, nearly.

Ex. Suppose in Ex. 1, No. 768, the alt. of Canopus is 3′ in error.

| | | |
|---|---|---|
| | | 3·43 |
| Canopus az. 14° | sin. | 9·38 |
| 14° and 72°, Tab. 71 | | 9·39 |
| 1′ 8″ | | 2·20 |

The ERROR OF LAT. is therefore about 3′ 24″.

(2.) The error of pol. dist. will be worth notice only in the case of the moon, in consequence of her rapid change of declination, and the uncertainty of the Green. Date.

Find the error of each hour-angle in which the moon's pol. dist. is involved by No. 615 (3). This gives the error of the computed interval; and the error of the correction of lat. is the same part of the corr. itself, that the error of the computed interval is of that interval.

(3.) The error of the rate of the watch will rarely be sensible.

---

*bodies*, would require the hour-angles to be known; but the observer who is well acquainted with the positions of the circles, as shewn in the figures, p. 162, will perceive at the time of observation how the angle D is composed.

* When the lat. is found, the hour-angle and azimuth may be computed thus:—

For the hour-angle. To the log. sine of D add the log. sine of the outer zen. dist. (already taken out) and the log. sec. of the lat.: the sum is the log. sine of the hour-angle corresponding, or of its suppl. Circumstances will usually decide; but, in a doubtful case, take the sum of the log. sines of the decl. and lat.: if this is less than the log. cos. of the zen. dist., the hour-angle is found; if greater, take the supplement.

For the azimuth. To the log. sine of D add the log. sine of the outer pol. dist. (already taken out) and the log. sec. of the lat.: the sum is the log. sine of the azim. or its suppl. If this is doubtful, when the sum of the log. sine of the lat. and cos. of the zen. dist. is less than the log. sine of the decl., the azim. is found; if greater, take the suppl. Reckon the azimuth from the N. in N. lat., and S. in S. lat.

## V. By the Altitude of the Pole Star.

772. *The Observation.* Observe the alt. of the pole star, noting the time. On shore, note also the thermometer and barometer.

773. *The Computation. At Sea.* (1.) The error of the Watch on A.T. being known, take the R.A. of the sun from the Nautical Almanac, or Table 61, and add the A.T. of observation to it: the result is the R.A. of the meridian.

(2.) Correct the alt. for index-error, dip, and refraction.

(3.) Enter Table 51 with the R.A. of the mer. and the alt.; take out the correction, and apply it as there directed: the result is the latitude, north.

Ex. 1. July 5th, 1890, at $11^h\ 2^m$ P.M. app. time, obs. alt. of the pole star, 51° 20′; ind. corr. +2′; height of eye 16 feet: required the Latitude.

| | | |
|---|---|---|
| App. Time | | $11^h\ 2^m$ |
| R.A. ⊙ | | 6 58 |
| R.A. Mer. | | 18 0 |
| ✱ Obs. Alt. | | 51° 20′ |
| Ind. Corr. | +2′ | |
| Table 38 | −5 | −3 |
| | | 51 17 |
| $18^h\ 0^m$, Alt. 50° | | +27 |
| Lat. | | 51 44 N. |

Ex. 2. March 11th, 1890, at $3^h\ 30^m$ A.M. app. time, obs. alt. of the pole star, 53° 51′; ind. corr. −3′; height of eye 12 feet: required the Latitude.

| | | |
|---|---|---|
| App. Time | | $15^h\ 30^m$ |
| R.A. ⊙ | | 23 26 |
| | | 38 56 |
| | | −24 |
| R.A. Mer. | | 14 56 |
| ✱ Obs. Alt. | | 53° 51′ |
| Ind. Corr. | −3′ | |
| Table 38 | −4 | −7 |
| | | 53 44 |
| $15^h\ 0^m$, alt. 50° | | +1 9 |
| Lat. | | 54 53 N. |

774. *Accurately.* (1.) Find the Greenwich Date; reduce to it the Sid. T. at mean noon; take out the star's R.A. and decl. from the Nautical Almanac, and find the pol. dist.

Find the star's hour-angle.

(2.) Correct the altitude, accurately.

(3.) For the 1st Correction. To the log. sec. of the hour-angle add the prop. log. of the pol. dist.: the sum (rejecting tens) is the prop. log. of the 1st Correction.

For the 2d Correction. To the log. cosec. of the hour-angle add the prop. log. of the pol. dist; double the sum; add to this the const. 1·5821 and the log. cot. of the altitude: the sum (rejecting tens) is the prop. log. of the 2d Correction.

(4.) When the hour-angle is *greater* than $6^h$ and *less* than $18^h$, *add* the 1st Corr. to the altitude; when the hour-angle is *less* than $6^h$ or *greater* than $18^h$, *subtract* it.

*Add* the 2d Correction in all cases

Ex. July 24th, 1890, long. 0ʰ 6ᵐ W.; at 10ʰ 24ᵐ 12ˢ·8 obs. alt. of Polaris in the quicksilver, 109° 36′ 40″; ind. corr. −1′ 30″, therm. 62°, bar. 30·0 inches: required the Latitude.

| | | |
|---|---|---|
| Gr. Date, 24th, 10ʰ 30ᵐ 13ˢ | | |
| Sid. T. mean noon, 24th | | 8ʰ 8ᵐ 18ˢ·2 |
| 10ʰ | 1ᵐ 38ˢ·6 | |
| 30ᵐ | 4·9 | +1 43·5 |
| 13ˢ | 0 | |
| Red. Sid. Time | | 8 10 1·7 |
| M.T. | | 10 24 12·8 |
| R.A. Mer. | | 18 34 14·5 |
| ✱ R.A. | | −1 14 2·1 |
| Hour-angle | | 17 20 12·4 |
| Or | | 5 20 12·4 |

| | | | |
|---|---|---|---|
| 1st Corr. | | 2d Corr. | |
| 5ʰ 20ᵐ 12ˢ Sec. | 0·7625 | cosec. | 0·0066 |
| P.D. 1° 16′ 56″ P.L. | 0·3092 | P.L. | 0·3692 |
| 1st Corr. 13′ 17″ P.L. | 1·1317 | | 0·3758 |
| | | | 2 |
| | | | 0·7516 |
| | | Const. | 1·5821 |
| | | 54° 47′ cot. | 9·8487 |
| | | 2d Corr. 1′ 11″ P.L. | 2·1824 |

| | | |
|---|---|---|
| ✱ R.A. | | 1ʰ 14ᵐ 2ˢ·1 |
| Decl. | | 88° 39′ 31″ |
| Alt. | | 109° 36′ 40 |
| Ind. Corr. | | − 1 30 |
| | | 2)109 35 10 |
| | | 54 47 35 |
| Ref. | 41″ | −40 |
| Ther. | 1 | |
| True Alt. | | 54 46 55 |
| 1st Corr. | | 13 17 |
| 2d Corr. | | 1 11 |
| LAT. | | 55 1 23 N. |

775. *Degree of Dependance.* The error is very nearly the same as that of the alt., as a small error of time produces but little effect.

N.B.—The Nautical Almanac method for obtaining Latitude from Pole Star is strongly recommended. Every year tables are calculated expressly for this purpose. Where accuracy is required, as in observations for latitude made on shore, these yearly tables should always be used.

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## CHAPTER VI.

### FINDING THE TIME.

I. BY A SINGLE ALTITUDE. II. BY DIFFERENCE OF ALTITUDE NEAR THE MERIDIAN. III. BY EQUAL ALTITUDES. IV. RATING THE CHRONOMETER.

776. In consequence of the perpetual revolution of the celestial bodies, the hour-angle of any one of them affords the measure of time, No. 471, &c. By whatever method, therefore, the hour-angle may be determined, the time may be deduced. At sea, where the only fixed object to which the ever-changing positions of the celestial bodies can be referred is the horizon, altitude is the only means of determining the time.

### I. BY A SINGLE ALTITUDE.

777. The sun's hour-angle being apparent time, when his alt. is observed, the time is at once determined. In the case of any other

celestial body which does not pass the meridian with the sun, it is necessary to allow for the difference of their hour-angles, or of their right ascensions (No. 471), at the instant of observation, by referring both bodies to the first point of Aries (from which R.A. is reckoned), as will be described.

## 1. *Altitude above the Horizon.*

778. *Limits.* The body should be nearly E. or W., because, when on the prime vertical, errors, both of the latitude of the observer, and of the altitude observed, produce the least effect on the hour-angle.

In general, however, the body may be observed at any time, while moving at the rate of not less than 6′ of alt. in $1^m$ of time; because in this case an error of 1′ in the alt. will cause not more than $10^s$ error of time, and the same error of lat. will in the same case cause a still smaller error of time. The *smallest* azimuth, reckoned either from N. or S., which the body can have under this last condition, is seen in Table 46, in the column of 6′.

On the other hand, the alt. should not be observed when small, as, for ex., under 10° or 15°, on account of the uncertainty of refraction, especially in very hot or very cold weather.

779. In lat. 60° 24′ and upwards, 1′ error of alt. must always cause more than $10^s$ error of time; the body should therefore be observed as nearly E. and W. as possible.

In the tropics, on the other hand, the time may often be more correctly determined, when the body is less than an hour from the meridian, than at several hours from it in high latitudes.

At sea, the uncertainty of the sea-horizon may sometimes be removed by observing to opposite points. Errors of alt. proper to the instrument, or to the eye, are obviated by observing the alt., of the same measure, on opposite sides of the meridian.

### [1.] *To find Apparent Time, and thence Mean Time, by the Altitude of the Sun.*

780. *The Observation.* Observe a set of altitudes, (Number 557) at the proper limits, noting the times. See also No. 535.

For accuracy, note the thermometer and barometer.

781. *The Computation.* (1.) Having found the time corresponding to the altitude, find the Green. Date by the chronometer No. 575, which will be mean time; or by the time roughly estimated and the long. by acc., No. 576, which will generally be App. Time Reduce to this the sun's declination, No. 580, or, for common purposes at sea, this may be done by No. 579. Find the sun's polar distance, No. 443.

When mean time is required, reduce the Equation of Time No. 583 or 584.

(2.) Correct the alt. at sea by No. 647, or, if greater accuracy is required, by No. 649.

(3.) Compute the sun's hour-angle, No. 614.

(4.) When the sun is to the W. (or P.M.), this hour-angle is

*Apparent Time*; when he is to the E. (or A.M.), subtract the hour-angle from $24^h$: the remainder is A T. reckoned on the *day before*.

(5) For Mean Time. Apply the reduced equation of time as directed in p. I. of the Nautical Almanac, or in Table 62, to the App. Time: the result is Mean Time.

The difference between the time of observation, as shewn by the watch, and either of these times, is the error of the watch on that time.

Ex. 1.* Jan. 12th, 1902, at sea, at about $9^h\ 30^m$ A.M. app. time; lat. 35° 35′ N.; long. 14° W.; height of eye, 30 feet; ind. corr. + 4′ 30″; obs. alt. of sun as below: required app. and mean time, and the error of the watch on each time, at the instant of observation.

*Note.*—The differences of the alts. and the times are taken to test their accuracy by means of their agreement with each other, No. 556.

| | | Diff. | | | Diff. |
|---|---|---|---|---|---|
| Times by W. | $9^h\ 30^m\ 28^s$ | $0^m\ 35^s$ | Alt. | 22° 18′ 20″ | 4′ 40″ |
| | 31 3 | 31 | | 23 | 3 50 |
| | 31 34 | 33 | | 26 50 | 3 50 |
| | 32 7 | 27 | | 30 40 | 3 20 |
| | 32 34 | | | 34 | |
| | 157 46 | | | 132 50 | |
| Time | 9 31 33 | | Alt. | 22 26 34 | |

| | | | |
|---|---|---|---|
| Jan. | $11^d\ 21^h\ 30^m$ | | |
| Long. 14° W. | + 56 | | |
| G.A.T. Jan. | 11 22 26 | | |
| Decl. $11^d$ | 21° 54′ 19″ S. | | |
| Corr. | − 8 52 | | |
| Red. Decl. | 21 45 27 S. | | |
| | 90 | | |
| Pol. Dist. | 111 45 27 | | |
| Eq. Time $11^d$ | $7^m\ 51^s$ | | |
| Corr. | + 22 | | |
| Red. Eq. Time | 8 13 | | |
| Alt. | 22° 39′ | | |
| Lat. | 35 55 | sec. | 0·09158 |
| P.D. | 111 45 | cosec. | 0·03207 |
| | 170 19 | | |
| | 85 9 | cos. | 8·92710 |
| | 62 30 | sine | 9·94793 |
| Hour-angle | $2^h\ 27^m\ 15^s$ | sin. sq. | 8·99868 |
| A.T. | 21 32 45 | | |

| | |
|---|---|
| Obs. Alt. ☉ | 22° 26′ 34″ |
| Index error | + 4 30 |
| Table 38 | + 8 0 |
| True Alt. | 22 39 4 |
| A.T. at Ship | $21^h\ 32^m\ 45^s$ |
| Watch | 21 31 33 |
| Watch slow for A.T. | 1 12 |
| A.T. at Ship | 21 32 45 |
| Eq. Time | + 8 13 |
| M. Time | 21 40 58 |
| Watch | 21 31 33 |
| Slow for M.T. | 9 25 |
| Chronometer Time of Observation | $10^h\ 39^m\ 49^s$ |
| Chr. fast on G.M.T. | − 2 31 |
| G.M.T. of Obs. | 10 37 18 |
| Ship M.T. of Obs. | 9 40 58 |
| | 56 20 |
| Long. *See* No. 827 | 14° 5′ 0″ W. |

Ex. 2. March 12th, at about $4^h\ 15^m$ P.M. mean time, lat. 50° 48′ N., long. 65° 58′ E.; obs. alt. ☉ 14° 50′ 10″; corresponding time by W. $4^h\ 13^m\ 54^s$; ind corr. − 2′ 20″; height of eye, 18 feet: required A.T. and M.T. and the error of the watch on each

G.M.T. March $11^d\ 23^h\ 51^m$, pol. dist. 93° 15′, true alt 14° 55′, Eq. T. + $9^m\ 55^s$; hour-angle P.M. or A.T. $4^h\ 5^m\ 54^s$; watch *fast* on A.T. $8^m$; M.T. $4^h\ 15^m\ 49^s$, watch *slow* on M.T. $1^m\ 55^s$.

* In this example some of the quantities are noted to seconds for the sake of a form; but at sea the nearest minute (to which the hour-angle is here worked) is generally enough, unless the observation itself is remarkably good.

Ex. 3. Oct. 20th, 1878, at sea, at $4^h\ 40^m$ P.M. app. time; lat. 41° 18′ S., long. 21° W.; height of eye 16 feet; ind. corr. −2′; at $4^h\ 28^m\ 56^s$ by watch, obs. alt. ☉ 23° 7′: required A.T. and M.T. and the Error of the Watch on each.

G.A.T. Oct. $20^d\ 6^h\ 4^m$, pol. dist. 79° 31′, true alt. 23° 15′, Eq. T. $-15^m\ 11^s$; A.T. $4^h\ 32^m\ 42^s$; Watch *slow* on A.T. $3^m\ 46^s$; M.T. $4^h\ 17^m\ 31^s$; Watch *fast* on M.T. $11^m\ 25^s$.

[2.] *To find Mean Time, and thence Apparent Time, by the Altitude of a Star.*

782. *The Observation* is the same as for the sun, Nos. 541, 542.

783. *The Computation.* (1) Having found the means of the times and the altitudes, take from the Nautical Almanac, or Table 63, the star's R.A. and declin., and also from the Nautical Almanac, or Table 61, the sidereal time at mean noon for the given day.

(2.) Correct the altitude, No. 652 or 653.

(3.) Compute the star's hour-angle, No. 614.

(4) When the star is to the W. of the meridian, *add* the hour-angle to the star's R A.; when to the E., *subtract* the star's hour-angle from its R.A. (increased if necessary by $24^h$); the result is the R.A. of the meridian.

From the latter (increased if necessary by $24^h$) subtract the sidereal time at mean noon; the rem. is the approximate M.T.

From this last subtract the Retardation upon it, Table 24.

Take out the Acceleration for the long.; in W. long *subtract* the Accel. from the result, in E. long. *add* it; the result, if less than $12^h$, is Mean Time; if greater than $12^h$, reckon the time on the preceding day.

(5.) For App. Time. By the M.T. obtained, and the long. by acc., or by the chronometer, find the Gr. Date; reduce the equation of time and apply it as directed in p. II. of the Nautical Almanac, or the contrary way to that directed in Table 62.

Ex. 1. Jan. 1st, 1902, P.M., lat. 50° 46′ N., long. 61° 37′ W., at $7^h\ 56^m\ 18^s$ by watch, obs. alt of Procyon 15° 40′ to the S. and E., eye 20 feet, ind. err. 0′: required the Mean and App. Times, and the Error of the Watch.

Procyon's R.A. $7^h\ 34^m\ 10^s$; Decl. 5° 28′ N.; Sid. T. mean noon, $18^h\ 40^m\ 48^s$.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Obs. Alt. | 15° 40′ | Alt. | 15° 32′ | | | Hour-angle | $-4^h\ 48^m\ 12^s$ |
| Ind. Corr. 0′ / Table 38 −8 | −8 | Lat. | 50 46 | sec. | 0·19895 | ★ R.A. | 7 34 10 |
| | | P.D. | 84 32 | cosec. | 0·00198 | R.A. Mer. ($+24^h$) | 2 45 58 |
| True Alt. | 15 32 | | 150 50 | | | Sid. T. M. Noon − | 18 40 48 |
| | h m s | | 75 25 | cos. | 9·40103 | Approx. M.T. | 8 5 10 |
| Chr. at Time of Obs. | 12 11 30 | | 59 53 | sine | 9·93702 | Ret. | −1 19 |
| Chr. fast on Gr. | −2 15 | | $4^h\ 48^m\ 12^s$ | sin.sq. | 9·53898 | | 8 3 51 |
| | | | | | | Accel. 61° 37′ W. | −40 |
| Gr. MT. | 12 9 15 | | | | | M.T. | 8 3 11 |
| Ship M.T. | 8 3 11 | | | | | Time by Watch | 7 56 18 |
| Long. in Time | 4 6 4 | | | | | Watch *slow* on M.T. | 6 53 |
| Long. | 61° 31′ 0″ W. | | | | | | |

The Red. Eq T. is $3^m\ 34^s$, which *subtracted* from M.T. gives A.T. $7^h\ 59^m\ 37^s$, and the watch *slow* on A.T. $3^m\ 19^s$.

Ex. 2. April 27th, 1902, A.M., lat. 29° 47′ 45″ S., long. 31° 7′ E. at $2^h$ $19^m$ $41^s$ by watch, obtained true alt. of Altair 25° 14′ 20″ to the E. and N.: required the M.T. of observation.

Altair's R.A. $19^h$ $46^m$ $2^s$, Decl. 8° 36′ 35″ N., Sid. T. M. Noon $2^h$ $18^m$ $9^s$.

| | | | | |
|---|---|---|---|---|
| Alt. | 25° 14′ 20″ | | | |
| Lat. | 29 47 45 | sec. | 0·061561 | |
| P.D. | 98 36 35 | cosec. | 0·004920 | |
| | 153 38 40 | | | |
| | 76 49 20 | cos. | 9·357794 | |
| | 51 35 0 | sin | 9·894046 | |
| $3^h$ $37^m$ $8^s$ | | sin. sq. | 9·318321 | |

| | |
|---|---|
| Hour-angle | $-3^h$ $37^m$ $8^s$ |
| ✱ R.A. | 19 46 2 |
| R.A. Mer. | 16 8 54 |
| Sid. T. M Noon | −2 18 9 |
| Approx. M.T. | 13 50 45 |
| Ret. | −2 16 |
| | 13 48 29 |
| Accel. long. 31° 7′ E. | +0 20 |
| MEAN TIME | 13 48 49 |

### [8.] *To find Mean Time, and thence Apparent Time, by the Altitude of the Moon or a Planet.*

784. *The Observation* is the same as for the sun. See, also, Nos. 540, 541, 542.

785. *The Computation.* (1.) Having found the means of the times and of the altitudes, find the Gr. Date as nearly as possible by the chron., No. 575, or by the estimated M.T. and long. by acc., No. 576. Reduce the moon's R.A., No 591, and decl., No. 589, and thence her pol. dist.; also her horiz. parall., No. 586 or 587, and semid., Table 39.

(2.) Deduce the app. alt., No. 654. Take out the correction of alt., Table 39. Correct the altitude.

(3.) Compute the hour-angle, and proceed as for a star, 783 (4).

Ex. 1. July 21st, 1878, A.M., lat. 39° 57′ N., long. 8° 53 E.; M.T. at Green. by chron. $20^d$ $11^h$ $48^m$, obs. alt. ☽ 24° 10′ E. of mer.; eye 16 feet.

| | | | | |
|---|---|---|---|---|
| ☽'s R.A. | | $0^h$ $33^m$ $19^s$ | | |
| Corr. | | 1 26 | | |
| Red. R.A. | | 0 34 45 | | |
| ☽'s Red. H.P. | | 54′ 13″ | | |
| ☽'s Aug. Semid. | | 14 53 | | |
| ☽'s Decl. | | 8° 26′ 35″ N. | | |
| | | 1 2 | | |
| Red. Decl. | | 8 27 37 N. | | |
| | | 90 | | |
| Pol. Dist. | | 81 32 23 | | |
| Alt. | 25° 8′ | | | |
| Lat. | 39 57 | sec. | 0·11543 | |
| Pol Dist. | 81 32 | cosec. | 0·00476 | |
| | 146 37 | | | |
| | 73 18½ | cos. | 9·45822 | |
| | 48 10½ | sin. | 9·87226 | |
| $4^h$ $16^m$ $45^s$ | | sin. sq. | 9 45067 | |

| | | |
|---|---|---|
| Obs. Alt. | | 24° 10 |
| Dip. | −4′ | +11 |
| Semid. | +15 | |
| | | 24 21 |
| Corr. Par. | | +47 |
| True Alt. | | 25 8 |
| ☽'s R.A. (+$24^h$) | | $0^h$ $34^m$ $45^s$ |
| Hour-angle | | −4 16 45 |
| R.A. of mer. | | 20 18 0 |
| Sid. T.M. Noon | | 7 52 32 |
| Approx. M.T. at ship | | 12 25 28 |
| Ret. | | −2 2 |
| | | 12 23 26 |
| Accel. for 8° 53′ E. | | +6 |
| M.T. at Ship | | 12 23 32 |

Ex. 2. Feb. 22d, 1878, at about $9^h$ $30^m$ P.M., lat. 42° 40′ N., long. 140° W., obs. alt. Mars 23° 43′ W. of mer., time by watch $9^h$ $24^m$ $27^s$ P.M., eye 18 feet: find M.T. and Error of Watch.

G. T. Feb. $22^d$ $18^h$ $50^m$, Mar's Red. R.A. $2^h$ $47^m$ $33^s$, Red. Decl. 1 ° 10 N., True Alt 18° 37′.

| | | | |
|---|---|---|---|
| Alt. | 23° 37 | | |
| Lat. | 42 40 | sec. | 0·13353 |
| P D. | 72 50 | cosec. | 0·01979 |
| | 139 7 | | |
| | 69 33½ | cos. | 9·54314 |
| | 45 56½ | sin. | 9·85651 |
| | $4^h$ $53^m$ $30^s$ | sin sq. | 9·55297 |

| | |
|---|---|
| Hour-angle | $4^h$ $53^m$ $39^s$ W. |
| Mars' R.A. | 2 47 33 |
| R. A. of Mer. | 7 41 12 |
| Sid. T.M.-Noon | 22 9 2 |
| Approx. M.T. | 9 32 10 |
| Ret. | −1 34 |
| | 9 30 36 |
| Accel. 140° W. | −1 32 |
| M.T. | 9 29 4 |

Whence the watch is $4^m$ $37^s$ *slow* on M.T.

786. When the true G.M.T. is given by a chronometer, the moon's R.A. and declination may be correctly found. When the moon is at her greatest declination, N. or S., a small error in the Gr. Date will but slightly affect her pol. dist. An error of $1^m$ in the Gr. Date causes about $2^s$ error in the moon's reduced R.A.

787. If the errors of the watch, as found by observation of two bodies on different sides of the meridian, but on the same side of the prime vertical, by the same observer with the same instrument, be not identical, that error is nearest to the true error of the watch which accompanies the greater or outer azimuth. If the azimuths are equal, the mean of the errors is the true error.

788. *Degree of Dependance.* The alt. and the lat. being in general, at sea, more or less uncertain, and the pol. dist. of the sun and moon being reducible with precision in certain cases only, the time is in general liable to three causes of error. See No. 615.

When it is proposed to test the observation, the parts to 30″ for the sec., &c., will be taken out with those quantities.

## 2. *By the Altitude* 0, *or the Body on the Horizon.*

789. In low latitudes the entire orb of the sun is, during certain seasons, frequently seen at rising and setting; and in the variable climates of high latitudes it is occasionally visible, though more usually clouded at those times. When the instant at which either limb touches the horizon can be distinctly noted, the time may be determined approximately; and though the degree of approximation be rude as compared with some other methods, yet the result may often be valuable, especially after one or more days without observation. It is also a recommendation to this method, as a resource when others fail, that it is independent of every instrument except a watch or other means of measuring time.*

(1.) Find the time of sunrise or sunset in Table 26. Apply to this the long. in time, as directed, No. 576: the result is the Green. Date. Reduce the declination, and find the pol. dist.

(2.) To the horizontal refraction, 33′, add the depression, Table 8, and from the sum *subtract* the semid. when the *lower* limb is ob-

* Mr. Fisher acquaints me that he has employed this observation on a few occasions, but circumstances were not convenient for comparing the results with those of other observations.

served, or *add* it when the *upper* limb is observed: the result is the angular depression of the sun's centre below the horizon at the instant of observation.

(3.) Compute the hour-angle of the sun below the horizon by No. 642, using, instead of 18°, the sun's depression.*

(4.) At sunset this hour-angle is app. time; at sunrise take the suppl. to 12 hours.

Ex. 1. May 12th, 1878, lat. 51° 20′ N., long. 26° W., observed the sun's lower limb at setting touch the horizon at $7^h\ 40^m\ 56^s$ by watch; eye 16 feet: required App. Time.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ☉ Decl. 18°. Table 26 gives | | Hor. Refr. | 33′ | Depr. | 0° 21′ | | |
| App. Time Sunset | $7^h\ 35^m$. | Depr. | 4 | Lat. | 51 20 | sec. | 0·20427 |
| Long. 26° W. | 1 44 | | 37 | P.D. | 71 44 | cosec. | 0·02246 |
| G.A.T. 12th | 9 19 | Semid. | −16 | | 123 25 | | |
| Decl. 12th | 18° 10′ N. | Depr. Centre | 21 | | 61 42 | sin. | 9·04472 |
| Corr. | +6 | | | | 61 21 | cos. | 9·68075 |
| Red. Decl. | 18 16 N. | A.T. | $7^h\ 40^m\ 7^s$ | | | sin. sq. | 9·85220 |
| | | Watch | 7 40 56 | | | | |
| | | | 0 49 Watch *fast*. | | | | |

Ex. 2. Oct. 14th, 1878, lat. 18° 39′ N., long. 62° 30′ E., the sun's upper limb at rising appeared on the horizon at $5^h\ 46^m\ 11^s$ by watch; eye 20 feet: required App. Time.

Gr. Date, Oct. $13^d\ 14^h\ 0^m$, red. decl. 8° 3′ S.; depr. of sun's centre 54′; Hour-angle $5^h\ 52^m\ 54^s$; App. Time $6^h\ 7^m\ 6^s$ A.M.; watch $20^m\ 55^s$ *slow* on A.T.

790. *Degree of Dependance.* This we have at present no certain *data* for determining, more especially when the observation is taken from a considerable elevation, as from a hill.

The terrestrial refraction does not, it should seem, affect the instant of the apparent passage of a celestial body over the visible horizon, since the rays of light from the horizon and those from the body are similarly affected; and hence the uncertainty of the result is probably due entirely to that of the astronomical refraction at the time and place. It may be proper, accordingly, to admit an error of 2′, at least, in the refraction; and the effect on the result is then found by merely adding together the parts for 30″ of the cosine and sine, dividing the sum by the parts for $1^s$ of the sine square, and doubling the result.

Ex. In Ex. 1, above, the parts are 34 and 116; the sum, divided by 20, gives $7\frac{1}{2}^s$, which, doubled, is $15^s$, the effect due to 2′ error in the refr. In Ex. 2 this is $8^s$.

* In the tropics the method No. 638 may be substituted, using log. sine depr. ☉ cent.

As an aid to the working of a sun chronometer, Davis's "Chronometer" Tables will be found very useful; they contain hour angles calculated exactly for degrees of Latitude, Altitude, and Declination, with means of making allowance for the minutes which must be taken into account. J. D. Potter, 145 Minories, London, E., price 10*s*. 6*d*.

## II. By Difference of Altitude near the Meridian.

791. When the sun is too near the meridian for a satisfactory observation of a single altitude, the time may be determined approximately, and sometimes nearly, by means of the observed difference of-alt. in a measured interval.

The method has been already introduced in the Short Double Altitude, p. 256, and it was on the ground that the same observation might be usefully employed for Time also, that the small corrections from p. 223, which are scarcely appreciable in the resulting latitude, were applied. It is also worth while, in finding the time by this method, to correct for change of declination.

The method (as already shewn in Case II., p. 259) is available with alts. taken on both sides of the meridian; but, as this case would be comparatively rare, the rules have been arranged for observations on the *same* side of the meridian only.*

792. *Limits.* The observations should both be within an hour from noon. The interval should constitute a large portion of the mid. time from noon; but it should not, generally, amount to the whole time from noon.

*The Observation* is that in No. 726.

793. *The Computation.* (1.) Reduce the declin., by the long., to noon at the place, which will be near enough.

(2.) Find the interval, and correct the second of the times by watch for the rate in the interval, when considerable. Correct the alts., and reduce the 1st to the place of the 2d; find their mean and their difference. Correct the diff. of alts., and also the interval by the quantity in the Table, p. 223.†

(3.) Compute the hour-angle at the middle of the interval, No. 729 (2), and add half the interval. When the observation is P.M. this is App. T., and being compared with the second time by watch, shews the error of the watch. When the observation is A.M., take the suppl. of this time to $12^h$.

*Note.* If the rising or falling of the sun has not been distinctly noticed, or it is uncertain whether the alts. are on the same or different sides of the meridian, ascertain the fact by the precept, No. 728.

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* For the like reason, namely, not to increase unnecessarily the number of precepts, the observation below the pole is not treated; this presents no difficulty.

† This is the quantity which, added to the sine, makes it equal to the arc, and by means of it we employ the table of sines equally well for arcs.

Ex. 1. May 14th, 1878, about $11^h$ A.M., lat. 48° 4′ N., long. 21° 11′ W., at $11^h 28^m 20^s$ by watch, obs. alt. ⊙ 58° 9′; at $11^h 52^m 50^s$ by watch, obs. alt. ⊙ 59° 39′; ind. corr. − 1′ 20″; height of eye, 16 feet; rate, 5½ knots; ⊙ a-head at 1st obs.: required the Error of the Watch.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Times by Watch | $11^h 28^m 20^s$ | Alt. ⊙ | 58° 9′ 0″ | Alt. ⊙ | 59° 39′ 0″ | Alts. | 58° 21′ 11″ |
| | 11 52 50 | Ind. Corr. | −1 20 | | −1 20 | | 59 49 1 |
| Interv. | 24 30 | Dip | −4 0 | | −4 0 | | 118 10 12 |
| Corr. | +3 | | 58 3 40 | | 59 33 40 | Mean | 59 5 6 |
| | 24 33 | Corr. Alt. | −32 | | −30 | Diff. | 1 27 50 |
| ⊙ Decl. 14th | 18° 40′ N. | | 58 3 8 | | 59 33 10 | Corr. | +1 |
| 21° W. | +1 | Semid. | +15 51 | | +15 51 | | 1 27 51 |
| Red. Decl. | 18 41 N. | | 58 18 59 | 2d Alt. | 59 49 1 | | |
| | | Run | +2 12 | | | | |
| | | 1st Alt. | 58 21 11 | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Diff. Alts. | 1° 27′ 51″ | sine | 8·4074 | Hour-angle | $0^h 44^m 44^s$ |
| Interv. | $24^m 33^s$ | cosec. | 0·9710 | Comp. Mid. T. | 11 15 16 |
| Lat. | 48° 4′ | sec. | 0·1750 | Half Int. | +12 15 |
| Decl. | 18 41 | sec. | 0·0235 | T. of 2d Obs. computed | 11 27 31 |
| Mean Alt. | 59 5 | cos. | 9·7108 | Do. by Watch | 11 52 50 |
| Hour-angle | $0^h 44^m 44^s$ | sine | 9·2877 | Watch *fast* | 25 19 |

Ex. 2. Lat. 10° 41′ S., red. decl. 20° 56′ N., alts. ⊙ 58° 2′ and 57° 17′, interval $12^m 14^s$ Computed App. Time of 2d Observation, $0^h 39^m 0^s$.

794. *Correction for Change of Declination.* When the sun is on the meridian, his motion in declination (which then takes place on the meridian) is perp. to the horizon, and consequently affects the alt. by exactly the same quantity. When, on the other hand, that part of the sun's celestial meridian or declin. circle, on which he is, is parallel to the horizon, his change of declin. does not affect the alt. at all. Hence the corresponding change of alt. is always between 0 and the whole amount of change of declination.

The 2d alt. differs therefore by the whole, or a part, of the change of declin. in the interval, from what it would have been had the decl. remained constant. When the motion in declin. tends to increase the alt. the 2d alt. is too great; otherwise too small. There is, however, no necessity, in this method, for a very nice process of correction, for when the mer. alt. is small, and the sun not far from the meridian, the motion. in declin. corresponds very nearly to that of alt., and the entire change may be applied; and when, on the other hand, the mer. alt. is great, the motion in alt. is so rapid, that a few seconds, in the estimation, are of no consequence in practice, or the whole quantity may even be neglected.

Ex. 1. May 3rd, 1878, lat. 26° 14′ N., long. 161° W., at $10^h 31^m 18^s$ by watch, obtained true alt. ⊙ 71° 49′, and at $11^h 7^m 21^s$ true alt. 77° 46′: find the Error of the Watch.

The Hour-angle is $46^m 18^s$, Mid. T. $11^h 13^m 42^s$, and Watch *slow* $24^m 22^s$.

Ex. 2. Nov. 4th, 1878, P.M., lat. 63° 46′ N., long. 54° W., at $2^h 14^m 56^s$ by watch, obs. alt. ⊙ 10° 18′ 1″, and at $2^h 36^m 27^s$ obs. alt. ⊙ 10° 2′ 29″. Ind. corr. + 2′, height of eye 16 feet, the ship having no way.

The diff. alts. 15′ 40″, and Int. $21^m 32^s$ (corr. by $1^s$), give Mid. T. $25^m 46^s$. The change of decl. 17″, added to 2d alt. gives diff. alts. 15′ 23″, and corrected Mid. T. $25^m 18^s$.

795. *Degree of Dependance.* As the interval may be measured

with precision, and as the lat., declin., and alt., are required approximately only, the value of the result depends almost entirely on the diff. alts.

(1.) The error of the mid. time due to a given error in the diff. alt. is found by taking away the sine employed, and adding that of the diff. alts. vitiated by a proposed error. The result is more trustworthy as the diff. alts. is greater.

In Ex. 1, No. 793, lat. 48° 4′ N., an error of 30″ in the diff. of alts. causes 15ˢ error of time; the obs. alts. would be better nearer noon.

In Ex. 1, No. 794, 30″ error of diff. alts. causes 4ˢ error of time.

In Ex. 2, No. 793, 30″ error of diff. alts. causes 22ˢ error of time.

In Ex. 2, No. 794, lat. 63° 46′, 30″ error of diff. alts. causes 48ˢ. The case is unfavourable from the smallness of the motion in alt.

(2.) The chief merit of the method is its insensibility to an error in the latitude, which, under the same circumstances, renders the observation of a Single Alt. useless. The effect of a proposed error is found by changing the sec. lat. before employed for the sec. of the lat. proposed.

In the following examples the effect of an error of lat. in the result by Single Alt. also is noted for comparison of the two methods.

In Ex. 1, No. 794, lat. 26° 14′, 10′ error of lat. (that is, using 26° 24′) causes only 4ˢ error of time. The effect of this error on the time by the single alt. 71° 49′ would be 28ˢ.

In Ex. 2, No. 793, 10′ error of lat. causes 1ˢ error of time. The error of time by the single alt. 57° 17′ would be 2ᵐ 9ˢ.

Since a single alt. very near the meridian cannot be employed for finding the time, and since the latitude at sea is usually uncertain some miles, unless it has been determined very recently, the above method is adapted to finding the time at ship during that portion of the day when the single altitude is not practicable.

## III. By Equal Altitudes.

796. Since the altitude of a body which does not change its declination varies exactly at the same rate while rising on the E. side of the meridian as while falling on the W. side, the same altitude occurs at the same hour-angle on each side of the meridian, and the middle point of time between the instants of two equal altitudes is the instant at which the body passes the meridian. Hence the time and, consequently, the error of the watch, may be found by observation of equal altitudes.

In the case of the sun, the middle point of time, or the mean of the observed times of equal altitudes A.M. and P.M., is apparent noon. In the case of a star, or other celestial body, the mean of the observed times corresponds to the R.A. of the star when on the meridian, that is, to the sidereal time, which may be converted into A.T. or M.T.

797. Since the sun changes his declination sensibly in large intervals of time, two equal alts. A.M. and P.M. do not in general correspond to equal hour-angles, and it becomes necessary to apply to the mean of the observed times a correction, which is called the *Equation of Equal Altitudes.*

The object of the computation is to find what time the watch shewed when the body was on the meridian; the rate, therefore, does not affect the result, unless it is irregular, in which case the mean of the A.M. and P.M. times is not the time shewn by the watch when the interval is half expired.

In like manner, the variation of the sun's motion in R.A. (which is the variation of the equation of time) produces no effect, provided it be uniform. The irregularity of this variation is inconsiderable

### 1. *Equal Altitudes at Sea.*

798. When the course made good during the interval of the observation of two equal altitudes is true E. or W., the ship changes her longitude only by the portion of time which she gains or loses on the sun in the interval; this change introduces no correction, and the only question is the time by watch when the interval is half expired. But when the ship changes her latitude, the same altitude no longer corresponds to the same time from noon, and a correction becomes necessary.*

799. This method, though but approximate, has some advantages: it is independent of the terrestrial refraction, provided this remains unchanged in the interval employed; and the correction for change of lat., when necessary, requires the lat. and alt. to be but roughly known. In the tropics the interval may in general be very small, on account of the rapid change of altitude, and the correction for change of latitude in such cases may sometimes be omitted. In high latitudes, on the contrary, the ship's change of latitude considerably alters the time from noon at which the 2d alt. (which should be equal to the 1st) is taken: hence, in such cases, the method is less useful.

*Note.*—As the equation of equal alts. is generally a small quantity as compared with the correction due to change of place, we shall not here consider it. If, however, it is required to introduce it, proceed afterwards to No. 806.

800. *The Observation.* Observe the sun's alt. before noon, noting the time. Note the instant of the same alt. of the same limb P.M. For greater accuracy, several equal alts. should be obtained.

When the motion in alt. is quick, both limbs may be observed.

801. *The Computation.* (1.) Take the mean of the A.M. and P.M. times by watch; this, when the ship does not change her lat., is the mean time by watch of apparent noon. Then the Equation of Time *applied as to Mean Time,* will give the time of mean noon at ship as shown by the watch. Applying to this the error of the watch on Greenwich will give Greenwich time at the mean noon of the ship, which is the longitude in time.

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* N.B.—The altitude should not be less than 70°, or the time from noon more than $10^m$.

(2.) Correction for change of latitude. With half the interval as an hour-angle compute the azimuth, No. 676.

To the log. sine of half the D. Lat. made good, add the log. sec. of the lat., and the log. cotan. of the azim.: the sum, rejecting tens, is the log. sine of the correction, *in time*.

When the ship has *approached* the sun in the interval, *subtract* this time from the above mean; when she has *receded* from the sun *add* it: the result is the time by watch at apparent noon.

Ex. 1. June 8th, 1826, lat. by acc. 6° N., at $2^h 43^m 1^s$ by watch (A.M.) and at $3^h 0^m 3^s$ (P.M.) obs. alt. ⊙ 84° 30′ to the northward; course, N.N.W. true, rate, 3½ knots.
The interval, $17^m$, gives Dist. run 1·1 mile and D. Lat. 1.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Alt. (true) | 84° 46′ | sec. | 1·040 | D. Lat. | 30″ | sin. | 6·163 |
| Decl. | 22 50 | cos. | 9·965 | Lat. | 6° | sec. | 0·002 |
| Half-Int. | $8^m 31^s$ | sin. | 8·570 | Az. | 22° | cot. | 0·394 |
| Azim. | 22° | sin. | 9·575 | Corr. | $-0^h\ 0^m\ 5^s$ | sin. | 6·559 |
| | | | | | 2 51 32 | | |
| | | | | T. by Watch of App. Noon | 2 51 27 | or Watch *fast*. | |

Here the sun is to the northward, and the course is to the northward, or the ship has *approached* the sun.

Ex. 2. June 22d, 1828, at sea, lat. 4° S., course S.W. true, rate 7½ knots, obs. alts of the sun to the northward; ship receding from the sun.

| | | | |
|---|---|---|---|
| Alt. ⊙ 59° 44 | Times | $12^h 29^m 57^s$ A.M. | $2^h 8^m 39^s$ P.M. |
| 50 | | 30 53 | 7 37 |
| 55 | | 31 45 | 6 45 |
| | Means | 12 30 52 | 2 7 40 int. $1^h 37^m$ |
| | | | 0 30 52 |
| | Approx. T. by Watch of noon | | 1 19 16 or Watch fast. |

The Dist. run in $1^h 37^m$ is 12m.; D. Lat. made good, 8′·5.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Alt. | 60° | sec. | 0·301 | D. Lat. | 4′ 15″ | sin. | 7·092 |
| Decl. | 23½ | cos. | 9·962 | Lat. | 4° | sec. | 0·001 |
| Half Int. | $48^m 30^s$ | sin. | 9·322 | Azim. | 22½° | cot. | 0·383 |
| Azim. | 22½° | sin. | 9·585 | Corr. | $+0^h\ 0^m 41^s$ | sin. | 7·476 |
| | | | | | 1 19 16 | | |
| | | | | T. by Watch of App. Noon | 1 19 57 | | |
| | | | | or *error* of the watch, *fast*. | | | |

802. *Degree of Dependance.* (1.) The error of time due to an error of 1′ in one of the alts. is half that due to 1′ change of alt., No. 788 (1.)

(2.) To find the error due to an error of 1′ in the D. Lat. made good, divide the correction obtained by the D. Lat. For ex., 1′ error in Ex. 2 causes $5^s$ error in the correction.

## 2. *Equal Altitudes on Shore.*

803. The method of equal altitudes is susceptible of considerable accuracy, but it can be completely put in practice on shore only, as the sea-horizon is always subject to uncertainty.

### [1.] *The Sun, Morning and Evening.*

805. *The Observation.* In the A.M., when the sun is within the limits (No. 778), set the index of the sextant at the altitude, nearly; clamp the index, and observe the instant of the alts. of both limbs, noting the times. Do the same in the afternoon, when the limbs will follow in reverse order.

The value of the method consists in the same altitude being repeated, without regard to the precise measure of it. But as the second or corresponding altitude is often lost by a cloud hiding the object, the usual practice is to set the index to certain whole divisions, as 10′, 20′, &c., and to observe the altitudes. The moving of the index destroys, indeed, the integrity of the method, since the second altitude is no longer identical with the first, but is merely inferred to be equal to it from the reading. The errors, however are greatly diminished by taking numerous altitudes: or a number of instruments may be employed, set to different altitudes.

806. *The Computation.* (1.) Reckon the time P.M. as $12^h$, $13^h$, &c., instead of $0^h$, $1^h$, &c. Add together the A.M. and P.M. times of observation; take the mean of these sums, and divide it by 2. Take the difference between the 1st and 3d times (as set down in the example below) to the nearest minute, and call it the interval.

(2.) Find the Greenwich Date for apparent noon at the place; reduce the sun's decl. (p. I. of the Naut. Alm.) to the nearest minute only, marking it as of the *same* or *contrary* name to the latitude, and as *increasing* or *decreasing*. Reduce the equation of time, p. I. Naut. Alm.

(3.) Take the sum of the changes of the sun's declination for the $24^h$ before and the $24^h$ after the Gr. Date; call this the double change.*

(4.) Compute the equation of equal altitudes thus:—

Part I. From Table 72 take out the logarithms A and B. To log. A add the log. cot. of the latitude and the prop. log. of the double change: the sum, rejecting tens, is the prop. log. of Part I.

Part II. To log. B add the log. cot. of the decl. and the prop. log. of the double change: the sum, rejecting tens, is the prop. log. of Part II.

(5.) Apply these parts, which form the equation, to the approximate noon by watch, by the following directions.

| | Part I. | | Part II. | |
|---|---|---|---|---|
| | Lat. and Declin. | | Interval | |
| | of the *same* name. | of *contrary* names. | *less* than 12 hours. | *greater* than 12 hours. |
| Declination increasing | *sub.* | *add* | *add* | *sub.* |
| Declination decreasing | *add* | *sub.* | *sub.* | *add* |

The result is the time shewn by the watch at the instant the sun was on the meridian, or apparent noon by the watch, and therefore shews the error of the watch on A.T.

To obtain the error on M.T. To apparent noon, $0^h\,0^m\,0^s$, or

* As the decl. in Table 60 is given only to the nearest minute, the daily change, as taken from this table, may be a minute in error. This will not cause an error of $1^s$ in the equation of equal alts.; but, for precision, the Nautical Almanac is necessary.

$12^h\ 0^m\ 0^s$, apply the reduced Equation of T. as directed p. I. of the Naut. Alm., or Table 62: the result is the *mean time* of the sun's meridian passage (as in No. 624). By comparing with this the time of apparent noon by the watch, its error on mean time is found.

Three places in the logarithms give the equation to $0^s.1$.*

Ex. 1. Feb. 15th, 1830, at Ascension, lat. 7° 57′ S., long. 14½° W., the following observations of the sun's limbs were taken in the quicksilver, the sextant being clamped at 81°.

| A.M. | P.M. | Sums, deducting 24. | |
|---|---|---|---|
| $10^h\ 45^m\ 40^s$ | $17^h\ 29^m\ 19^s$ | $4^h\ 14^m\ 59^s$ | Red. Decl. 12° 44′ S. |
| 10 47 54 | 17 27 8 ·5 | 4 15 2 ·5 | Eq. of T. $13^m\ 50^s.5$ *additive.* |
| | Sum | 8 30 1 ·5 | |
| | | 4 15 0 ·7 | Two-daily change, 39′ 18″, |
| | Approx. Noon by Watch | 2 7 30 ·3 | *decreasing.* |

| | | | |
|---|---|---|---|
| From $10^h\ 46^m$ | | | |
| to 17 27 | | | |
| Int. 6 41 | log. A | 2·218 | |
| | Lat. cot. | 0·855 | |
| | 39′ 18″ p. l. | 0·661 | |
| Part I. $2^s.0$ | pr. log. | 3·734 | |

Lat. and decl. *same* name; decl. *decreasing*, add.

| | | |
|---|---|---|
| Log. B | | 2·412 |
| Decl. cot. | | 0·646 |
| | | 0·661 |
| Part II. $2^s.1$ | | 3·719 |

Int. less than $12^h$; decl. *decreasing*, subtract.

| | | |
|---|---|---|
| Approx. Noon | | $2^h\ 7^m\ 30^s.3$ |
| −2·1 / +2·0 | Eq. of Eq. Alts. | −0 ·1 |
| App. Noon by Watch | | 2 7 30 ·2 |
| Eq. of T. *additive*, or Mean Noon, No. 624 | | 13 50 ·5 |
| Watch fast on M.T. | | 1 53 39 ·7 |

Ex. 2. July 24th, 1878, lat. 55° 1′ N., long. $0^h\ 6^m$ W., obtained following observations of sun's limbs in the quicksilver, the sextant being clamped at 49°.

| A.M. | P.M. | Sums deducting $24^h$. |
|---|---|---|
| $7^h\ 6^m\ 51^s$ | $17^h\ 12^m\ 39^s.5$ ... | $0^h\ 19^m\ 30^s.5$ |
| 7 10 27·5 | 17 8 57 ... | 0 19 24 ·5 |
| | Sum | 55 ·0 |
| | | 0 19 27 ·5 |
| | | 0 9 43 ·7 |

| | |
|---|---|
| ☉'s Red. Decl. | 19° 52′ N. *decr.* |
| Two-daily change | 25′ 17″ |
| Eq. of T. | $6^m\ 14^s.1$ *addit.* |

Int. $10^h\ 2^m$; Part I., $15^s.6$, lat. and decl. *same* name; decl. *decreasing*, add. Part II., $1^s.0$ int. less than $12^h$; decl. *decreasing*, subtract; app. noon by watch, $0^h\ 9^m\ 58^s.3$; Eq. of T. additive, or M.T. of Mer. Pass. $0^h\ 6^m\ 14^s.1$. Watch fast on M.T. $0^h\ 3^m\ 44^s.2$.

### [2.] *The Sun, Evening and Morning.*

807. Instead of observing A.M. and P.M. on the same day, it is often convenient to observe on the afternoon of one day and the morning of the next.

*The Computation.* (1.) Take the mean of the times as directed; No. 806; this is the approximate time by watch of apparent midnight. Find the interval as in No. 806.

(3.) Find the Green. Date in app. time for midnight at the place

* It is often convenient, when all possible accuracy is required, to employ the logarithms of numbers. In this case, take the arith. complements of the logs. A and B, employ the tangents of the lat. and decl., and the log. of the two-daily change in seconds.

Ex. (the above.)

| | | | |
|---|---|---|---|
| Log. A 2·2183 | ar. co. | 7·7817 | |
| Lat. | tan. | 9·1450 | |
| 39′ 18″ = 2358″ | log. | 3·3725 | |
| Part I. $1^s.99$ | log. | 0·2992 | |

| | | |
|---|---|---|
| Log. B 2·4121 | ar. co. | 7·5879 |
| Decl. | tan. | 9·3541 |
| ........................ | | 3·3725 |
| Part II. $2^s.06$ | log. | 0·3145 |

Reduce the sun's decl. and the Eq. of Time.

(3.) Find the double change, as before directed.

(4.) Compute the equation of equal altitudes, apply the 1st part the contrary way to (5): the result is the time by watch of apparent midnight.

Ex. Feb. 22d, 1830, P.M., and Feb. 23d, A.M., lat. 7° 57′ S., long. 14½° W., obtained observations of equal altitudes.

| P.M. | A.M. | Sums (—12h). | |
|---|---|---|---|
| $5^h\ 18^m\ 32^s$ | $10^h\ 59^m\ 47^s$ | $4^h\ 18^m\ 19^s$ | Decl. 12° 44′ S., *decreasing*. |
| 5 19 36 | 10 58 41 | 4 18 17 | Eq. of T. $13^m\ 46^s{\cdot}4$, *additive*. |
| 5 20 40·5 | 10 57 36 | 4 18 16·5 | |
| | | 52·5 | Double change, 43′ 8″ |
| | | 4 18 17·5 | |
| | Approx. Midnight by Watch | 2 9 8·7 | |

**Part I.**

| | | | |
|---|---|---|---|
| | $5^h\ 19^m$ | | |
| | 10 58 | | |
| Int. | 5 39 | log. A | 2·235 |
| | | Lat. cot. | 0·855 |
| | | 43′ 8″ | 0·614 |
| | —4·2 | | 3·704 |

**Part II.**

| | |
|---|---|
| Log. B | 2·307 |
| Decl. cot. | 0·646 |
| | 0·614 |
| $2^s{\cdot}5$ | 3·627 |

The int. is greater than $12^h$, that used for log. A being its suppl. The Eq. of eq. alts. is $+0^s{\cdot}3$; the watch fast on M.T. $1^h\ 55^m\ 22^s{\cdot}6$.

### [3.] *Equal Altitudes of a Star.*

808. This observation determines the absolute time with much precision and convenience, as there is no equation of equal altitudes.

809. *The Computation.* (1.) The mean of the times shewn by the watch is the time by watch corresponding to the sidereal time, or R.A. of the merid., which, in this case, is the same as the R.A. of the star.

(2.) Find M.T. by No. 607, and thence the error of the watch.

810. *Correction for Change of Refraction.* As the method of equal altitudes is capable of much precision, and as the rate deduced may be much affected by small errors in the absolute time, it is worth while to make the proper correction for every cause of inaccuracy. A shift of wind or a fall of rain, in the interval, may be accompanied by a change of refraction, which, especially when the altitude is low, may produce a sensible effect. To allow for this,

(1.) Find the correction of the refraction at both observations for the barom. and therm., Tables 32, 33; then, when the corrections differ,

(2.) To the prop. log. of their diff. add the prop. log. of the time the sun takes to move through his diameter (which, if not shewn by the observation, may be found by note *, p. 221), and the ar. comp. of the prop. log. of the semi-diameter; the sum is the prop. log. of a portion of time, *half* of which is to be applied to the time of noon, or midnight, thus:—

1st obs. A.M., or to the eastward, when the east. refr. is the *greater*, *add*; when the *lesser*, *subtract*.

1st obs. P.M., or to the westward, when the east. refr. is the *greater*, *subtract*; when the *lesser*, *add*.

Ex. May 21st, 1830, Fort Villagagnon, Rio de Janeiro, lat. 22° 55′ S., long. 43° W. obtained equal alts. 57° in the quicksilver, A.M. and P.M.; the refr. at the eastern observation 12″ *less* than at the west.

Reduced decl. 20° 50′ N. (of *contrary* name to lat. and *increasing*), double change 24′ 36″ Eq. of T. $3^m 44^s.7$, *subtr.* from A. T

| A.M. | P.M. | Sums | |
|---|---|---|---|
| $7^h 21^m 54^s$ | $13^h 25^m 6^s$ | $20^h 47^m 0^s$ | The int. $6^h$ from |
| 7 23 23 | 13 23 36 | 20 46 59 | $7^h 22^m$ to $13^h 22^m$ |
| 7 24 56 | 13 22 4 | 20 47 0 | gives the two parts |
| 3 2 | | 140 59 | $+3^s.7$ and $+2^s.2$, or |
| | | 20 46 59.7 | the equation of eq. |
| | | 10 23 29.8 | alts. $+5^s.9$. |

Correction for unequal refraction.

| | | |
|---|---|---|
| 12″ | prop. log. | 2.95 |
| $3^m 2^s$ | do. | 1.77 |
| 15′ 49″ | Ar. co. do. | 8.94 |
| $2^s.3$ | prop. log. | 3.66 |
| Corr. $-1^s.1$ | | |

| | |
|---|---|
| Approx. Noon by Watch | $10^h 23^m 29^s.8$ |
| Eq. Equal Alts. | $+5.9$ |
| | 10 23 35.7 |
| Corr. for Refract. | $-1.1$ |
| App. Noon by Watch | 10 23 34.6 |
| Eq. of T. $+12^h$ | 12 3 44.7 |
| Watch slow on A. T. | 1 36 25.4 |
| Watch *slow* on M.T. | 1 32 40.7 |

811. *Degree of Dependance.* The error of the equation of equal altitudes caused by an error in the double change of decl. is a matter of simple proportion. The effects of small errors in the lat. and decl. are insensible, therefore neither the lat. of the place nor the declin. is required to great precision. But variations in the refraction, not to be removed by corrections, will always leave the result in some degree doubtful. On this account, the method, even under the most favourable circumstances, can rarely be considered as affording extreme precision.

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## IV. Rating the Chronometer.

812. The Rate of a chronometer is the difference of its error from day to day. It is called *gaining* when the watch goes too *fast*, and *losing* when it goes too *slow*.

813. When the chronometer is *fast*, either on G. M. T. or on the time at place, if the error is *increasing*, the rate is *gaining*; if *decreasing*, the rate is *losing*. When the chron. is *slow*, if the error is *increasing*, it is *losing*; if *decreasing*, it is *gaining*.

The amount of the daily rate (supposed uniform) is found by dividing the change of the error by the number of days in the interval between the observations.

| | | |
|---|---|---|
| Ex. | May 27th, at $9^h$ A.M. chron. slow | $2^h 7^m 18^s$ |
| | June 3d, at $5^h$ P.M. slow | 2 6 51 |
| | Diff. of Error in $7^d 8^h$ | 0 0 27 |

Then $27^s$, divided by 7.33 days, gives $3^s.7$ daily rate, *gaining*.

814. When the error is found to have changed from fast to slow, or from slow to fast, the rate is the sum of the errors divided by the number of days elapsed.

Ex. 1. June 28th, at 3 P.M., the chron. was $0^m 7^s.0$ fast; on July 5th it was $0^m 16^s.1$ slow: required the Daily Rate. The sum $23^s.1$, divided by 7 (days), gives $3^s.3$, *losing*.

Ex. 2. On the 14th, the chron. was $0^m\ 17^s$ slow; on the 31st, it was $0^m\ 12^s$ fast: required the Rate. The sum $0^m\ 29^s$, divided by 17, gives $1^s{\cdot}7$, *gaining*.

815. As the chronometer rarely goes for any length of time without some irregularity, the rate should be deduced afresh at every opportunity. This is done, 1st, by finding the *absolute error on the time* at place, by observation, after intervals of a few days; 2dly, by direct comparison of the *interval of time* shewn by the chronometer with that measured by a clock of known rate, or with the motion of a star. Also, as longitude is measured by time, No. 479, the absolute longitudes of places, when correctly laid down, and their differences of long. may be employed in a corresponding manner.

All observations for the purpose of rating a chronometer should be made, if possible, on shore, on account of the uncertainty of the sea-horizon, because a small error in the absolute time may produce a great error in the daily rate deduced. Also, the observations should be made by the same person with the same instrument, and under the same circumstances, as nearly as possible.

### 1. *By Comparison with the Absolute Time, or Longitude*

#### [1.] *By the Time.*

816. The best observation (out of the observatory) for the purpose, is equal altitudes carried on for several days. The next in value is the same alt. repeated several days successively, in the same part of the day; for the times determined by A.M. and P.M. sights on the same day do not, it appears, agree exactly either at sea or on shore.*

As the rate cannot be depended upon for a considerable length of time, it is necessary to take frequent opportunities of obtaining alts. on shore by the artificial horizon. It is proper, therefore, to remark, that by a little care, and by not mixing A.M. and P.M. sights, the rate may be determined nearly as well as by equal altitudes.

817. At sea, the lunar observation, No. 836, or, under very favourable circumstances, the moon's altitude, No. 864, affords the absolute error of the chronometer on G. M. T., and may discover, accordingly, if any considerable change in the rate has taken place; but it would be highly injudicious to attempt to establish a rate from observations so discordant as these usually are.

818. An excellent method has been afforded of late years, of determining the error and rate of the chronometer by the establishment of time-balls at some observatories. These, with the G. M. T. at the instant the ball is dropped, are given in Table 13. The time-ball obviates the necessity of observations for rate.

819. When the ship leaves any place, and after an interval not much exceeding a fortnight returns to it again, the error of the

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* The late Captain Hewett informed me, that being obliged to keep account of the daily rates of his chronometers, by means of altitudes observed from the sea-horizon, while surveying the North Sea, in H.M.S. Fairy, the constant discrepancies between the A.M. and P.M. sights rendered it necessary to employ the A.M. sights alone.

chronometer accumulated in her absence is found directly by comparing the time shewn by the chronometer with the times obtained by observation both at her departure and at her return. The error thus found affords the actual *sea-rate*, and the method, when it can be practised, is far more efficient than that of deducing harbour-rates.

Ex. By an observation taken immediately before the ship's departure from a port the chron. was found slow $3^h\ 27^m\ 14^s$. By an observation taken at her return, or 11·3 days afterwards, the error was $3^h\ 27^m\ 44^s{\cdot}5$, or $30^s{\cdot}5$ more. Hence the RATE during her absence has been, on the average, $2^s{\cdot}7$ *losing*.

[2.] *By the Longitude.*

820. When, on making a well-determined point of land, the long. by chron. does not agree with the actual position of the ship, and when, accordingly, the chronometer must have been going at a different rate from what was supposed, it will be convenient to refer to the following Table.

| | Sailing E. | Sailing W. |
|---|---|---|
| | The Chronometer has | |
| The land not made so soon as expected. | gained less, or lost more, | gained more, or lost less, |
| The land made unexpectedly. | gained more, or lost less, | gained less, or lost more, |
| | than allowed for. | |

Ex. A ship from India to the Cape of Good Hope makes the land unexpectedly.
The ship is sailing W., the land made too soon; the chron. has therefore gained less or lost more than allowed for.

But it must be borne in mind that chronometers do not preserve the same rates, generally speaking, for a long time together; and, therefore, after a considerable interval, as upwards of a fortnight, this method shews only the gain or loss *on the whole*, not whether the chronometers are gaining or losing now.

## 2. *By Comparison of Intervals, of Time, or Longitude.*

[1.] *By a Clock.*

821. The chronometer being compared at different times with a clock of which the rate is known (as in No. 564), the difference of the errors for the intervals is obtained, and thence the rate is deduced. The mode of comparison is already described, p. 203.

[2.] *By a Star.*

822. Since every star returns to the same point of the heavens $3^m\ 55^s{\cdot}91$ of mean time earlier every mean solar day, the return of the same star to the same altitude, or to the wire of a fixed telescope, day after day, determines the rate very correctly. The alt. should

be considerable, in order to avoid errors of refraction, and the telescope, for the same reason, should be nearly in the meridian.

To find the rate, multiply $3^m\ 55^s\cdot91$ by the number of days elapsed, and subtract the product from the first time noted; the remainder is the time the chronometer would shew if it went uniformly, and the difference between this and the time it shews is the difference of the error for the interval, which gives the daily rate.

Ex. At an observation of a star on May 1st, the chron. shewed $7^h\ 51^m\ 11^s$; after four days it shewed $7^h\ 35^m\ 44^s\cdot6$: required the Daily Rate.

| | |
|---|---|
| First time noted | $7^h\ 51^m\ 11^s$ |
| $3^m\ 55^s\cdot91 \times 4$ | $-\ 15\ \ 43\cdot6$ |
| | $7\ \ 35\ \ 27\cdot4$ |
| | $7\ \ 35\ \ 44\cdot6$ |
| Gaining in four days | $17\cdot2$ |

hence the DAILY RATE is $4^s\cdot3$, *gaining*.

The disappearance of a star behind any elevated object answers the same purpose.

[3.] *By Difference of Longitude.*

823. When the error of the chronometer upon the time at any known place A is compared with the error on the time at another known place B, the difference between these two errors is the diff. long., in time, between the places. Hence if the difference of the errors does not agree with the Diff. Long. found from Table 10, or in Table of Secondary Meridians, p. 392, the discrepancy arises from a wrong rate having been employed in the interval between the observations for time, and the true rate may be found by trial, as in the following example:—

Ex. At Falmouth, Feb. 3d, at $3^h\ 20^m\ 18^s$ M.T. by observation, the chron. shewed $4^h\ 31^m\ 47^s$, or was $1^h\ 11^m\ 29^s$ fast. At Funchal, on the 12th, at $5^h\ 30^m\ 27^s$ M.T., or $9\cdot1$ days afterwards, the chron. shewed $7^h\ 29^m\ 34^s$. The supposed rate, $2^s\cdot3$ *gaining*. The D. Long. in Table 10 A is $47^m\ 28^s$. Required the true rate.

| | | | |
|---|---|---|---|
| Obs. at Falm., T. by chron. | $4^h\ 31^m\ 47^s$ | Obs. at Funchal, T. by chron. | $7^h\ 29^m\ 34^s$ |
| M.T. by obs. | $3\ \ 20\ \ 18$ | $2^s\cdot3 \times 9\cdot1$ d. *gain* | $-21$ |
| 1st error, fast | $1\ \ 11\ \ 29$ | | $7\ \ 29\ \ 13$ |
| | | M.T. by obs. | $5\ \ 30\ \ 27$ |
| | | 2d error, fast | $1\ \ 58\ \ 46$ |
| | | 1st error, ditto | $1\ \ 11\ \ 29$ |
| | | Difference, or *chron. D. Long.* | $47\ \ 17$ |

This diff. should be $47^m\ 28^s$, or is too small by $11^s$. By inspecting the process, it is evident that the quantity $21^s$ (which, from the nature of the case, is supposed to be in error) is too large by $11^s$. The RATE, therefore, is $10^s$ divided by $9\cdot1$, or $1^s\cdot1$ *gaining*.

When one error is fast and the other slow, make them both fast or both slow, by adding or subtracting any number of hours.

### 3. *Keeping Account of the Chronometer.*

824. In keeping account of the chronometer, the error on G.M.T. is entered in a book as fast or slow, with the date, and the rate is applied to this according as it is gaining or losing, day by day.

If, after a time, the long. or G.M.T. be obtained independently, the error on G.M.T. is found; if this does not agree with the rate

allowed, a new rate must be assigned from consideration of the circumstances.

825. As it is impossible, without an independent reference, to determine whether a chronometer, A, is gaining upon another, B, or B is losing while A goes as before, no direct rules of certain application can be given for reducing the rates of chronometers by mere comparison. Since, however, it may be presumed, in general, that in a number of watches the true time will be that shewn by the majority, regard being had to the quality of each, it is proper to keep an account, in which an approved watch being taken as the standard, the rest are severally compared with it every day.

It is convenient to distinguish the chronometers by letters, as A, B, C, &c., and to write the difference between A and B thus, A—B; that between A and C thus, A—C, over each column.

Advantage should be taken of favourable opportunities of landing at well-determined places (*see* Table of Longitudes accepted for Secondary Meridians, p. 392) for good observations of time, because the diff. long. between the places will at once discover any considerable change in the rate, afford means of correcting it, and be a means of obtaining the *sea-rates* of the chronometers.

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# CHAPTER VII.

## FINDING THE LONGITUDE.

I. BY THE CHRONOMETER. II. BY THE LUNAR OBSERVATION. III. BY THE ALTITUDE OF THE MOON. IV. BY AN OCCULTATION. V. BY ECLIPSES OF JUPITER'S SATELLITES.

826. The apparent motions of the celestial bodies parallel to the equator, produced by the revolution of the earth round its axis, being perpetual, no fixed point or circle can be obtained from which the longitude of the observer, which is measured, like right ascension, on the equator, may be determined. Longitude, accordingly, can be ascertained only with reference to the meridian of some other place; and, as it is measured by time (No. 193), it is determined by comparison of the time at place with the time at some other place.

### I. BY THE CHRONOMETER.

#### 1. *Determination of the Absolute Longitude.*

827. The most convenient method of finding the longitude is by comparison of the time at place with the time at Greenwich, as shewn by a chronometer.

The mean time at place being found (Chapter VI.), take the difference between this time and the time by chronometer, brought up to the time of observation by applying the error with the rate.

When the time at Greenwich is the *least*, the long. is E.; when the *greatest*, it is W.

Ex. 1. The M.T. at place is $3^h 48^m 2^s$; the G.M.T. is $4^h 15^m 11^s$: hence the Long. of the place is $0^h 27^m 9^s$, or $6° 47' 15''$ W.

Ex. 2. The M.T. at place is $7^h 14^m 22^s$; the G.M.T. is $2^h 6^m 57^s$: hence the Long. is $5^h 7^m 25^s$, or $76° 51' 15''$ E.

828. *Degree of Dependance.* The time at place, as deduced from observation, and the time shewn by chron., being both liable to error, the error of the resulting longitude is made up of the sum or difference of these two errors.

829. When the rate of the chronometer has changed, and the long. is required at a time past, the error of the chronometer at the time proposed must be deduced from the two rates by consideration of the circumstances, as no rule can apply to all cases.

## 2. *Determination of Difference of Longitude.*

830. The ordinary method is to find the absolute longitudes of both places by comparison of the Greenwich mean time, as above described, and then to take the difference between them.

Ex. M.T., at a place A, is $3^h 11^m 43^s$, when the G.M.T. is $7^h 7^m 18^s$: hence the long of A is $3^h 55^m 35^s$ W. Again, some days afterwards the M.T., at a place B, is $2^h 19^m 45^s$, when the G.M.T. is $6^h 26^m 34^s$: hence the long. of B is $4^h 6^m 49^s$ W.

The Diff. Long. between the places is, therefore, $11^m 14^s$, and B is west of A.

831. But it is more concise, in a question relating to a *difference* only, to proceed without regard to the absolute longitude of either place, by considering merely the error of the chron. on the time at each of the two places, as in the following example:—

Ex. 1. At $3^h 11^m 43^s$ M.T., by obs. at a place A, the chronometer shewed $5^h 11^m 19^s$, or was $1^h 59^m 36^s$ fast on the time at A. Again, some days afterwards, at $2^h 19^m 45^s$ M.T., at a place B, the chron. (after applying the rate) shewed $4^h 30^m 35^s$, or was $2^h 10^m 50^s$ fast on the time at B.

Now it is evident that if A and B were in the same long., the chron., supposing the rate truly determined, would have the same error at each place; and hence the difference of the errors, $1^h 59^m 36^s$ and $2^h 10^m 50^s$, or $11^m 14^s$, is the Diff. Long.

Since the chron. is *faster* at B than at A, the time at B is *behind* that at A, or B is west of A.

The proceeding, reduced to a rule, is as follows:—

Find, by observation, the error of the chron. on the time at place. Having moved to another place, take an observation for time; correct the time shewn by the chron. by applying the rate for the time elapsed since the former observation, and find the error: the difference of the two errors is the diff. long.

When the chron. is *fast* at both places, the place at which the error is the greatest is *west* of the other.

When the chron. is *slow* at both places, the place at which the error is the greatest is *east* of the other.

When the chron. is fast at one place and slow at the other (as may occur when the error is less than the diff. long.), add 5 or 6

hours to each of the times by chron. in order to render both the errors of the same kind.

| | | | |
|---|---|---|---|
| Ex. 2. At A, M.T. $5^h\ 36^m\ 10^s$, | chron. $6^h\ 36^m\ 20^s$, | error | $1^h\ 0^m\ 10^s$ fast |
| At B, M.T. 3 28 30, | chron. 4 9 20, | error | 0 40 50 |
| A west of B, | | Diff. Long. | 0 19 20 |

832. Since the whole value of a chronometric determination depends upon the rate of the chronometer, and since the rate is liable to change, the result is better as the time occupied in the run is less. This, however, does not, in strictness, apply to intervals less than 24 hours; for the works go through an entire revolution in 24 hours, and the *rate*, which is determined for an entire day, may be unequally distributed over different parts of the 24 hours. For extreme precision, the rate should be known for given intervals on the dial-plate.

833. When the ship returns without loss of time from a place to that from which she set out, the opportunity will in general be very favourable for determining the difference of longitude.

834. While a chronometer continues to gain or to lose, the difference of longitude shewn by it between two places will be differently affected, according as it is measured eastwards or westwards: hence, if the differences do not agree, the true diff. long. will be between them.

When the chron. *gains* on its rate, the computed long. is to the *west* of the true long.; when the chron. *loses* on its rate, the computed long. is to the *east*.

If the rate is steady, the true diff. long. will be correctly found by dividing the error according to the number of the days in the two passages.

### 3. *Communication of Chronometric Differences.*

835. Individuals possessing one or more good chronometers frequently have opportunities of furnishing, verifying, or correcting meridian distances. It is proper, therefore, here to enumerate the considerations which influence the value of the results, more especially as many such determinations are communicated to authority from time to time, which, however, not being accompanied with the details necessary for an estimation of their value, remain unemployed.

(1.) It is absolutely necessary to specify or to describe the *exact spot of observation* at each place.

(2.) The *number of days* employed in the run, or in the interval between the observations for time, or both, if these differ much, together with the *number of chronometers*, should be expressed; also, the times and manner of rating, and the character of the rate, as steady or unsteady, should be briefly noticed.

(3.) The *maker's name* and the *number* of the chronometer should be specified, because the character of a watch affects the value of a determination in which it is employed.

(4.) When there are several chronometers, the result given by each should be exhibited. The general *arithmetical mean* should be given, and, besides this, an *estimated mean*, obtained by giving more or less weight to the several results, according to the performance of each chronometer, and of which the observer alone can be a judge. The two final results should be expressed in *time*, and also in *arc*, for the more ready comparison of positions on the chart.

(5.) The *extreme difference* of the greatest and least results by the different chronometers employed should be stated, as this shews whether the chronometers went well together or not; for, though their going together does not prove that all or any of them are right, their not going together proves that some of them are wrong.

(6.) All observations for the longitudes of places are supposed to be made by means of the quicksilver, unless the contrary is expressed. When the altitudes are taken from the sea-horizon, the result should, therefore, be distinguished by the word (*sea*).

(7.) It will be useful to state the temperature of the chronometer-room, and to remark whether it has remained constant or been subject to variation. Also, the general direction of the ship's head should be noted.

(8.) Lastly, every result should be given without any regard as to *whether it agrees or not with received determinations*. Many received positions are very erroneous, and the only means by which they can be decisively rectified are the comparisons of independent and impartial evidence.

In the following example, D. L. is the abbreviation of Diff. Long.; ch. is that of chronometers; d. that of days; and the extreme difference is denoted by the number of seconds enclosed in brackets, implying limit or boundary.*

Ex. May, 1838, Capt. A., of H.M.S. ——, sailed from Barbadoes to Port Royal, Jamaica, the points of observation being Engineers' Wharf and Fort Charles. He carried five chronometers, viz., No. 152, Molyneux; No. 192, Breguet; No. 702, Arnold and Dent; No. 650, Parkinson and Frodsham; and No. 490, M'Cabe. The passage occupied seven days. The extreme difference of the results was 7 seconds of time. The arithmetical mean was $1^h\,8^m\,49^s$; the estimated mean, $1^h\,8^m\,52^s$. The temperature of the chronometer-room ranged from 78° to 80°; the ship's head chiefly west.

These particulars, abbreviated, stand thus:—

Capt. A., May 1838, D. L. *Barbados* (Eng. Wharf) to *Port Royal* (Fort Charles), 5 ch.

7 d. [$7^s$]

Arith. Mean, $1^h\,8^m\,49^s = 17°\,12'\,15''$

Estim. Mean, $1\;\;8\;\;52 = 17\;\;13\;\;0$

| | | | |
|---|---|---|---|
| M. | No. 152 | $1^h\,8^m\,46^s$ | |
| B. | No. 192 | 1 8 52 | |
| A. and D. | No. 702 | 1 8 53 | Temp. 78° to 80° [2°] |
| P. and F. | No. 650 | 1 8 45 | Head west. |
| M'C. | No. 490 | 1 8 49 | |

* This plan was proposed in the Naut. Mag., 1839, p. 402, to which the reader is referred for other details of the subject.

## II. The Lunar Observation.



836. The angular distance of the moon from any celestial body being in perpetual change, each of the several degrees of magnitude through which it passes corresponds to a certain instant of time. Accordingly, the distance of the moon from the sun and certain other bodies, at the end of every three hours, being given in the Nautical Almanac, the observation of this distance affords the means of determining the time at Greenwich, and thence the longitude of the observer.

This observation, on account of its great importance at sea, has been distinguished by the name of the *Lunar Observation.*

837. If the distance between the moon and the other body were the same to the spectator, whether he were at the surface or the centre of the earth, there would evidently be nothing more to do than to measure the distance by an instrument, to find from the Nautical Almanac the Greenwich time corresponding, and to compare this time with the time at place. But the refraction of the sun, a star, or a planet, being greater than its parallax in altitude, causes one of these bodies to appear *above* its true place; while, on the contrary, the moon's parallax in alt. being greater than her refraction, causes her to appear *below* her true place.

Z is the zenith, S and ☽ the true places of the sun (or star) and moon, S′ and ☽′ their apparent places. Then S ☽ is the true distance, and S′ ☽′ the apparent distance.

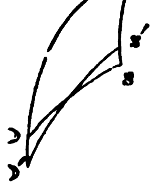

*Fig.* 1.

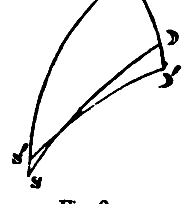

*Fig.* 2.

*Fig.* 3.

SS′ is the sun's corr. of alt., ☽☽′ the moon's corr. of alt. In fig. 1, where the ☽'s alt. is the lesser, the app. dist. exceeds the true, for ☽′ is farther from S than ☽ is, and S′ is also farther from ☽ than S is. In fig. 2, the app. dist. is the lesser. In fig. 3, both angles at S and ☽ are acute, as is the case when the alts. are nearly equal, and always when the distance exceeds 85°.

As ☽☽′ is always less than 56′, the arc ☽ *m*, fig. 3, of a circle, having its centre at S, is nearly a right line, and ☽′*m* (which, from the apparent place of the moon, is here the excess of the app. dist. above the true) is equal to ☽☽′ cos. of the angle at ☽′. The like term (or 1st correction of the app. dist.) for the sun is SS′ cos. S, or SS′ cos. S′ nearly. This is the principle of the approximate methods.*

Hence the *apparent* distance between the moon and the other body differs from the *true* distance, except in the particular case in which the two opposite effects happen exactly to compensate. This last circumstance may sometimes occur during the time that two bodies within distance are above the horizon, but not being discoverable from the observation it is productive of no simplification.

The process of reducing the apparent to the true distance, or removing the effects of parallax and refraction, is called *Clearing the Distance.*

838. It is evident from the above that the difference between the true and apparent distances depends almost entirely on the corrections of altitude (No. 438); and, consequently, is affected by every variation, however minute, of those corrections. Also, since the most rapid change of distance is about 1° 48′ in three hours, the effect of 1′ error of dist. is 25′ of long., or the effect of 15″ error of distance is 6′ of long., in the most favourable case. Hence it may become of great importance to the accuracy of the result, in many cases, that the heights of the barometer and thermometer should be noted at the time of observation.

839. The lunar observation, which is the only independent method of finding the longitude generally available at sea, is also, from not being confined like some others to a particular instant, of service on shore. A single observation, however, is not capable of affording a decisive result; great practice is necessary for measuring the distance successfully; and the application of so many small corrections as are necessary when accuracy is required is, even with extraordinary care and some skill, scarcely compatible with extreme precision.

840. *Limits.* The distance must fall between the greatest and

* The approximate process will be easily intelligible by attending to the following considerations.

The moon must always be *raised*, and the sun or star *lowered*, to attain their true places. Now, when the moon is the lower of the two bodies, it is evident that raising her will diminish the apparent distance; that is, her correction of distance must be *subtractive*. Again, when she is the higher body it is generally additive. When the sun or star is the lower body, *lowering* it will increase the app. dist.; its corr. of dist. is therefore *additive*, but subtractive in general when the uppermost body.

The angle at the *lower* body, Z ☽′S′, or Z S′☽′, is *always acute*, the corresponding angle at the other body will generally be obtuse when the altitudes are very unequal, and the dist. not great.

The *correction of dist.* in Method I. is the D. Lat. corresponding to this angle as a course, and the corr. of alt. as Dist. The sum or diff. of the Dep. and N is the cosine of the angle in question to the radius 100. When the dist. is less than 90° and the Dep. greater than N, the angle is acute, but obtuse when the Dep. is the lesser. Thus, in Ex. 1 the angle at the moon is 55°½; that at the star, 76°.

When the moon's alt. amounts to nearly 80°, or when the distance is so small as 20°, M and N vary irregularly, and Method I. does not serve well.

least distances in the Nautical Almanac. The alts. should not be less than 5° or 6°; and, when the barometer and thermometer are not at hand, not less than 12° or 15°, especially in very hot or very cold weather.

As the chief part of the computation consists of *clearing the distance*, it will be more convenient for reference to consider this portion of the work separately.

### 1. *Clearing the Distance.*

#### [1.] *Approximate Methods.*

841. In these methods the object is to find the *correction* of the apparent distance due to the corrections of altitude of each body. The first, or that by *inspection*, is performed by means of the Spherical Traverse Table; and the second, by *logarithms*,* is a useful and convenient process, without the embarrassment of various cases, and requiring only four places of figures.

The approximate methods are, in general, not susceptible of much precision when the distance is less than 20°.

842. Method I. *By Inspection.* (1.) For the Moon's Correction of Distance. With the moon's app. alt. and the compl. of the app. dist. to 90°, take out M and N.

With the sun's or star's† alt. as Course, and M as Dist. find the Dep., which place under N.

When the distance is *less* than 90°, take the *difference* of this Dep. and N, marking the Dep. according as it is greater or less than N.

When the distance is *greater* than 90°, take the *sum* of the Dep and N.

With the Dist. 100, and the said *diff.* or *sum* as D. Lat., find the Course.‡ With this course and the moon's corr. of alt. as Dist., find the D. Lat; this is the moon's correction of distance.

For the Moon's 2d Corr. Enter Table 56 with the app. dist. and the moon's corr. of alt., and take out the seconds. Enter again with the corr. of dist. and take out the seconds. The diff. of these two quantities is the 2d corr., which apply as directed in the Table.

(2.) For the Sun's or Star's Correction of Distance. With the sun's or star's app. alt. and the co-dist., take out M and N.

With the moon's alt. as Course and M as Dist. find the Dep., which place under N, marking it as greater or less than N when the dist. is less than 90°.

Take the *diff.* or *sum* as before directed.

With the Dist. 100 and this *diff.* or *sum* as D. Lat. find the Course. With this course and the sun's or star's corr. of alt. as Dist. find the D. Lat.; this is the corr. of distance required.§

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* This is a slight variation of the method commonly known among seamen as Norie's 4th method, and attributed to Mendoza Rios.

† In the case of a planet, substitute the word planet for star in the several rules.

‡ If this sum or diff. exceed 100, a mistake has been made.

§ The correction of distance may be found more correctly by multiplying the diff. or sum

*Note.* In finding the moon's corr. work to the nearest *half degree;* and when the sun's or star's alt. is less than 20°, take out the Dep. to the nearest *third* or *quarter* of a degree. In the sun's or star's corr. work to the nearest *whole degree.*

Apply the corrections to the app. dist. as follows; the result is the true distance.

| Distance *less* than 90° | | | | Distance *greater* than 90° | |
|---|---|---|---|---|---|
| ☽ Corr. of Dist. | | ⊙ or ✱ Corr. of Dist. | | ☽ Corr. of Dist. | ⊙ or ✱ Corr. of Dist. |
| When the Dep. is | | When the Dep. is | | | |
| *less* than N | *greater* than N | *less* than N | *greater* than N | | |
| *add* | *sub.* | *sub.* | *add* | *sub.* | *add* |
| ☽ 2d Correct. of Dist. *add* | | | | ☽ 2d Correct. of Dist. *sub.* | |

Ex. 1. (Dist. *less* than 90°.) App. alt. ⊙ 47° 31′; A. alt. ☽ 36° 52′; app. dist. 48° 20′ 29″. ⊙ corr. of alt. 47″; ☽ corr. of alt. 45′ 35″. (Co-dist. 41½°.)

☽'s Corrections.

☽ 37° and 41½°, M 167, N 66·6
⊙ 47½° and 167, Dep. 123·1 (gr.)
(*diff.*) 56·5

Dist. 100 and D. Lat. 56·5 give the Course 55½°; at which,

Dist. 45′ gives D. Lat. 25·5 — 25′ 30″
35″ — 20
25 50

(which *sub.*, since 123·1 exceeds 66·6.)

☽ 2d corr. 16″
5 — + 11″

⊙'s Correction.

⊙ 47° and 41°, M 194·3, N 93·2
☽ 37° and 194, Dep. 116·8 (gr.)
(*diff.*) 23·6

Dist. 100 and D. Lat. 23·6 give the Course 76°; at which,

Dist. 47″ gives D. Lat. 11″
(which *add*, since 116·8 exceeds 93·2.)

| | |
|---|---|
| ⊙ corr. | +0° 0′ 11″ |
| ☽ 2 corrs. | −25 39 |
| | −0 25 28 |
| A. dist. | 48 20 29 |
| TRUE DIST. | 47 55 1 |

Ex. 2. (Dist. *greater* than 90°.) App. alt. ⊙ 13° 10′; app. alt. ☽ 36° 6′; app. dist. 120° 29′ 53″. Hor. par. 59′ 42″; ☽ corr. of alt. 46′ 58″; ⊙ corr. of alt. 3′ 56″. (Co-dist. 30½°.)

☽'s Corrections.

☽ 36° and 30½°, M 143·4, N 42·8
⊙ 13¼° and 143·4, Dep. 32·9
(*sum*) 75·7

100 and D. Lat. 75·7 give Course 41°.

46′ gives 34′·7 — 34′ 42″
58″ — 44
−35 26

☽ 2d corr. 120° and 47′, 11″ } −5″
35, 6 }

⊙'s Correction.

⊙ 13° and 30°, M 118·5 N 13·3
☽ 36° and 118, Dep. 69·4
(*sum*) 82·7

100 and D. Lat. 82·7, Course 34°.

3′ gives 2′·5, — 0° 2′ 30″
56″ — 46

| | |
|---|---|
| | +0 3 16 |
| | −0 35 31 |
| | −0 32 15 |
| | 120 29 53 |
| TRUE DIST. | 119 57 38 |

---

(of the Dep. and N) by the correction of alt., pointing off two more decimals than the product contains. The seconds may either be taken separately, or as decimals of a minute.

This process, worked however roughly, affords a check against a mistake in using the Traverse Table.

Ex. 1 of No. 842.

| | |
|---|---|
| Diff. | 56·5 |
| ☽ corr. of alt. 45′ 35″ | 45·6 |
| Prod. | 2576·40 |
| Pointing off two dec. | 25·76 or 25′ 46″ |

| | |
|---|---|
| Diff. | 23·6 |
| ⊙ corr. of alt. 47″ | 47 |
| Prod. | 1109·2 |
| Pointing off two dec. | 11·09 or 11″ |

Ex. 3. App. alt. ☉ 72° 0; app. alt. ☽ 27° 1′; app. dist. 72° 18′ 32″. ☉ corr. of alt. 15″; ☽ corr. of alt. 46′ 30″. (Co-dist. 17½°.)

☽ 27° and 17½°, M 117·4 N 15·6
☉ 72° and 117, Dep. 111·3
95·7

100 and 95·7, Course 17°.

46′ 44 0″
30″ 29
−44 29

☽ 2d corr. 72° and 46′, 7″
44, 6 } +1″

☉ 72° and 17°, M 358·4, N 94·1
☽ 27° and 338, Dep. 153·0
58·9

100 and 58·9, Course 54°.

16′, ☉ corr. +0° 0′ 9″
−0 44 28
−0 44 19
72 18 32
True Dist. 71 34 13

Ex. 4. (Correcting for the barom. and therm.) Suppose, in Ex. 2 above, the barom. is 30·7 in. and the therm. 38°; the ☽ corr. of alt. will be 46′ 54″, by No. 655, and the ☉'s corr. of alt. 4′ 9″, No. 651.

46′ 34′ 42″
54″ 41
−35 23

4′ 3′ 18″
9″ 7
+3 25
True Dist. 119° 57′ 50″

843. The following examples exhibit those steps only which, in proceeding by No. 842, a practised computer will find it necessary to write down. The errors are marked against each result as given in Dr. Inman's "Navigation."

Ex. 1. ☉ A. alt. 25° 20′; ☽ A. alt. 25° 35′. ☉ corr. of alt. 1′ 52″; ☽ corr. of alt. 48′ 21″; app. dist. 104° 37′ 49″. (Co-dist. 14½°.)

114·4 12·1
49
(52°) 29′ 36″ 61·1
13
−29 49 4″, +4″
0

113·7 11·6
50·0
61·6
(52°) +0° 1′ 9″
−0 29 45
−0 28 36
104 37 49
True Dist. 104 9 13 (3′ too small).

Ex. 2. A. alt. Spic. Virg. 48° 0′; A. alt. ☽ 69° 48′. ✱ corr. alt. 51″; ☽ ditto, 18′ 39″. Hor. par. 55′; A. dist. 55° 46′ 34″. (Co-dist. 34°.)

352·7 185·3
262·3
13′ 54″ 77·0
30
−14 24
3″
1 } +2″

180·3 74·9
169·1
94·2
+0° 0′ 48″
−0 14 22
−0 13 34
55 46 34
True Dist. 55 33 0 (19″ too small).

Ex. 3. A. alt. ☉ 60° 39′; A. alt. ☽ 34° 41′. ☉ corr. alt. 28″; ☽ corr. 43′ 40″. Hor. par. 54′ 47″; A. dist 43° 44′ 50″. (Co-dist. 46°.)

175·1 71·1
153·1
35′ 12 82·0
33
−35 45
17″
5 } +12″

296·9 186·8
170·4
16·4
−0° 0′ 4″
−0 35 33
−0 35 37
43 44 50
True Dist. 43 9 13 (17″ too small).

It is evident from these examples, which, with those before given,

exhibit a sufficient variety of cases, that the method is accurate enough for navigation in the open sea.

844. Method II. *By Logarithms.*—Set down in order the sun's or star's app. alt., the moon's app. alt., and the app. dist.; take half the sum, and subtract from it the first term in order (sun's or star's alt.); call the rem. the 1st rem.; subtract the second term in order (the moon's alt.), and call this rem. the 2d rem.

For the 1st Corr. To the log. cos. of the moon's app. alt. add the log. sine of the app. dist., the const. 9·6990, the log. sec. of the half sum, the log. cosec. of the 1st rem., and the prop. log. of the moon's corr. of alt.: the sum (rejecting tens) is the prop. log. of the 1st correction.

For the 2d Corr. Take the difference between the moon's corr of alt. and the 1st corr. Enter Table 56 with the app. dist. and the moon's corr. of alt., and take out the seconds. Enter again with the above difference, take out the corresponding seconds, and subtract them from those taken out before: the rem. is the 2d corr. Apply this corr. as directed in the table.

For the 3d Corr. To the log. cos. of the sun's (or star's) app. alt. add the log. sine of the app. dist., the const. 9·6990, the log. sec. of the half sum, the log. cosec. of the 2d rem., and the prop. log. of the sun's (or star's) corr. of alt.: the sum (rejecting tens) is the prop. log. of the 3d correction.

(As the 2d, 3d, and 4th logs. are common to the two corrections, it will be convenient to take the sum of these three logs.)

Subtract from the app. dist. the moon's corr. of alt. and the 3d corr.; add the 1st corr., the sun's (or star's) corr. of alt., and apply the moon's 2d corr. as directed in Table 56: the result is the true distance.

Ex. 1. App. alt. ⊙ 47° 31; app. alt. ☽ 36° 52; app. dist. 48° 20′ 29″. Sun's corr. of alt. 47″; moon's corr. of alt. 45′ 35″.

| | | | | | |
|---|---|---|---|---|---|
| ⊙ Alt. | 47° 31′ | ........ | | cos. | 9·8296 |
| ☽ Alt. | 36 52 | cos. | 9·9031 | | |
| Dist. | 48 20 | sin. | 9·8733 | | |
| | 132 43 | | 9·6990 | | 9·9690 |
| Half S. | 66 21 | sec. | 0·3967 | | |
| 1st Rem. | 18 50 | cosec. | 0·4910 | | |
| 2d Rem. | 29 29 | ........ | | cosec. | 0·3079 |
| | 45′ 35″ | pr. log. | 0·5965 | 47″ pr. log. | 2·3613 |
| 1st Corr. | 19 45 | pr. log. | 0·9596 | 3d Corr. 37″, | 2·4678 |
| Diff.* | 26 | | | | |

A. Dist. 48°, and ☽ Corr. Alt. 46′, Tab. 56, 16″
26. 6
2d Corr. + 10

| | |
|---|---|
| A. Dist. | 48° 20′ 29″ |
| ☽ Corr. Alt. | − 45 35 |
| 3d Corr. | − 37 |
| | 47 34 17 |
| 1st Corr. | + 19 45 |
| ⊙ Corr. Alt. | + 47 |
| ☽ 2d Corr. | + 10 |
| TRUE DIST. | 47 54 59 |

Ex. 2. App. alt. ⊙ 32° 36′, app. alt. ☽ 65° 22′, app. dist. 81° 15′ 51″; ⊙'s corr. of alt. 1′ 22″, ☽'s corr. of alt. 22′ 27″: required True Distance.
1st Corr. 37″, 2nd Corr. 0, 3d Corr. 0, TRUE DIST. 80° 55′ 23″.

Ex. 3. App. alt. ✱ 50° 44′, app. alt. ☽ 27° 50′, app. dist. 93° 9′ 6″, ☽'s corr. of alt. 50′ 25″, ✱ corr. of alt. 47″.
1st. Corr. 4′ 45″, 2d Corr. 0, 3d Corr. 9″, TRUE DIST. 92° 24′ 4″.

* This diff. is the moon's corr. of dist. by the method No. 842. The sun's or star's corr. of dist. is found in like manner, thus: 47″ − 37″ = 10″ (agreeing within 1″).

### [2.] *The Rigorous Method.*

845. In this method we find, by calculation, the true distance directly from the apparent distance and apparent altitudes.

(1.) Take both the app. alts. to the nearest even or odd minute, take their sum, and call the supplement of it the *1st supplement.*

Subtract from this suppl. the moon's corr. of alt., and add to it the sun's or star's corr. of alt.; call the result the *2d supplement.*

(2.) Take out the Logarithmic Difference, Table 73.

Take the app. dist. to the nearest even minute. Mark the seconds, if taken in *excess*, to be *subtracted*, or if *omitted*, to be *added* afterwards. To this add the 1st suppl., take the half sum, and from the half sum subtract the app. dist.

Add the log. sines of this half sum and remainder to the log. diff.; the sum (rejecting tens) is the log. sine square of an auxiliary arc $x$.

(3.) Under $x$ put the 2d suppl., take the sum and the diff., and half the sum and half the diff.

Add together the log. sines of the last two terms; the sum is the log. sine square of an arc, which becomes the true distance on applying the reserved seconds.

Ex. 1. A. alt. ☉ 47° 31′; app. alt. ☽ 36° 52; app. dist. 48° 20′ 29.
Sun's corr. of alt. 47″; moon's H. P. 58′ 35″; moon's corr. of alt. 45′ 35

| | | | |
|---|---|---|---|
| ☉ Alt. | 47° 32′ 0 | | |
| ☽ do. | 36 52 0 | | |
| | 84 24 0 | 1st Sup. | 95° 36′ 0″ |
| | | 45′ 35″ + 47″, | − 44 48 |
| | | 2d Sup. | 94 51 12 |
| ☽ 36° 50′, H. P. 58′, | | | 9·995792 |
| 2, | | − 5 | |
| | 35″, | −45 | |
| ☉ 47°, | | −14 | − 64 |
| | | Log. Diff. | 9·995728 |

| | | | |
|---|---|---|---|
| A. Dist. | 48° 20′ (29″ omitted) | | |
| 1st Sup. | 95 36 | | |
| Sum | 143 56 | | |
| Half S. | 71 58 | sine | 9·978124 |
| Rem. | 23 38 | sine | 9·603017 |
| $x$ | 75° 48′ 48″ | sin. sq. | 9·576869 |

| | | | |
|---|---|---|---|
| $x$ | 75° 48′ 48″ | | |
| 2d Sup. | 94 51 12 | | |
| Sum | 170 40 0 | | |
| Diff. | 19 2 24 | | |
| Half S. | 85 20 0 | sine | 9·998558 |
| Half D. | 9 31 12 | sine | 9·218363 |
| | | pts. for ″ | 149 |
| | 47 54 32 | sin. sq. | 9·217070 |
| add | 29 | | |
| Tr. Dist. | 47 55 1 | | |

846. It is useful to bear in mind, as a check against a gross mistake in clearing the dist., that the true and apparent distances cannot differ by more than the *sum* of the corrections of altitude. Again, when the moon's alt. is *equal* to, or *less* than, that of the other body, the true distance is *less* than the app. dist.; but the contrary does not always hold when the moon's alt. is the *greater*.

## 2. *Lunar Observation by the Sun.*

847. *The Observation.* (1.) The alts. of the sun and moon are required at the instant at which the distance is observed; when, therefore, the observer has assistants provided with proper watches, they will obtain the alts. during the time that he is observing the distance. See Nos. 560 and 561.

When the observer is alone, he will first observe the alt. of the body farthest from the meridian, then that of the other body, and then the distance; concluding with the alts. in the reverse order.* As precision is not necessary in the alts., one observation of the alt. will generally be enough at each time.

The time by watch is, of course, to be noted at each contact.

(2.) To observe the distance. Set the index nearly to the distance in the Nautical Almanac, at the nearest estimated Greenwich time; put down one or more shades to screen the central mirror, direct the sight to the moon, and, holding the plane of the instrument in the line joining the two bodies, vibrate it slowly round the line of sight as an axis till the sun's image is seen. Make a contact roughly, clamp the index, put in the telescope (previously adjusted to distinct vision by the moon), and complete the contact. See note §, p. 182.

The relative brightness of the object and image is most conveniently adjusted by altering the distance of the telescope from the plane of the sextant by means of the screw for the purpose, as this motion causes a greater or lesser quantity of light to proceed to the eye from the silvered or brightest part of the mirror.

Observe at least 3 or 5 distances, or, with the circle, 3 or 5 pairs.

When, at sea, the ship has much motion, the observer fixes himself firmly in a corner, or lies on his back on the deck, in order to remove, as much as possible, the sense of bodily effort and inconvenience which disturbs the eye and the attention.

(3.) For precision observe the moon's true bearing; if she is near the zenith, observe that of the star instead.

848. *The Computation.*—(1.) Having reduced the alts. to the time of the mean of the distances, No. 660, find the Gr. Date. At sea, the Gr. Date is required only to the nearest hour; but if the moon's alt. is not observed, it must be found with precision. Reduce the hor. par., and thence the semid., from Table 40. Augment the semid., Table 42. For precision, correct the hor. par. by Table 41.

(2.) Find the App. Alts. of the centres by applying the ind. corr., dip, and semid.

Correct the observed distance for ind. error, and add the semidiameters of the bodies: the result is the *apparent distance.*

(3.) Find the Sun's Corr. of Alt. by subtracting the par. in alt. from the refraction. Find the Moon's Cor. of Alt. by Table 39. Correct for the therm. and barom. whenever these instruments are accessible. Tables 32, 33.

(4.) Find the true distance by No. 842, 844; or, for precision, No. 845, and apply the corrections, Nos. 852 and 853.

(5.) For the G.M.T. Find, in the Nautical Almanac, the two distances between which the true distance falls. Take out the first of these, and set it down under the true dist., and write against it

* The reason of this order, as a general rule in such cases, is, that the outer body preserves uniformity in its change of alt. for a longer time than the other, and consequently its alt. may be reduced, by simple proportion, to an intermediate time, with less error than the alt. of the other body. See No. 558.

its prop. log given in the Nautical Almanac; note also the time (that is, the three hours) corresponding.

Take the difference between the two distances thus set down, and from its prop. log. subtract the prop. log. taken from the Nautical Almanac; the remainder is the prop. log. of a portion of time to be *added* to the time from the Nautical Almanac. The result is the G.M.T. of the true distance.

For precision, see No. 856.

The G.M.T. being found, the long. is determined.

Ex. 1. H M S. Eden, April 7th, 1831, lat. by acc. 34° 30′ S., long. 42° W., watch slow on the chron. 8ʰ 16ᵐ 31ˢ; chron. slow of G.M.T. 4ʰ 54ᵐ 33ˢ; height of eye, 16 feet; ind corr. −7′ 36″; had the following observations: required the error of the chronometer.

| Times by Watch. | Alt. ☽ | Alt. ☉ | Distance. |
|---|---|---|---|
| 12ʰ 57ᵐ 24ˢ | 39° 2′ | | |
| 12 58 36 | | 47° 33′ | |
| 1 1 29 | | | 66° 0′ 8″ (the mean of three sights.) |
| 1 5 47 | | 47 52 | |
| 1 8 18 | 36 42 | | |

Reduction of the Altitudes to the time 1ʰ 1ᵐ 29ˢ.

| ☽ | | | | ☉ | | | |
|---|---|---|---|---|---|---|---|
| 39° 2′, | 12ʰ 57ᵐ 24ˢ, | 4ᵐ 5ˢ | 1·644 | 47° 33′, | 0ʰ 58ᵐ 36ˢ, | 2ᵐ 53ˢ | 1·795 |
| | 1 1 29 | | | | 1 1 29 | | |
| 36 42, | 1 8 18, | 10 54 | 8·782 | 47 52, | 1 5 47, | 7 11 | 8·601 |
| 2 20 | | | 0·109 | 19 | | | 0·976 |
| | | −52′ | 0·535 | | | +8′ | 1·372 |
| 39 2 | | | | 47 33 | | | |
| Moon's Alt. 38 10 | | | | Sun's Alt. 47 41 | | | |

Reduced Obs.—Time, 1ʰ 1ᵐ 29ˢ; Alt. ☽ 38° 10′; Alt. ☉ 47° 41′; Obs. Dist. 66° 0′ 8″.

| | | | |
|---|---|---|---|
| Time by Watch | 1ʰ 1ᵐ | ☽ H. P. on the 7th, noon, | 56′ 34″ |
| Watch slow of Chron. | 8 16 | midnt. | 56 59 |
| Time of Obs. by Chron. | 9 17 | Var. in 12ʰ | 25 |
| Chron. slow | 4 55 | Prop. Part for 2ʰ, 4″, H. P. | 56 38 |
| | 14 12 | Corresp. Sem. 15′ 26″, aug. do. 15′ 35″. | |
| Gr. Date,* 7th | 2 12 | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Obs. ☽ | | 38° 10′ | Obs. ☉ | | 47° 41′ | Obs. Dist. | | 66° 0′ 8″ |
| Ind. Corr. | − 8′ | | Ind. Corr. | − 8′ | | Ind. Corr. | − 7′ 36″ | |
| Dip | − 4 | | Dip | − 4 | | ☽ Sem. | + 15 35 | |
| Sem. | − 16 | −28 | Semid. | + 16 | +4 | ☉ Sem | + 15 59 | +23 58 |
| ☽ App. Alt. | | 37 42 | ☉ App. Alt. | | 47 45 | App. Dist. | | 66 24 6 |

| | | | | |
|---|---|---|---|---|
| ☽ App. Alt. 37° 40′, H. P. 56′, | 43′ 5″ | | ☉ App. Alt. 48°, Refr. | 53″ |
| 2 pts. | − 2″ | | Par. in Alt. | −6 |
| 38 | +30 | +28 | ☉ Corr. of Alt. | 47 |
| ☽ Corr. of Alt. | | 43 33 | | |

Clearing the Distance (No. 842), to the End.

☽ Alt. 37½°, and Co-dist. 23½°
M 137·5, N 33·4
☉ 47½° and 137·5 Dep. 101·4 (gr.)
(Diff.) 68·0

☽ 1st Corr. −29′ 37″
☽ 2d Corr. 44′, 8″ ⎫
30, 3 ⎭ Corr. + 5″

☉ Alt. 47° and 23°, M 159·3, N 45·5
37° and 159 Dep. 95·7 (gr.)
50·2

| | | |
|---|---|---|
| ☉ Corr. | +0° 0 24 | |
| ☽ 2 Corrs. | −0 29 32 | |
| | −0 29 8 | |
| A. Dist. | 66 24 6 | |
| True Dist. | 65 54 58 | |
| Do. at 0ʰ | 67 0 8 | p. log. ·3051 |
| | 1 5 10 | p. log. ·4412 |
| | 2ʰ 11ᵐ 35ˢ | p. log. ·1361 |
| T. of Pr. Dist. | 0 | |
| G.M.T. | 2 11 35 | |

* In working by an approximate method, an expert computer will infer the Gr. Date at once, and perform many other parts of the computation with little or no writing.

The watch being slow of the chron. $8^h\ 16^m\ 31^s$, the time of the obs. by the chron. is $1^h\ 1^m\ 29^s + 8^h\ 16^m\ 31^s$, or $9^h\ 18^m\ 0^s$; the chron. is therefore $7^h\ 6^m\ 26^s$ fast, or $4^h\ 53^m\ 35^s$ slow of the G.M.T. Now, by Table 58, an error of 1 in the dist. causes, in this case, an error of $2^m\ 8^s$ in the G.M.T.; hence the result may be considered as confirming the error of the chron. nearly enough.*

Ex. 2. Sept. 28th, 1878, at $3^h\ 11^m\ 40^s$ P.M., M.T. at ship; in lat. 48° 50′ N., long. acc. 146° 55′ W.; obtained the mean of 7 distances between sun and moon 34° 48′ 16″, obs. alt. ☉ 22° 37′, obs. alt. ☽ 18° 7′; height of eye 16 feet.

| | | | | | | |
|---|---|---|---|---|---|---|
| Gr. Date, Sept. $28^d\ 12^h\ 59^m\ 20^s$ | | | App. Dist. | | | 35° 20′ 54″ |
| ☽'s Red. H.P. | | 60′ 35″ | ☉'s App. Alt. | | | 22 49 |
| Aug. Semid. | | 16 37 | ☽'s App. Alt. | | | 18 20 |
| ☉'s alt. 22° 49′ | Ref. | 2′ 18″ | 18° 20′ H.P. 60 | | | 54′ 4 |
| | Par. | −8 | | 35′ | | +33 |
| ☉'s corr. of alt. | | 2 10 | ☽'s Corr. of Alt. | | | 54 37 |

Clearing the Distance by No. 844.

| | | | | | |
|---|---|---|---|---|---|
| ☉ App. Alt. 22° 49 | | | ......cos. | 9·9646 | |
| ☽ App. Alt. | 18 20 | cos. | 9·9774 | | |
| App. Dist. | 35 21 | sin. | 9·7624 | | |
| | 76 30 | | 9·6990 | 9·5664 | |
| Half Sum | 38 15 | sec. | 0·1050 | | |
| 1st Rem. | 15 26 | cosec. | 0·5749 | | |
| 2d Rem. | 19 55 | | | cosec. 0·4677 | |
| Corr. Alt. | 54′ 37″ | P.L. | 0·5179 | 2′ 10″ P.L. | 1·9195 |
| 1st Corr. | 41 34 | P.L. | 0·6366 | 3 Cor. 2 10 P.L. | 1·9182 |
| Diff. | 13 3 | | | | |

Dist. 35° 55′ Corr. 38″
13 2
2d Corr. +36

| | | | |
|---|---|---|---|
| App. Dist. | | 35° 20′ 54″ | |
| ☽ Cor. Alt. 54′ 37″ } 3d Corr. 2 10 } | | −56 47 | |
| | | 34 24 7 | |
| 1st Corr. | | +41 34 | |
| ☉'s Corr. Alt. | | + 2 10 | |
| 2d Corr. | | + 36 | |
| True Dist. | | 35 8 27 | |
| At $12^h$ | | 34 34 33 | P.L. 2417 |
| | | 0 33 54 | P.L. 7251 |
| | | $0^h\ 59^m\ 8^s$ | P.L. 4834 |
| | | 12 | |
| M.T.G. | $28^d$ | 12 59 8 | |
| M.T.S. | $28^d$ | 3 11 40 | |
| Long. | | 9 47 28 | |
| | | = 146° 52 W. | |

Ex. 3. Sept. 1st, 1878, at $4^h\ 40^m\ 4^s$ P.M., M.T. at ship; lat. 3° 2′ N., long. acc. 1° 5′ W., obs. alt. ☉ 20° 0′, obs. alt. ☽ 62° 30′, obs. dist. 61° 26′ 26″; height of eye 18 feet.

| | | | | | | |
|---|---|---|---|---|---|---|
| Gr. Date, Sept. $1^d\ 4^h\ 44^m\ 24^s$ | | | App. Dist. | | | 61° 58′ 51″ |
| ☽'s Red. H.P. | | 59′ 38″ | ☉'s App. Alt. | | | 20 12 |
| Aug. Semid. | | 16 31 | ☽'s App. Alt. | | | 62 42 |
| | | | 62° 40′ H.P. 59′ | | | 26 36″ |
| ☉'s Alt. 20′ 12′ | Ref. | 2′ 37′ | 2 | | −2 } | |
| | Par. | −8 | | 38″ | +·8 } | +16 |
| ☉'s Corr. of Alt. | | 2 29 | ☽'s Corr. of Alt. | | | 26 52 |

* The Nautical Almanac, before 1834, was computed for apparent time; the above result is therefore Greenwich app. time. This does not, however, in any way affect the value of a mere example.

Clearing the Distance by No. 844.

| | | | | |
|---|---|---|---|---|
| ☉ App Alt. | 20° 12 | | | cos. 9·9724 |
| ☽ App. Alt. | 62 42 | cos. | 9·6615 | |
| App. Dist. | 61 59 | sin. | 9·9459 | |
| | 144 53 | | 9·6990 | 0·1653 |
| Half Sum | 72 26½ | sec. | 0·5204 | |
| 1st Rem. | 52 14½ | cosec. | 0·1020 | |
| 2d Rem. | 9 44½ | | | cosec. 0·7716 |
| Corr. Alt. | 26′ 52″ | P.L. | 0·8261 | 2′ 29″ P.L. 1·8602 |
| 1st Corr. | 31 39 | P.L. | 0·7549 | 3Cor. 0′ 18″ P.L. 2·7695 |
| Diff. | 4 47 | | | |

| | | |
|---|---|---|
| Dist. 62° | 27 | Corr. 4″ |
| | 5 | 0 |
| | 2d Corr. | +4 |

| | | |
|---|---|---|
| App. Dist. | | 61° 58′ 51″ |
| ☽ Corr. Alt. 26′ 52″ | | −27 10 |
| 3d Corr. 0 18 | | |
| | | 61 31 41 |
| 1st Corr. | | +31 39 |
| ☉'s Corr. Alt. | | + 2 29 |
| 2d Corr. | | + 0 4 |
| True Dist. | | 62 5 53 |
| At $3^h$ | | 61 7 38 P.L. 2541 |
| | | 0 58 15 P.L. 4900 |
| | | $1^h 44^m 33^s$ P.L. 2359 |
| | | 3 |
| M.T.G. | $1^d$ | 4 44 33 |
| M.T.S. | $1^d$ | 4 40 4 |
| Long. | | 4 29 |
| | | = 1° 7′ 15″ W. |

Ex. 4. Sept. 30th, 1878, at $4^h 44^m 46^s$ P.M., M.T. at ship, lat. 17° 9′ S., long. acc. 102° 40′ W.; obs. alt. ☉ 16° 12′; obs. alt. ☽ 73° 14′; obs. dist. 60° 22′ 59″; height of eye 16 feet.

G.M.T. Sept. $30^d\ 11^h\ 35^m\ 26^s$, corr. H.P. 58′ 59″, aug semid. 16′ 21″. ☉'s app. alt. 16° 24′, ☽'s app alt. 73° 26′, app. dist. 60° 55′ 21″; ☉'s corr. of alt. 3′ 8″, ☽'s corr. of alt. 16′ 32″, true dist. 61° 10′ 36″. LONG. 102° 47′ 30″ W.

### 3. *Lunar Observation by a Star or a Planet.*

849. *The Observation.*—Take the alts. as directed, No. 847. In taking the distance, direct the view to the star, make the contact nearly between the star and the illuminated edge of the moon, whether it be the nearest or farthest limb; clamp the index, put in the telescope previously adjusted to distinct vision by the star, and complete the contact by bisecting or splitting the star upon the moon's limb.*

When the moon is bright, it is necessary to use a shade.

The setting of the index, No. 847 (2), is a more important step in observing with the star than with the sun, for the amount of distance is often the only security for employing the right star.

For precision, note the azimuth as directed No. 847 (3).

850. *The Computation.* (1.) Proceed by No. 848 (1). For a planet, take out the hor. par. from the Nautical Almanac, and reduce it.

(2.) Find the app. alts. as in No. 848 (2).

For the app. dist., correct the observed dist. for ind. error. When the *nearest* limb is observed, *add* the moon's semid.; when the *farthest*, *subtract* it.

---

* It has been recommended to observe the star open of the moon's edge, leaving a dark space of about 40″. But this dark space will appear differently in different telescopes; and, moreover, it is better to be in the practice of observing accurately than loosely.

The inaccuracy which arises in bisecting a planet when it is not, as we should say of the moon, at the full, is but small; since, even in the case of Venus, the only planet which ever appears as a crescent when observed with the moon, it can scarcely exceed 6″ or 8″. It has been proposed to correct for this by a special computation.

(3.) Find the star's corr. of alt., which is the refraction. For a planet, apply the par. in alt. from Table 45. For the moon, take her corr. out of Table 39. For precision, correct for the height of the barom. and therm.

(4.) Find the true distance, and proceed as in No. 848 (4), to the end.

Ex. July 16th, 1826, near midnight, lat. by acc. 27° 5′ N., at $2^h\ 34^m\ 13^s$ by the chron., obs. alt. ☽ 35° 12′; obs. alt. Fomalhaut, 12° 51′; obs. dist. farthest limb, 70° 1′ 10″. Ind. corr. −20″; height of eye, 16 feet: required the error of the chron. supposed fast on G.M.T. $1^h\ 6^m\ 25^s$.

| | | | |
|---|---|---|---|
| Time by chron. | $2^h\ 34^m$ | H.P. 16th, midnight | 59′ 42″ |
| Chron. fast. | 1 6 | 17th, noon | 59 35 |
| G.D. 6th, past midnt. | 1 28 | Var. in $12^h$ | 7 |
| | | Red. H.P. | 59 41 |
| | | Corresp Sem. 16′ 16″; Aug. do. 16′ 27″. | |

| | | | | | |
|---|---|---|---|---|---|
| Obs. Alt. ☽ | 35° 12′ | Obs. Alt. ✱ | 12° 51′ | Obs. Dist. | 70° 1′ 10″ |
| Dip − 4′ } Sem. + 16 } | + 12 | Dip | −4 | Ind. Corr. | −20 |
| | | ✱ A. Alt. | 12 47 | ☽ Sem. | −16 27 |
| ☽ A. Alt. | 35 24 | | | A. Dist. | 69 44 23 |

| | | | |
|---|---|---|---|
| 35° 20′, and H.P. 59′, | 46′ 47″ | ✱ Alt. | 12° 47′ |
| 4, − 2″ } 41″, + 33 } | + 31 | | |
| ☽ Corr. of Alt. | 47 18 | ✱ Corr. of Alt. | 4 12″ |

Clearing the Distance (by No. 842) to the End.

| | | | |
|---|---|---|---|
| ☽ 35½° and 20°, M 130·7 N. 26·0 | | ✱ 13° and 20°, M 109·2 N. 8·4 | |
| ✱ 13° and 131 Dep. 29·5 (gr.) | | ☽ 35° and 109 Dep. 62·5 (gr.) | |
| 3·5 | | ✱ Corr. +0° 2′ 12″ | 54·1 |
| ☽ 1st Corr. | −1 36″ | ☽ 2 Corrs. −0 1 30 | |
| ☽ 2d Corr. {47′, 6″ / 2, 0} | +6 | +0 0 42 | |
| | | A. Dist. 69 44 23 | |
| | | True Dist. 69 45 5 | |
| | | Dist. at Mid. 70 31 15 | p. log. ·2747 |
| | | 46 10 | p. log. ·5909 |
| | | G.M.T. $1^h\ 26^m\ 55^s$ | p. log. ·3162 |
| | | T. by Chron. 2 34 13 | |
| | | Error, *fast* 1 7 18 | |

Ex. 2. Sept. 7th, 1838, P.M., lat. 3° 2′ N., long. $4^h\ 0^m$ W., at $12^h\ 57^m\ 8^s$ by watch, obs. five distances of the moon's nearest limb from Aldebaran, 27° 47′ 12″. App. alt. ✱ 26° 32′; app. alt. ☽ 53° 34′; watch slow $9^m\ 17^s$ of M.T.; ind. corr. −1′ 10″: required the longitude.

☽ red. H.P. 59′ 48″; true dist., by No. 845, 28° 37′ 17″; dist. at $XV^h$, 29° 47′ 47″.
Long. 59° 56′ W.

Ex. 3. Sept. 2d, 1840, P.M., lat. 3° 2′ N., long. 60° 0′ W., at $8^h\ 48^m\ 39^s$ by watch, obtained the mean of 5 distances between Saturn and the moon's nearest limb, 89° 42′ 55″; ind. corr. −1′ 25″; watch slow of M.T. $7^m\ 33^s$; app. alt. ☽ 53° 3′; app. alt. Sat. 23° 34′.

☽ red. H.P. 60′ 44″; true dist., by No. 845, 89° 56′ 11″; dist. at $III^h$, 89° 1′ 31″.
Long. 60° 1′ W.

Ex. 4. July 14th, 1878, at $2^h\ 10^m\ 0^s$ A.M., M.T. at ship, lat. 22° 0′ S., long. acc. 149° 30′ E., obs. alt. Antares 19° 33′, obs. alt. ☽ 51° 48′, obs. dist. near limb 75 22′ 49″, height of eye 24 feet.

G.M.T. July 13^d 4^h 12^m, corr. H.P. 56′ 41″. aug. semid. 15′ 29″, * app. alt. 19° 28′, ☽'s app. alt. 51° 59′ app. dist. 79° 38′ 18″, * corr. 2′ 44″, ☽'s corr. 34′ 9″, true dist. 79° 29′ 41″. LONG. 149° 33′ E.

Ex. 5. June 19th, 1878, at 4^h 30^m A.M; M.T. at ship, lat. 20° 10′ N., long. acc. 75° W., obs. alt. Venus 23° 14′, obs. alt. ☽ 52° 54′; obs. dist. near limb 86° 45′ 44″, height of eye 16 feet.

G.M.T. June 18^d 21^h 30^m, corr. H.P. 55′ 7″, aug. semid. 15′ 14″, Venus' app. alt. 23° 10′, ☽'s app alt. 53° 5′; app. dist. 87° 0′ 58″, Venus' corr. 2′ 9″, ☽'s corr. 32′ 23″, true dist. 86° 43′ 48″. LONG. 75° 6′ 15″ W

### 4. *Special Corrections.*

851. When precision is required, it is necessary, besides removing from the distance the general effects of refraction and parallax, to apply certain corrections.

#### [1.] *Correction for the Elliptical Figure of the Disc.*

852. Since the refraction of each point of the disc of the sun or moon is greater as the alt. of such point is less, and since the change of refraction is proportional to small changes of alt., the upper and lower halves of the circular disc take more or less the figures of ellipses, the lower half being more flattened than the upper half. The distance, therefore, between the centre and the limb, as it would actually be observed, is less than the horizontal semidiameter of the Tables. The elliptical figure of the sun, due to this cause, is often conspicuous at rising and setting. The correction in Table 53 is to be subtracted from the semidiameter.*

#### [2.] *Correction for the Spheroidal Figure of the Earth.*

853. The true distance found from the data, as above, is deduced on the supposition that the earth is a sphere, instead of a spheroid. The true distance found is, in fact, that corresponding to a sphere of smaller dimensions than those circumscribed by the equator,† and to an horizon differently placed with respect to the equator, or to another latitude than that of the spectator.

Since, however, the mere change of the place of the spectator would cause no alteration in the apparent angular distance of two stars, the change of distance arises solely from the variation of the apparent place of the moon, produced by the changing of the observer's astronomical latitude for the geocentric latitude. The change of place of the moon is thus in general the resultant of a change both of her altitude and her azimuth.

This correction is 0 at the equator and poles, and is greatest in lat. 45°. As it cannot much exceed $\frac{1}{60}$ of the reduction of latitude, it may in practice be omitted, but the effect rarely disappears altogether.

---

* We have not applied this correction, because at low altitudes, the only case in which it is sensible, the observation is not to be depended upon within such small quantities.

† The correction on this account has already been made in the reduction of the moon's equatorial parallax.

854. To correct the distance.

Enter Table 55 with the lat. and the alt. 90°, and take out the number.

For Part I. Enter Table 5 with the complements of the moon's azimuth and of the angle at the moon (found by No. 842 or 844),* and take out M. Divide the number by M.

For Part II. Enter Table 5 with the moon's azimuth and the angle at the moon, and take out M. Divide the number by M.

The quotients are in seconds, and are to be applied to the distance as follows.

*Note.*—The observer is supposed to face the moon, and the azimuth is reckoned from the S. in N. lat., and from the N. in S. lat.

| | Part I. | | | | Part II. | | |
|---|---|---|---|---|---|---|---|
| | In N. Lat. | | In S. Lat. | | Angle at the ☽ *less* than 90° | Azimuth of the ☽ | |
| | Sun or Star | | Sun or Star | | | less than 90° | *greater* than 90° |
| ☽ to the Eastward | to the *right* | to the *left* | to the *right* | to the *left* | | | |
| | sub. | add | add | sub. | | sub. | add |
| ☽ to the Westward | add | sub. | sub. | add | Angle *greater* than 90° | add | sub. |

Ex. Lat. 48° N.; moon's alt. 30°; star's alt. 61°; dist. 54°; moon's azim. S. 72° E.; and the star to the right.

The angle at the moon is 34°.

The number in Table 55 is 1100.

Co-az. 18°, Co-ang. 56°, M 188·0

$\frac{1100}{188} = 6''$, *subtractive.*

Az. 72°, Ang. 34°, M 390

$\frac{1100}{390} = 3''$, *subtractive.*

Hence the Correction is $- 9''$.

855. When the moon is near the zenith, or when her alt. exceeds 80°, with the lat. and the compl. of the star's azimuth as an altitude, take out the seconds from Table 57, and divide them by 100; the quotient is the correction required in seconds.

When the star's azim. (reckoned as above) is *less* than 90°, *subtract* the corr., otherwise add it.

---

* Since the angle at one or both bodies, which is given by the method No. 842, is necessary in making the corrections, No. 852, 853, and since that method affords both an approximation by which the long. by acc., if greatly in error may be corrected, and at the same time a check against any important error in the rigorous process itself, it will be advisable to employ it on all occasions.

The angle at the body may be found from No. 844, when that method is employed, thus:—Take the sum of the logs., rejecting the const. 9·6990 and the prop. log.; the ar. co log. of this sum is the log. sine square of the angle required.

Ex. No. 844.

| | | | | | |
|---|---|---|---|---|---|
| Sum of four logs. | | 0·6641 | Sum of logs. | | 0·4075 |
| Angle at ☽ 55° 30 | sin. sq. | 9·3359 | Angle at ☉ 77° 12′ | sin. sq. | 9·5925 |

[3.] *Correction for the Inequality of the Moon's Motion.*

856. Since the moon does not generally change her distance from the sun or a star at the same rate, both at the beginning and end of 3 hours, it is often proper to apply a correction to the Gr. M.T. found, which, in the extreme case, may be in error 50′ of long.

When the distance exceeds 26°, this correction will not exceed 15′ of long.; when the distance is near 90°, it will not exceed 2′. In general, it is smallest in the case in which the sun or star is in a direction perpendicular to the line of cusps or horns.

857. Take the diff. between the prop. logs. in the Nautical Almanac against the two distances between which the given true dist. falls. With this diff., and the portion of time found in No. 848 (5), enter Table 57, and take out the seconds. When the prop. logs. in the Nautical Almanac are *increasing*, *subtract* these seconds; when *decreasing*, *add* them; the result is the M.T. at Greenwich, corrected.

Ex. 1. Dist. in Naut. Alm., preceding given dist.,

| | | | |
|---|---|---|---|
| | 22° 58′ 21″ | prop. log. | 3079 |
| following do. | 24 56 56 | do. | 3054 (*decreasing*) |
| | | Diff. | 25 |
| Diff. 25 under Int. 13$^m$, (*add*) | 0$^h$ 0$^m$ 2$^s$ | | |
| | 0 26 9 | | |
| CORRECTED G. M. T. | 0 26 11 | | |

Ex. 2. In Ex. 2, No. 850, dist. 29° 47′ 47″ has the prop. log. 2527; the next in order has 2581; the diff. 54 gives 14$^s$ to be *subtracted*; and the long. corrected, 59° 52′ W.

858. *Degree of Dependance.* The true distance is affected by errors of observation, and by errors of computation. An error in the distance, of whatever kind, produces, on the average, about 30 times its amount in the longitude; thus, 10″ error of distance produce about 300″ or 5′ error of longitude.

The observed distance is liable to the ordinary errors of angular distance, the chief of which are, perhaps, most usually that due to defect of parallelism of the telescope, and that arising from making the contact above or below the centre of the field. Irradiation is also included in the errors of observation.

859. The error of the computed result arises from two sources; the errors in the elements of the observation, and those of the method of solution.

(1.) Under the first of these heads are comprised the errors in the horiz. par. in reducing it to the Gr. Date, and for the figure of the earth, the error of the tabular semidiameter;* and that of refraction in low altitudes.

(2.) The effects of errors of a few minutes in the altitude are insensible. Hence an ill-defined horizon is no great detriment to a

* The Greenwich observations shew that the semidiameter of the moon, as given in Burckhardt's tables, is 3″ too small.—See "Green. Obs." 1837.

good observation; and hence, also, in computing the altitudes, precision is not essential. This last remark is worth attention, since the calculation of altitudes is a heavy addition to the work of a lunar. On the same account it will not be necessary to consider the change of place during the observation, unless the second alt. of either body be lost.

(3.) The importance of correcting for the barometer and thermometer has been noticed, No. 838. The atmospherical correction is of most consequence at low altitudes, and when the bodies are in or near a vertical plane.

(4.) The smaller corrections, namely, reduction of equatorial parallax, corrections for elliptical disc, for the figure of the earth, and for unequal motion, cannot all be applied the same way in any observation; compensation will accordingly take place to a considerable extent even when these corrections are omitted altogether. It will, however, be advisable to apply the latter correction, No. 856, when large.

860. The error of the method of solution, No. 842, may be estimated for distances exceeding 50° at not more than 20″, in general, or 10′ of long.

Method II., No. 844, will, in the same cases, be more accurate.

861. The effects of errors in general, and especially constant errors of observation, are removed in a considerable degree by observing *equal distances* on *opposite sides* of the moon, since the errors of the resulting longitudes will be of opposite kinds. The true long. will not, however, be the *mean* of the two erroneous longitudes, unless the moon changes her distance from both bodies at the same rate.

When the two longitudes in such a case differ widely, add the prop. log. of their difference in time to the prop. log. of the *greater* motion in 3 hours (which is the *smaller* of the prop. logs. in the Nautical Almanac), and the ar. co. prop. log. of the sum of the two 3-hourly motions; the sum is the prop. log. of a portion of the time to be applied to the long. obtained by the star whose prop. log. is employed.

Since the true long. must fall between the two given results, it will be known at once whether to add or subtract.

When the sum exceeds 3°, read the degr. and min. as min. and sec.

Ex. The long. by Regulus, in a certain case of a lunar, is $2^h\ 37^m\ 15^s$; by Antares, $2^h\ 40^m\ 58^s$; the distances being nearly equal on opposite sides, and observed by the same observer with the same instrument. The 3-hourly motion of Regulus is 1° 45′ 31″, that of Antares 1° 30′ 29″: required the True Long.

| | | | | | |
|---|---|---|---|---|---|
| Long. Reg. | $2^h\ 37^m\ 15^s$ | 3-hour. mot. | 1° 45′ 31″ | p. l. (1′ 45″) | 2·0101 |
| Ant. | 2 40 58 | do. | 1 30 29 | | |
| | | | 3 16 0 | ar. co. (3′ 16″) | 8·2588 |
| | 3 43 ......... | | | p. l. | 1·6851 |
| | | | $0^h\ 2^m\ 0^s$ | p. l. | 1·9540 |
| | | | 2 37 15 | | |
| | | Long. req. | 2 39 15 (9s more than the mean). | | |

862. After the result has been obtained with the utmost care, there remains the error of the lunar tables, which appears to be about $0^s{\cdot}5$ of R.A., or 4′ of long. This can be removed only by careful examination of observations of the moon, made near the same time in a fixed observatory. In general, the result will have more value as the moon's horizontal parallax is greater, because her motion is then more rapid; on the contrary, the result is of less value as the horiz. par. is less. Since the changes of the moon's R.A., at their maximum and minimum, are nearly in the ratio of 5 to 3 and since the change of R.A. is in a considerable degree, though not in exact proportion, greater as her distance from the earth is less, it is evident that the place of the moon at the time of observation materially affects the value of the result.*

### 5. *Computation of the Altitudes.*

863. When the altitudes are not observed they must be calculated. M. T. is supposed to be given.

(1.) Reduce to the Gr. Date the sid. time at mean noon, also the R.A. and decl. of each body, unless one of them is the sun, in which case reduce the equat. of time instead of his R. A.

(2.) Find the hour-angles, Nos. 609 to 612, and compute the alt. of each body, No. 667. See No. 859 (2).

For the *apparent* altitudes. Take out the corrections of altitude to the true alts., found as if for app. alts., to the nearest minute, and apply these corrections the *contrary way* to that directed in the rules, Nos. 644, &c.†

Ex. Sept 11th, 1838, A.M., at Fort St. Joaquim, lat. 3° 2′ N., long. $4^h\ 0^m$ W., at $9^h\ 49^m\ 40^s$ by watch, obtained the mean of five distances of the sun and moon, 82° 16′ 51″. Ind. corr. − 55″; watch fast of M. T. $3^m\ 2^s$; therm. 85°; barom. 29·7 inch.

| | | | | |
|---|---|---|---|---|
| T. by watch | $9^h\ 49^m\ 40^s$ | ☽ H. P. 11th, | noon | 56′ 56″ |
| Watch fast | − 3 2 | | midn. | 56 32 |
| | 9 46 38 | | | 0 24 |
| M. T. | 21 46 38 | | | 0 3 |
| Long W. | 4 0 0 | | | 56 56 |
| Gr. Date, 10th, | 25 46 38 | Red. H. P. | | 56 53 |
| or 11th, | 1 46 38 | Semid. | | 15 30 |

* In combining the results of different observations for the purpose of deducing the longitude of a place, regard would be had to this and other circumstances in giving a different weight to each several result. The final determination of positions, however, by means of observations made at different times and under different circumstances, concerns the hydrographer or geographer rather than the seaman or traveller, and is not a subject for this volume.

† As the altitudes in a lunar are not required with precision, Tables 43 and 44, which are necessary to remove the inaccuracy of using the true alts. as arguments, will rarely be employed.

It will be prudent to verify the result by the method of inspection (see Expl. of Table 5), in order to avoid entailing any material error on the whole of the subsequent computation.

### Elements for computing the Altitudes.*

| | |
|---|---|
| Sid. T. noon | 11h 20m 14s |
| 1h, 10s | |
| 46m½, 7 | 17 |
| Red. S. T. | 11 20 31 |
| M. T. | 21 46 38 |
| | 33 7 9 |
| Eq. of T. 11th, | 3m 23s |
| 12th, | 3 44 |
| | 21 |
| Red. Eq T. | 3 24 |

| | |
|---|---|
| M. T. | 21h 46m 38s |
| | + 3 24 |
| | 21 50 2 W. |
| ☉ H.-ang. | 2 9 58 |
| ☉ Decl. | 4° 38′ 38″ N. |
| | 4 15 45 N. |
| | 22 53 |
| | 1 40 |
| | 4 38 38 |
| Red. Decl. | 4 36 58 N. |
| P. Dist. | 85 23 |

| | | |
|---|---|---|
| ☽ R. A. 11th, 1h, | | 5h 41m 14 |
| 2, | | 5 43 42 |
| | | 2 28 |
| | | 9·5229 |
| | 2m 28s | 1·8632 |
| | 46 38 | 0·5866 |
| | 0h 1m 55s | 1·9727 |
| | 5 41 14 | |
| Red. R. A. | 5 43 9 | |
| | 33 7 9 | |
| ☽ H.-A. | 3 24 0 | |
| ☽ Decl. | 28° 36′ 48″ N. | |
| D. 13″ | 1 | |
| ☽ Decl. | 28 38 | |
| P. Dist. | 61 22 | |

### Computation of the Altitudes.

| | | |
|---|---|---|
| ☉ H.-A. | 2h 9m 58s | |
| Suppl. | 9 50 2 | sin. sq. 9·96461 |
| P. D. | 85° 23′ | sine 9·99859 |
| Col. | 86 58 | sine 9·99939 |
| | 172 21 | |
| Arc x | 146 36 | sin. sq. 9·96259 |
| | 318 57 | |
| | 25 45 | |
| | 159 28 | sine 9·54500 |
| | 12 53 | sine 9·34824 |
| | 32° 29′ | sin. sq. 8·89324 |
| ☉ Tr. Alt. | 57 31 | |
| Corr. Alt. | + 1 | |
| ☉ A. Alt. | 57 32 | |

| | | |
|---|---|---|
| ☽ H.-A. | 3h 24m 0s | |
| Suppl. | 8 36 0 | sin. sq. 9·91098 |
| P. D. | 61° 22′ | sine 9·94335 |
| Col. | 86 58 | sine 9·99939 |
| | 148 20 | |
| Arc x | 115 21 | sin. sq. 9·85372 |
| | 263 41 | |
| | 32 59 | |
| | 131 50 | sine 9·87221 |
| | 16 29 | sine 9·45291 |
| | 54° 45′ | sin. sq. 9·32512 |
| ☽ Tr. Alt. | 35 15 | |
| Corr. Alt. | − 46 | |
| ☽ A. Alt. | 34 29 | |

| | |
|---|---|
| | 82° 16′ 51 |
| | − 55 |
| | 82 15 56 |
| | + 15 55 |
| | + 15 50 |
| | + 9 |
| A. Dist. | 82 47 50 |

| | | |
|---|---|---|
| ☉ 57° 32′, | | 37″ |
| | | − 5 |
| 85°, | − 2″ | 32 |
| 2, | 0 | − 2 |
| ☉ Corr. of Alt. | | 30 |

| | | |
|---|---|---|
| ☽ 34° 20′, H. P. 56′, | | 44′ 50″ |
| 9 | − 4″ | |
| 53″ | + 43 | + 39 |
| | | 45 29 |
| 85°, | − 5″ | |
| | − 1 | + 6 |
| ☽ Corr. of Alt. | | 45 35 |

Proceeding to clear the distance by No. 845, the log. diff. is 9·996092, and the true dist. 82° 4′ 51″. The next dist. preceding is 82° 58′ 33″, at noon; and the G. M. T. 1h 47m 0s, or Long. 60° 5′ 30″ W.†

---

* To adapt this form for computing the altitudes to the case of a planet, put the planet's hor. par. in the place of the equat. of time; and in the next column the planet's R. A.

† This observation, and those in Examples 2 and 3 of No. 850, were taken, with several others, by Sir Robert Schomburgh, to whom I am indebted for them.

## III. By the Moon's Altitude.

864. Since Mean Time is determined by the hour-angle and R.A. of a celestial body, the R.A. may be determined from the M.T. and the hour-angle, the latter being computed from the observed altitude. Now the moon's R.A. being given in the Nautical Almanac for certain points of time, the time at Greenwich corresponding to any given R.A. of the moon may be at once found.

The moon's altitude has accordingly been often thus employed in determining the longitude; but the method requires much caution, because an error of altitude produces, in the hour-angle computed from it, a quantity greater than itself, except in the single case in which the observer is on the equator and the body on the prime vertical, when these errors are equal. Accordingly, since an error in the moon's hour-angle appears in its full amount in her deduced R.A., and since the R.A. changes at the rate of about $2^m$ only in an hour, the longitude required is vitiated to the extent of not much less than thirty times the error of altitude in the most favourable cases.

It is evident, therefore, since the place of the sea-horizon is often doubtful from 1′ to 3′, that the result of a simple lunar altitude must be in general greatly inferior to that of a lunar distance, in which a good observer rarely makes an error exceeding half a minute. But as many persons, who are not sufficiently expert in the lunar observation to obtain on all occasions a satisfactory longitude, are nevertheless capable of observing altitudes with precision, and, moreover, as the stars, when the air is not very clear, are often too faint for the lunar observation, the former method may, on some occasions, prove of service, provided that proper steps are taken to diminish the effects of the errors of latitude and altitude.

Since on the equator, when the body is E. or W., an error of 1′ in alt. produces an error of $4^s$ in the hour-angle, and an error of $8^s$ in lat. 60° (or in the ratio of the secant of the latitude to 1), the method serves better in low than in high latitudes.

If the resulting longitude differs much from the long. by account, the computation should of course be repeated.

865. *Limits.* The azimuth is the same as that laid down for determining the time by a single altitude, No. 778. The alt. should in general not be less than 6° or 8°; and when the barometer and thermometer are not at hand, not less than 25° or 30°, especially in very cold or very hot weather.

866. *The Observation.* Observe the moon's alt., noting the time.

If the mean time is not accurately known, obtain observations for it.

At sea, the uncertainty of the apparent dip may be removed by referring the moon's altitude to the opposite point of the horizon, as well as to that under her (No. 535).

But it will be preferable to observe the *difference* of alt. of the moon and some star on nearly the same bearing, and to apply it to the star's alt. found by computation; for the time may sometimes be more nearly known than the lat., and the alt. of a star computed more nearly than it can be observed.

For Ex. Suppose, in lat. 40°, the ☽ bearing E.S.E. (true), that the place of the sea horizon is 1′ 30″ in error, and the time in error $5^s$. Then the error of the ☽'s computed hour-angle (and therefore of her R.A.) will be $9^s$ (No. 671), and the resulting error of long. about $4^m\ 30^s$, or 1° 4′ (Nos. 858, 864). Now the error of the computed alt. of a star E. or W. due to an error of $5^s$ will here be 56″ (No. 671); hence the error of the long., as determined by the moon's alt. referred to this star, will be diminished in the proportion of 1′ 30″ to 56″, that is, from 64′ to 40′.

867. *The Computation.* (1.) Find the Gr. Date, and reduce to it the Sid. T. at mean noon, the moon's decl., and thence her pol. dist., her hor. par., and semidiameter; correct the hor. par. by Table 41.

(2.) Add the M.T. to the red. Sid. T.; the sum (rejecting $24^h$ if it exceed $24^h$) is the R.A. of the meridian.

(3.) Correct the alt.*

(4.) Compute the moon's hour-angle, No. 614.

(5.) When the moon is to the E. of the meridian, *add* her hour-angle to the R.A. of the mer. If the sum exceed $24^h$, reject $24^h$. When to the W., *subtract* the hour-angle from the R.A. of the mer., increased, if necessary, by $24^h$: the result is the moon's R.A.

(6.) For the G. M. Time. Set down in order this R A., that preceding it, and that following it (from the Nautical Almanac); take the diff. between the 1st and 2d, and between the 2d and 3d, adding $24^h$, if necessary, to effect the subtraction.

To the constant 0·4771 add the prop. log. of the first of the diffs. and the ar. co. prop. log. of the 2d; the sum is the prop. log. of a portion of time to be *added* to the hour at Green. of the middle one of the three right ascensions: the sum is the G. M. T.

Ex. 1.† Jan. 5th, 1839, lat. 4° 54′ 0″ S., long. by acc. 33° 13′ W., at $20^h\ 56^m\ 40^s{\cdot}8$ M.T., obs. alt. ☽ 30° 6′ 20″ to the W.; ind. corr. −35″; height of eye, 12 feet; therm. 82°; barom. 30·0 inches: required the longitude.

| | | | | | |
|---|---|---|---|---|---|
| M. T. | $20^h\ 56^m\ 41^s$ | ☽ Decl. 5th, at $23^h$, 0° 16′ 39″ S. | | H. P. 5th, Mid. | 54′ 25″·2 |
| 33° 13′ W. | +2 12 52 | Diff. for $10^m$, 142″ | | 6th, Noon | 54 18·0 |
| Gr. D. | 23 9 33 | | 0° 16 39″ | Var. in $12^h$ | 7·2 |
| Sid. T. 5th, | 18 57 34·8 | 140″, $9^m$, 2′ 6″ | | 7″·2 and $11\frac{1}{4}^h$, | 0 6·8 |
| $23^h$ | 3 46·7 | $33^s$ 7·7 | | | 54 25·2 |
| $9^m$ | 1·5 | 2 $9\frac{1}{2}^m$ 1·9 | 2 16 | Equat H. P. | 54 18·4 |
| $33^s$ | ·1 | Red. Decl. | 0 18 55 S. | Corr. Table 41 | 0 |
| Red. S. T. | 19 1 23·1 | Pol. Dist. | 89 41 5 | Corr. Semid. | 14 48 |
| M. T. | 20 56 40·8 | | | Augm. | 7 |
| R. A. Mer. | 15 58 3·9 | | | Aug. Sem. | 14 55 |

* It cannot be worth while to follow the 2d and 3d precepts of No. 655, unless the observation is in every respect such as to afford extreme precision in the result.

† These examples are selected from observations made by Mr. J. C. Bowring on board H. M. S. Stag, with which I have been favoured by Mr. Pentland, her Majesty's late consul-general at Bolivia.

| | | | |
|---|---|---|---|
| Obs. Alt. ☽ | | | 30° 6′ 20″ |
| Ind Corr. | −0′ 35″ | | |
| Dip. | −3 20 | | −3 55 |
| | | | 30 2 25 |
| | | | −14 55 |
| | App. Alt. | | 29 47 30 |
| 29° 40′ and 54′ | | 45′ 14″ | |
| 7 *sub.* 3″ | | | |
| 18″ *add* 16 | | +13 | |
| | | 45 27 | |
| Th. 82° *add* 6 | | | |
| Bar. 30 0 | | 6 | +45 33 |
| | True Alt. | | 30 33 3 |

| | | | |
|---|---|---|---|
| Alt. | 30° 33′ 3″ | | |
| Lat. | 4 54 0 | sec. | 0·001590 |
| P. Dist. | 89 41 5 | cosec. | 0·000667 |
| | 125 8 8 | | |
| | 62 34 4 | cos. | 9·663417 |
| | 32 1 1 | sin. | 9·724415 |
| Hour-ang. | $3^h\ 57^m\ 25^s{\cdot}2$ | sin. sq. | 9·389429 |
| | 15 58 3·9 | | |
| R. A. ☽ | 12 0 38·7 | | 0·4771 |
| At $23^h$, | 12 0 23 9 | $0^m\ 14^s{\cdot}8$ | 2·8632 |
| 0, | 12 2 8·3 | 1 44·4 | 7·9853 |
| | $0^h\ 8^m\ 30^s{\cdot}3$ | | 1·3256 |
| | 23 | | |
| G. M. T. | 23 8 30·3 | | |
| M. T. | 20 56 40·8 | | |
| LONG. | 2 11 49·5 or 32° 57′ W. | | |

An error of $1^s$ of R. A. would produce here $34^s$ or $8\frac{1}{2}'$ error of long., as the R. A. changes very slowly. An error of 1′ of alt. would cause $4^s$ of R. A. and 34′ of long., and an error of 1′ of lat. only $0^s{\cdot}1$ of R. A. The moon's azim. is 87°.

Ex. 2. Jan. 23d, 1839, lat. 20° 57′ 10″ N., long. by acc. 42° 39′ W., at $3^h\ 32^m\ 10^s$ M.T. obs. alt. ☽ 42° 25′ 28″ to the E. Ind. corr. +1′ 37″; height of eye, 12 feet: required the Longitude.

| | | | | | |
|---|---|---|---|---|---|
| Gr. Date, 23d | $6^h\ 22^m\ 46^s$ | Red. Decl. | 21° 42′ 15′ N. | Equat. H. P. | 58′ 42″·1 |
| Red. S. T. | 20 9 35·7 | Pol. Dist. | 68 17 45 | Red. do. | 58 40·8 |
| R. A. Mer. | 23 41 45·7 | | | Corresp. Sem. | 16 0 |
| | | | | Aug. Sem. | 16 11 |

| | | | |
|---|---|---|---|
| ☽ Corr. of Alt. | 42′ 26″ | Hour-angle | $3^h\ 23^m\ 27^s{\cdot}0$ |
| ☽ True Alt. | 42 50 10 | ☽ R. A. | 3 5 12·7 |
| | | Do. at $6^h$ | 3 4 20·2 |
| | | | 3 6 41·8 |
| | | G. M. T. | $6^h\ 22^m\ 15^s$ |
| | | LONG. | 2 50 5 or 42° 31′ W |

An error of $1^s$ of R. A. produces here $25^s$, or 6′ error of long.; an error of 1′ of alt. produces $4^s{\cdot}3$ error of R. A., or 27′ of long.; and an error of 1′ of lat. causes $0^s{\cdot}9$ of R. A., or 5′ of long.

868. When two or three observations are taken on the same side of the meridian and prime vertical, the true long. is not the mean of the results, but is nearer to that which is furthest from the meridian.

When two observations are taken on opposite sides of the meridian and on the same side of the prime vertical, the right ascensions resulting will be affected in different ways by the same errors of altitude and latitude, and the true long. will be between the two results.

869. *Degree of Dependance.* This is determined by the effects produced on the hour-angle by given errors in the alt., lat., and pol. dist., No. 615. It is evident, from the remarks above, that unless considerable care, and some skill, are devoted to diminishing, according to the circumstances of the case, the effects of errors of latitude and altitude, it cannot be prudent, notwithstanding the occasional success of observations of this kind, to depend upon the result as nearer than ½ of a degree.

On shore, when the lat. and time are accurately known the result may, with proper attention, be more satisfactory.

No. 862 applies to this observation.

## IV. By an Occultation.

870. The moon in her perpetual revolution round the earth necessarily passes over every star or other body in her path at certain periods. The disappearance of a star or planet, called the *immersion*, and the reappearance from behind the body of the moon, called the *emersion*, being instantaneous, the phenomenon affords the means of determining the longitude at all places where it is visible.

At the instant of occultation the apparent R.A. of the moon's limb is the same as the R.A. of the star; the effect of the parallax of the moon being removed by computation, the true R.A. is deduced, and the G.M.T. thence found.

871. This observation affords, in favourable cases, the most decisive results, because it is both instantaneous and altogether independent of instrumental adjustments. On board ship the motion prevents the telescope, which is almost always necessary, from being kept steadily directed to the moon, and in consequence the method has been very rarely practised at sea. The precise instant of the phenomenon is, however, not necessary in all cases; it is enough that the observer is certain that at one instant he sees the star, and that at another he does not see it; because the whole resulting error in the time of observation in this case, and therefore in the longitude itself, cannot exceed the time elapsed between two sights of the moon.

872. The M.T. at Greenwich, at which the moon and the star to be occulted are in conjunction in R.A., is set down in the Nautical Almanac, as also the parallels between which the phenomenon is visible.

As it would require a distinct calculation to learn beforehand approximately the time at which the phenomenon will take place, the observer may content himself with finding, from the long. by acc., the time at place of the conjunction; he must then, at an early opportunity, single out the star, and watch the progress of the moon towards it. In general, when the star is to the *eastward* of the observer at the time of conjunction, the phenomenon occurs *before* that time; when to the *westward*, it occurs afterwards.

### 1. *Occultation of a Star.*

873. *The Observation.* Note the instant of immersion or emersion as nearly as possible.

874. *The Computation.* (1.) Find the Green. Date, and reduce to it the Sid. Time at mean noon, the moon's declination, hor. par., and semid.; reduce the hor. par. by Table 41.

(2.) Find the geocentric latitude by subtracting from the lat. the reduction of lat., Table 52. From the time at place find the star's hour-angle, No. 611.

(3.) For arc A. To the prop. log. of the reduced hor. par. add the log. cosec. of the geocentric lat. and the log. sec of the star's decl.: the sum is the prop. log. of arc A.

For arc B. To the prop. log. of the red. hor. par. add the log. sec. of the geoc. lat., the log. cosec. of the star's decl., and the log. sec. of the hour-angle: the sum is the prop. log. of arc B.

For arc C. Add together the prop. log. of the red. hor. par., the log. sec. of the geoc. lat., and the log. cosec. of the hour-angle; double the sum, add to it the const. 1·582, and the log. cot. of the star's decl.: the sum is the prop. log. of arc C.

(4.) When the lat. and decl. are of the *same* name, *add* A to the star's decl.; when of *contrary* names, *subtract* it.

When the star's hour-angle is *less* than $6^h$, subtract B from the star's decl.; when *greater* than $6^h$, *add* it

Subtract C from A.

Call the result the prepared declination.

(5.) For Part I. of the ☽'s Parallax in R. A. Take the diff. between the moon's decl. and the prepared decl.; under this diff put the semid.: take the diff. and sum. Add together the log. cos. of the prepared decl., the const. 1·1761, half the prop. logs. of the diff. and sum: the sum is the prop. log. of Part I.

For Part II. Add together the log. cos. of the prepared decl., the const. 1·1761, and the sum of the 3 logs. used in arc C: the sum is the prop. log. of Part II.

When the moon is on or near the meridian, this Part disappears.

(6.) Apply Parts I. and II. to the star's R. A., thus:—

Part I. In an *immersion*, *subtract*; in an *emersion*, *add*.

Part II. When the ☽ is to the E. of the Mer., *subtract*; when W., *add*. The result is the moon's R. A.

(7.) Find the G.M.T., as directed, No. 867 (6.)

**Ex.** Dec. 9th, 1823, lat. 9° 40′ S., long. by acc. 29° 51′ W., at $7^h\ 19^m\ 57^s$ M.T., observed the immersion of *ι* Aquarii,* W. of the meridian: required the longitude.

| | | | | | |
|---|---|---|---|---|---|
| Gr. Date, 9th | $9^h\ 19^m\ 23^s$ | ✱ Decl. | 5° 7′ 43″·6 S. | Red. Eq. H. P. | 54′ 38″·07 |
| Red.S.T. at m. n. | 17 11 13·7 | ☽ Red. Decl. | 5 16 22·6 | Red. H. P. | 54 38·04 |
| M.T. | 7 19 57 | | | Semid. | 14 53·4 |
| | 24 31 10·7 | | | Lat. | 9° 40′ |
| Star's R.A. | 22 28 39 | | | (Tab. 52) Cor. | −3 41 |
| Hour-angle | 2 2 31·7 | | | | 9 36 19 |
| Arc A. | | Arc B. | | Arc C. | |
| H.P. 54′ 38″ p. log. | 0·5178 | ................ | 0·5178 | ................ | 0·5178 |
| Geoc. Lat. cosec. | 0·7777 | sec. | 0·0061 | ................ | 0·0061 |
| ✱ Decl. sec. | 0·0017 | cosec. | 1·0487 | Hour-angle cosec. | 0·2928 |
| P. log. | 1·2972 | Hour-angle sec. | 0·0653 | | 0·8167 |
| A, | +9′ 4″·8 | P. log. | 1·6379 | 0·8167 × 2 = | 1·6334 |
| B & C, − | 4 8·8 | B, −4′ 8″·5 | | Const. | 1·5820 |
| | +4 56·0 | (Hour-angle *less* that $6^h$ | | ✱ Decl. cot. | 1·0469 |
| (Decl. S. lat. S. add.) | | subtract.) | | C, −0″·3 p. log. | 4·2623 |

* This occultation, kindly furnished me by the Hon. Capt. F. De Ros, R.N., is given as having been observed by him, at sea, in H.M. frigate Creole.

**Part I.**

| | | | |
|---|---|---|---|
| ✱ Decl. | 5° 7′ 43″·6 | | |
| Prep. Decl. | 5 12 29 ·6 | cos. | 9·9982 |
| ☽ Decl. | 5 16 22 ·6 | const. | 1·1761 |
| | 3 43 | | |
| Semid. | 14 53 ·4 | | |
| Diff. | 11 10 ·4 | ½ pro. log. | 0·6035 |
| Sum. | 18 36 ·4 | ½ pro. log. | 0·4928 |
| | −0 57 ·9 | pro. log. | 2·2706 |

(*Subtract*, being *immer*.)

**Part II**

| | | | |
|---|---|---|---|
| Cos. of Prep. Decl. | | | 9·9982 |
| Const. | | | 1·1761 |
| Sum of 3 logs. Arc C. | | | 0·8167 |
| Pt. II. | + $1^m$ $50^s$·2 | p. log. | 1·9910 |
| Pt. I. | −0 57 ·9 | | |
| | + 52 ·3 | | |
| ✱ R.A. | 22 28 39 | | |
| ☽ R.A. | 22 29 31 ·3 | | 4771 |
| At $9^h$ | 22 28 55 ·7 | 0′ 35″·6 | 2 4820 |
| At $10^h$ | 22 30 45 ·1 | 1 49 ·4 | 8·0060 |
| | 0 19 30 ·3 | p. log. | 9657 |
| | 9 | | |
| G.M.T. | 9 19 30 ·3 | | |
| Ship M.T. | 7 19 57 | | |
| Long. in time | 1 59 33 ·3 | or 29° 53′ 19″ W. | |

Ex. 2. Jan. 7th, 1836, Bedford, lat. 52° 8′ 28″ N., long. acc. $1^m$ W., at $10^h$ $45^m$ $53^s$·2 M.T. observed the immersion of *i* Leonis, E. of the meridian: required the Longitude.

Gr. Date $10^h$ $47^m$, Red. S.T. $19^h$ $6^m$ $8^s$·5, star's R.A. $10^h$ $23^m$ $26^s$·4, decl. 14° 58′ 38″·8 N., ☽ red. decl. 15° 49′ 40″ N., H.P. 55′ 54″·9, Semid. 15′ 16″·1, geocen. lat. 51° 57′ 19″.

Arc A. 42′ 33″, B. 3′ 21″·5, C. 2″·3. Prep. decl. 15° 37′ 48″·0. Part I. $39^s$·9, Pt. II. $2^m$ $12^s$·6. ☽ R.A. $10^h$ $20^m$ $33^s$·9. At $10^h$, $10^h$ $18^m$ $55^s$·5; at $11^h$, $10^h$ $20^m$ $58^s$·5. G.M.T. $10^h$ $48^m$ $0^s$. By corr. of Part I. $10^h$ $47^m$ $45^s$.

## 2. *Occultation of a Planet.*

875. *The Observation.* The planet having sensible semidiameter, the phenomenon does not take place instantaneously. Note the instant of final disappearance, or the instant of reappearance.

876. *The Computation.* Subtract the planet's horiz. parallax from the reduced horiz. parallax of the moon. Also subtract its semidiameter from the moon's semidiameter. In other respects proceed as for a star.

877. *Degree of Dependance.* A small error of Gr. Date will not sensibly affect the moon's parallax or semidiameter, and the declination is the only element liable to sensible error; Part I., therefore, is alone affected.

To find the error in the long. in time, caused by $1^m$ error of Gr. Date. Find the change of decl. in $1^m$, add it to the diff. of declin., and recompute Part I.: the diff. between the result and Part I., as computed before, is the diff. or error of R.A. The error of long. *in time* will be, on the average, 30 times greater.*

If the star pass very near the moon's upper or lower limb, the observation is not good.

The inequality of the moon's surface, and an imperfect estimation of the figure of the earth, may cause small inaccuracies.

The cases least liable to error on the several accounts enumerated are those which occur when the moon is near the meridian, and in which the central zone of the moon passes over the star. The emersion from the dark limb is the case most distinctly marked.

No. 862 applies to this observation.

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* Hence, to obtain the long. in time true to $1^s$ or 15″, the parallax in R.A. must be true to $0^s$·003. This remark shews the difficulty of obtaining extreme precision from any single observation.

## V. By Eclipses of Jupiter's Satellites.

878. The eclipse or disappearance of a satellite in the shadow of the planet, called the *Immersion*, or the reappearance after eclipse, called *Emersion*, being a phenomenon which takes place at the same absolute point of time wherever the spectator may be placed, affords a ready method of finding the longitude.

The diagrams of the positions of the planet and its satellites, as seen in N. lat., and other necessary information, are given in the Nautical Almanac. The figures must be reversed in S. lat. It will be convenient for the observer to bear in mind, that when Jupiter comes to the meridian before midnight, the whole eclipse (both immersion and emersion) takes place on the E. side of the planet; when after midnight, on the W. side. In an inverting telescope this will appear to be reversed.

879. *The Observation.* The telescope should have a magnifying power of not less than 40, and the observer should be ready some minutes before the time of observation, estimated by applying the long. by acc. to the time in the Nautical Almanac.

The sun should not be less than 8° below the horizon, nor Jupiter less than 8° above it, for the phenomenon to be distinctly visible.

880. *The Computation.* The difference between the M. T. at place, found by observation, and that at Greenwich, is the long.

Ex. Oct. 6th, 1822, near Igloolik, lat. 69° 21′ N., immersion of the 1st satellite, $10^h\ 29^m\ 33$, M. T. The M. T. at Gr., in the Nautical Almanac, is $15^h\ 56^m\ 0^s$; the diff., $5^h\ 26^m\ 27^s$, long. W.

881. *Degree of Dependance.* This method, though easy and convenient, is not very accurate; the eclipse is not instantaneous; and the clearness of the air, and the power employed, affect considerably the time of the phenomenon. Observers have been found to differ $40^s$ or $50^s$ in the same eclipse.

The observation may be considered complete only when the immersion and emersion of the same satellite are observed on the same evening, and as nearly as possible under the same circumstances. Thus, if the satellite disappear a little sooner than if the air had been clearer, it will emerge a little later from the same cause, and the mean of the two results may be near the truth.

The first satellite is preferable to the others on account of the greater rapidity of its motion.

# CHAPTER VIII.

## Finding the Variation of the Compass.

I. By the Amplitude. II. By the Azimuth. III. By Astronomical Bearings. IV. By Terrestrial Bearings.

882. The Variation is found by comparing the bearing of the sun or other celestial body, as shewn by the compass, with the true bearing as found by calculation. See No. 907.

883. When the time is known, the body may be observed, in the simplest cases, at its passage of the meridian, at which time it bears due N. or S., or at its passage of the prime vertical, when it bears due E. or W. In other cases, the true azimuth may be found by calculation.

When the time is not given the azimuth may be determined by observation of the altitude. When the altitude is nothing, or the body is on the horizon, as at rising or setting, it is usual to refer the bearing to the prime vertical, the angular distance from which (or the complement of the azimuth) is called the *amplitude*. The azimuth may also sometimes be determined from the observed difference of altitude in a measured interval of time.

The following rules are arranged more particularly for observations of the sun; but, after the explanations and precepts already given, no difficulty will occur in adapting them, when necessary, to observations of other celestial bodies.

### I. By the Amplitude.

884. This method, which is particularly convenient, is available twice a-day in fine weather, and at all seasons of the year.

885. *The Observation.** At sunrise, when the upper limb appears on the horizon, observe its bearing, and continue to take bearings of the centre, bisecting the sun's disc by keeping the up-

* The usual instructions for taking an amplitude direct the sun to be observed when his lower limb is half way between the centre and the horizon, at which time he is really on the horizon, No. 433. But as it is not easy to seize the bearing at the required instant, and still less so to observe several bearings equally distributed on both sides of the proper position, which is essential to a correct result, the sun is commonly observed a whole diameter too low. The observation as recommended above is more convenient in practice, and the error arising from not observing the sun at the instant to which the true amplitude corresponds (No. 446 (1)), is removed by the correction.

right wire on the upper limb, until the lower limb appears. Read off each bearing. At sunset, when the lower limb touches the horizon, proceed in like manner, until the apper limb disappears. See No. 221.

The mean of the readings, reckoning from the E. or W. point, is the *observed amplitude.*

886. *The Computation, by Inspection* (1.) Enter Table 59 with the Lat. and Declin., take out the amplitude, and mark it of the same name as the Declin.

(2.) Take from Table 59 A the correction. If this does not amount to nearly 1°, it may in general be omitted.

At *Rising.* In N. lat. apply the corr. to the *right* of the observed amplitude. In S. lat. apply it to the *left.*

At *Setting.* In N. lat. apply the corr. to the *left* of the observed amplitude. In S. lat. apply it to the *right.*

(3.) When the observed and true amplitudes are both N. or both S., their *difference* is the Variation. If one is N. and the other S., their *sum* is the Variation.

Then, the observer being in the centre of the compass, when the *observed* amplitude is to the *left* of the true, the Variation is East; when to the *right,* it is West.

**Ex. 1.** June 10th, lat. 17° N., long. 25° W., observed sun's amplitude at setting, W. 40° N.: required the Variation.

| | | |
|---|---|---|
| Lat. 17°, Decl. 23°, Amp. | W. 24° N. | |
| Obs. | W. 40 N. | |
| VAR. | 16 W. | |

**Ex. 2.** June 10th, lat. 36° 40′ S., long. 17° W., obtained sun's amplitude at setting, W. 12°·3 N.: required the Variation.

| | |
|---|---|
| Lat. 36°·7, Decl. 23°·0, Amp. | W. 29°·2 N. |
| 37° and 23°, Corr. 0°·7 } Obs. Amp. W. 12 ·3 N. } | W. 13 ·0 N. |
| VAR. | 16 ·2 E. |

**Ex. 3.** May 28th, lat. 47° N., long. 18° W., observed the sun's amplitude at rising, E. 10° N.

| | |
|---|---|
| Lat. 47°, Decl. 21½°, Amp. | E. 32°·5 N. |
| 50° and 22°, Corr. 0°·9 } Obs. Amp. E. 10 ·0 N. } | E. 9 ·1 N. |
| VAR. | 23 ·4 W. |

**Ex. 4.** Sept. 25th, lat. 7° N., long. 151° E., observed the sun's amplitude at rising, E. 4° N.: required the Variation.

| | |
|---|---|
| Lat. 7°, Decl. 1°, Amp. | E. 1° S. |
| Obs. Amp. | E. 4 N. |
| VAR. | 5 E. |

The Corr. here is 0.

The correction in Table 59 A is the same for a star or a planet as for the sun, and is applied in the same way. When the moon is employed, the correction, which, in the case of the sun or a star, involves the sum of the dip and horizontal refraction, is the excess of her horizontal parallax over this sum. As the moon's hor. par. is 1°, and the refraction ½°, in round numbers, this excess is about ½°, which is nearly the quantity employed in Table 59 A. This correction, therefore, serves for the moon, but it must be applied the *contrary* way to that directed for the sun.

887. *The Computation, Accurately.*

(1.) Find the Greenwich Date and reduce the declination to it.

(2.) To the log. sec. of the lat. add the log. sine of the declin.: the sum is the log. sine of the amplitude. Apply the correction as above.

888. *Degree of Dependance.* In low latitudes the amplitude is susceptible of much precision; in high latitudes refraction renders the result less certain. The relative temperature of the sea and the air produces no effect on the observed amplitude.

---

## II. By the Azimuth.

### 1. *By Azimuth on the Meridian.*

890. *The Observation.* When the sun approaches the meridian observe the azimuth, and continue observing till the same time after noon. The mean of the readings is the observed azimuth.

When the sun is observed to the southward, if the observed bearing is to the E. of S., the variation is E.; if to the W., it is W. When he is observed to the North, the contrary in each case.

### 2. *By Azimuth from the Short Double Altitude.*

891. The true azimuth is obtained from the observation of the short double altitude, p. 256, without regard to the apparent time.

Case I. Observations on the *same* side of the meridian, No. 729.

892. *The Observation.* Observe the sun's azimuth during the interval between observing the alts., so as to obtain it at the middle of the interval. See No. 221.

893. *The Computation.* Having corrected the alts. and taken their difference, No. 729 (1), add together the log. sine of the diff. of alts., the log. cosec. of the interval,* and the log. sec. of the lat.: the sum is the log. sine of the azimuth at the middle time from noon, nearly.

Ex. (Ex. 1, p. 258.) Lat. 34° 40′ S., diff. of alts. 59′·1, interval $20^m\ 12^s$.

| | | | |
|---|---|---|---|
| D. Alt. | 0° 59′·1 | sin. | 8·2353 |
| Int. | $20^m\ 12^s$ | cosec. | 1·0554 |
| Lat. | 34° 40′ | sec. | 0·0849 |
| Azimuth | 13°¾ | sin. | 9·3756 |

This azimuth compared with that observed would afford the variation.

---

* When it is intended to find the Variation by this method at the same time as the Latitude, it will be convenient to take the sum of these three logs. first. The five logs. employed in No. 729 will thus afford two distinct results.

894. *Degree of Dependance.* By adding to the result the diff. for 30″ in the sine of the D. alt., the effect on the azimuth of ½ in the diff. alts. is seen, and the effect of an error, or small variation of the D. alts. estimated. See also No. 679.

Case II. Observations on *different* sides of the meridian, No. 731.

895. *The Observation.* Observe the sun's azimuth when at the alt. nearest noon. See No. 221.

896. *The Computation.* Having found the time from noon of the greater alt., to the log. sine of this time add the log. cos. of the declin., and the log. sec. of the greater alt.; the sum is the log. sine of the azimuth at the time of observing the greater alt.

Ex. (Ex. 1, p. 259.) Time from noon, $11^m\ 59^s$, decl. $5\frac{1}{2}°$, greater alt. $49°\ 41'$.

| | | |
|---|---|---|
| T. from noon | $11^m\ 59^s$ | sin. 8·718 |
| Decl. | $5\frac{1}{2}°$ | cos. 9·998 |
| Great alt. | $49°\ 41'$ | sec. 0·189 |
| AZIMUTH | $4\frac{1}{2}°$ | sin. 8·905 |

### 3. *By Azimuth from Equal Altitudes.*

897. The true azimuth may be obtained directly from the observation of equal altitudes at sea, for time, No. 798. The azimuth, being computed as directed in No. 801, and compared with that observed at one or both of the times of equal altitudes, determines the variation. The altitude is required with more precision than for finding the time by the method, No. 798.

This method is, however, not always eligible, because in low latitudes, where the observation of equal altitudes is favourable for the determination of time, the altitudes near noon are great, and therefore unfavourable for the observation of the azimuth. See No. 889.

### 4. *By Azimuth on the Prime Vertical.*

898. *The Observation.* Having found by Table 29 either the app. time or the altitude at the instant of the passage of the prime vertical, begin to observe a little before that time, and continue observing till the same time afterwards.

The mean of the readings, when it is not accurately E. or W., is the variation.

A.M. If the sun bear to the northward of E., the variation is E.; if to the southward, it is W.

P.M. If the sun bear to the northward of W., the variation is W.; if to the southward, it is E.

899. As a celestial body, when on the prime vertical, changes its azimuth more slowly than at any other time, an error in the apparent time will be of little consequence, and the method will be found one of the most convenient in practice in high latitudes during the six months that include the summer.

### 5. *By Azimuth deduced from an Altitude.*

**900.** *The Observation.* Take bearings of the sun's centre, noting the time of each reading. Take an alt. as soon as convenient before and after the bearings, noting the times.

**901.** *The Computation.* (1.) Having found the mean of the azimuths and of the corresponding times, reduce the alts. to the mean of the times, No. 660, reduce the decl., correct the alt., and find the azimuth, No. 673 or 674.

Ex. Feb. 19th, 1828, P.M., Baia Bay, Naples, lat. 40° 50′ N., long. 14° 3′ E., Mr. Fisher observed the mean of seven azimuths of the sun by Kater's compass, N. 223° 24′ E. (or S. 43° 24′ W.) Sun's true alt. 33° 34′; sun's reduced decl. 11° 14′ S.

| | | | | |
|---|---|---|---|---|
| By Expl. Tab. 5, | | | Dist. 100 and D. Lat. 88·5 give | |
| lat. 41°, alt. 33½° M 158·9 | N | 57·5 | course or Az. S. | 28° W. |
| Decl. 11¼°, dist. 159 | Dep. | 31·0 (lesser) | Ditto observed | 43⅓ |
| | Sum | 88·5 | Var. | 15⅓ W. |

### 6. *By Azimuth deduced from the Time.*

**902.** The observation is already described in No. 900.

(1.) Find the Green. Date, to which reduce the declination and the elements employed in finding the hour-angle.

(2.) Compute the azimuth, No. 675.*

Ex. 1. June 23rd, 1829, P.M., at Constantinople, lat. 41° 1′ N., long. 28° 59′ E.; the mean of seven times by chron. $4^h\ 43^m\ 15^s$, and of seven azimuths of the sun, observed by Mr. Fisher with Kater's compass, between 286° 30′ and 288°, was N. 287° 16′ E., or N. 72° 44′ W.

Reduced pol. dist. 66° 33′.

| | | | | | |
|---|---|---|---|---|---|
| Time | $4^h\ 43^m\ 15^s$ | | | | |
| Chron fast on A.T. | 3 32 | | | | |
| Sun's Hour-angle | 4 39 43 | half $2^h\ 19^m\ 51^s$ | cot. 0·15531 | | 0·15531 |
| Pol Dist. | 66° 33′ | | | | |
| Colat. | 48 59 | | | | |
| | 114 92 | half 57° 46′ | sec. 0·27297 | cosec. | 0·07269 |
| | 17 34 | 8 47 | cos. 9·99488 | sin. | 9·18383 |
| | 69° 19′ | | tan. 0·42316 | 14° 28′ tan. | 9·41183 |
| | 14 28 | | | | |
| Azimuth | N 83 47 W. | | | | |
| Do. observed | N 72 44 W. | | | | |
| Var. | 11 3 W. | | | | |

Ex. 2. Dec. 27th, 1831, Lisbon, lat. 38° 42′ N., long. 9° 8′ W., Mr. Fisher observed the mean of ten azimuths of the sun by Kater's compass (between 165° and 166° 50′) to be N. 166° 7′ E. The mean of the times by chron. (between $10^h\ 7^m\ 30^s$ and $10^h\ 15^m\ 45^s$) was $10^h\ 11^m\ 47^s$. Chron. fast on A.T. $42^m\ 18^s$; red. pol. dist. 113° 22′.

Computed Az. N. 143° 44′ E.; Var. 22° 23′ W.

* The work of finding the Azimuth is much lessened by the use of suitable tables. Burdwood and Davis's Azimuth tables and Star Azimuth tables extend from the equator to 60° latitude, and are published in a convenient form by J. D. Potter, 145 Minories, London, E. Such tables are indispensable for the navigation of iron ships. *See also* Lecky's "Wrinkles," for stars.

## III. By Astronomical Bearings.

903. The true bearing of a point of land, or other terrestrial object, may be determined by means of the *difference of bearing* between it and the sun, or other celestial body; the true bearing of the latter being deduced by observation, or computed from the time.

The difference of bearing may be obtained directly by observing with the compass the bearings of both the sun and the object; or by the sextant, when the sun is on the horizon. But as the observation of two bearings at the same instant cannot always be conveniently made, the angular distance between the sun and the object is measured by a sextant or circle, and the bearing of the object alone observed. The difference of bearing is then deduced, by calculation, from the observed angular distance and the altitudes of the sun and the object.

The true azimuth of the object being thus obtained, the variation is deduced.

904. *The Observation.* Observe the sun's alt., then the angles between the object and the nearest and farthest limbs; lastly, observe the sun's alt., noting the times of each contact. Take the alt. of the object, at the point from which the sun's distance is measured.

When the variation is required at the same time, the bearing of the object must be obtained as nearly as possible at the time of the observation of the angular distance.

905. *The Computation.* (1.) Find the means of the times and angular distances, and reduce the sun's alt. to the mean of the times. Find the Green. Date, and reduce the sun's decl.; find his pol. dist., correct the obs. ang. dist., and the alt. of the object for index-error, when necessary.

*Note.* For common purposes, when the observer is not much elevated and the alt. of the object does not exceed a few minutes, the sun's decl. may be corrected at sight, the dip, refraction, parallax, and the alt. of the object neglected, and the precepts (2) and (4) omitted.

(2.) Find the app. alt. of the sun's centre (by applying the ind.-corr. dip, and semid.), and thence the true alt. by subtracting the refr. or corr. of alt.

(3.) Find the sun's true azimuth. When the sun is not near the meridian, this is found by No. 674. When he is near the meridian it is better found from the time, No. 675. The lat. will be required more correctly as the sun is nearer the meridian, and less so as he is farther from it.

(4.) For the corr. of ang. dist. arising from the point observed not being exactly on the true horizon. Take the diff. between the obs. alt. of the object and the apparent dip, Table 30.

To the log. sine of the remainder add the log. sine of the sun's app. alt. and the log. cosec. of the ang. dist.: the sum is the log. sine of the correction of the ang. dist.

When the dip is *less* than the alt. of the object, *add* the corr. to the ang. dist.; when the dip is the *greater* of the two, *subtract* it.

(5.) For the diff. of azimuth. To the log. cos. of the corrected ang. dist. add the log. sec. of the sun's app. alt.; the sum is the log. cos. of the diff. of azim. between the sun and the object.

When the ang. dist. exceeds 90°, take the supplement of the arc found as the diff. of azim.

(6.) For the Variation. Apply the diff. of azim. to the sun's azim., according to the case, which will be best understood by drawing a figure: the result is the true azim. or bearing of the object.

The true bearing compared with that observed shews the variation.

Ex. Dec. 4th, 1819, at 7ʰ 30ᵐ A.M., in Pernambuco Road, lat. 8° 4′ S., long. 34° 52′ W., M. Givry took the following alts. and angular dist., height of the eye 16 feet, ind.-corr. 0.—(*Mém. sur l'Emploi, &c.*)

| | | | | |
|---|---|---|---|---|
| Time by W. | 7ʰ 25ᵐ 40ˢ | Alt. ☉ 23° 16ᵐ | Ang. Dist. Circle. | Object. S. 31° 40′ W. |
| | 7 26 10 | 23 23 | 190° 30′ 30″ | Alt. 0 10 |
| Mean | | 23 19 5 | 95 15 15 | Corr. 0. |

(1.)

| | | |
|---|---|---|
| Green. Date, 3d, 21ʰ 47ᵐ | Red. Decl. | 22° 10′ 47″ S. |
| | Pol. Dist. | 67 49 |

(2.)

| | | |
|---|---|---|
| Obs. Alt. | | 23° 19′·8 |
| | −4′ } +16·2 } | +12·2 |
| App. Alt. | | 23 32 0 |
| | | −2 |
| True Alt. | | 23 30 |

(3.) Sun's Azimuth.

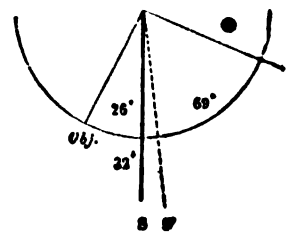
| | | | |
|---|---|---|---|
| Pol. Dist. | 67° 49′ | | |
| Lat. | 8 4 | sec. | 0·00432 |
| Alt. | 23 30 | sec. | 0·03760 |
| | 99 23 | | |
| | 49 41 | cos. | 9·81091 |
| | 18 8 | cos. | 9·97788 |
| | 110 45 | sin. sq. | 9·83071 |
| or S. | 69 15 E. | | |

(4.) Corr. of Ang. Dist.

| | | | |
|---|---|---|---|
| (Alt.) 10′ − (dip) 4′ = 6 | | sine | 7·242 |
| ☉ Alt. | 23° 30′ | sine | 9·601 |
| Dist. | 95 15 | cosec. | 0·002 |
| | +2 | sine | 6·845 |
| Corr. Ang. Dist. | 95 17 | | |

(5 & 6.) Computation of Diff. of Azim.

| | | | |
|---|---|---|---|
| Ang. Dist. | 95° 17′ | cos. | 8·9642 |
| ☉ Alt. | 23 30 | sec. | 0·0376 |
| Suppl. | 84° 14 | cos. | 9·0018 |
| | 95 46 | | |
| ☉ Az. | S 69 15 E. | | |
| Obj. Az. | S 26 31 W. | | |
| Observed | S 31 40 W. | | |
| Var. | 5 11 W. | | |



## IV. By Terrestrial Bearings.

906. The true bearing or azimuth of a mountain, at a considerable distance, is determined from its geographical position and that of the observer. As the true azimuth and the course on the great circle are the same thing, the problem is that in No. 339 (1), p. 133. But as mountains are rarely seen much beyond a hundred miles, it is near enough to proceed thus:—

Find the D. Lat. and D. Long. between the places in minutes of arc. Turn the D. Long. into Dep., No. 318 or 319. Find the Course, No. 280 (1). This is the approximate azimuth.

With the mid. lat. as a course, and the D. Long. as dist., find the Dep.; this is a number of minutes, one-half of which is to be subtracted from the approx. azim.; the remainder is the true azimuth, very nearly.

Ex. Lat. 60° 6′ N., long. 142° 50′ W., find the true azim. of Mt. St. Elias in lat. 60° 18′, long. 140° 52′.

D. Lat. 12 and D. Long. 118 give Dep. 58·6, and Course 78° 26′. Then 60° and 118 give Dep. 102 2; and 51′ subtracted from 78° 26′ gives the Azim. N. 77° 35′ E.

In low latitudes, and in all cases when the object is near N. or S., the correction may be neglected. (For more precision, see No. 395, p. 151.)

907. The term Variation, as defined in No. 882, and used in this chapter, is the difference between the true bearing of any object and its bearing by a compass. From what has been said in Chapter II., this quantity must differ from the correct variation by the instrumental error of the compass, by the local effects of the land, and, further, on board ship, by the deviation.

There may be instrumental errors in a compass, which cannot be detected unless the correct magnetic bearing of some object is known. For this reason it is desirable, when there is any reason to suspect the accuracy of the standard compass, that advantage should be taken of being in a port where the exact variation is known, to examine the compass according to the process described in No. 224. Errors in observed bearing, arising from the sight-vane not being vertical, or from the reflector being out of place, may be avoided by using low azimuth's amplitudes, or nearly horizontal bearings of terrestrial objects. Errors arising from the centre of the card not being in the same vertical plane as the line of sight, may be avoided by taking bearings of several objects distributed round the horizon. The true bearing of one object may be determined by process III. or IV., the others by horizontal angles therefrom.

The effects of such local disturbances as are mentioned in No. 222 may generally be eliminated, either on land or at sea, by observing in several positions, with the view of getting on oppo-

site sides of the disturbing cause, and taking the mean of the results as the correct variation.

When an observation is made at sea with a compass which is instrumentally correct, and is free from local disturbance of the land or ground, the difference between a true bearing and a compass bearing, commonly called the *Total Error*, enables the navigator to shape a correct true course. This is in general all that is actually required for navigation. But such an observation would not determine the variation, unless the deviation is exactly known. A good value of the deviation may be obtained by interpolation, if the ship has been swung a short time previously, and again a short time after. Allowing the same on the total error will give the variation.

When the compass is well placed, the mean of the total errors on two opposite cardinal points is a good value of the variation. A still better value may be obtained by taking the mean of the total errors on the four cardinal points.

To obtain an accurate compass bearing, it is necessary that the ship's head should be steadied as directed in No. 248. When a ship's head is moving to port or starboard, the compass card is obviously liable to be dragged round in the same direction as the head is moving, by the friction on the pivot. On the other hand, in iron ships it has been found, that when the head is moving to the right, the compass-needle stands a little to the left of its due position, and *vice versâ*. The last mentioned effect of the ship's motion in azimuth is especially noticeable when the ship's head is near the north or south points. It is due, possibly, to the transient magnetism not instantly adapting itself to the position of the ship, as she moves round in azimuth. An exact bearing can be obtained by taking the mean of two, taken with the ship's head moving in opposite directions; also an accurate deviation-table may be quickly obtained by turning a ship round to port and to starboard under steam, making use of the sun's azimuth, and taking the mean on the four cardinal points as the variation, where it is not otherwise known.

### *Reduction of the True Course to the Course by Compass.*

**908. When the true course to be steered is determined, it must be reduced to the course by compass. The variation of the compass is to be applied (No. 221); the result is the *correct magnetic course.* See p. 159.**

**When the total error (No. 907) of the compass is known, it is to be applied to the true course, otherwise the deviation (No. 227) must be applied to the *correct magnetic course*; the result is the *course by compass.***

# CHAPTER IX.

## The Tides.

I. Phenomena of the Tides. II. Rules for finding the Time of High Water. III. Tide-Observations.

In this chapter we shall attempt merely a general enumeration of the principal phenomena of the tides, with such other matters as are of direct practical importance.*

### I. Phenomena of the Tides.

**909.** The connexion observed in all ages, and, with particular exceptions, in all places, between the succession of high waters and the moon's meridian passage, has established the belief that the moon is the cause of the tides. The principle of gravitation,† on which the motions of the earth and the celestial bodies are calculated, and their figures explained, has confirmed, and at the same time corrected, this belief, by shewing that sensible effects must be produced not only by the moon, but also by the sun, though, from her greater nearness, the moon has by far the greater influence; and the general result would, naturally, until the observations were analysed, be attributed exclusively to her.

**910.** The attraction of the moon acting most strongly on those parts of the ocean which are nearest to her, that is, over which she is vertical, tends to draw these parts towards her, while their place is supplied by the water at the sides of the globe. And since the central parts are likewise more affected in the same action than the surface at the opposite or farthest side, the figure of the earth becomes elongated in the direction of a line drawn towards the moon; that is, the water is accumulated at the point exactly under

---

* The reader may refer, for additional information, to various papers, by Sir John Lubbock and the Rev. Dr. Whewell, in the *Philosophical Transactions*, &c., 1833, particularly to "An Essay towards a Map of Cotidal Lines," followed by other dissertations by Dr. Whewell; and to "The Tides," by Professor George Howard Darwin (John Murray, Albemarle Street).

† This principle is that there subsists amongst all particles of matter a mutual attraction whose intensity is inversely as the square of the distance.

the moon, and at another point distant from the former 180° in latitude and longitude. The moon, in her progress to the westward, causes thus, at each meridian in succession, a high water, not by drawing after her the water first raised, but by raising continually that under her at the time.

The opposite high water, or, as it is called, the *inferior* tide, would, if the moon's action was uninterrupted, follow the other, or *superior* tide, after the interval of half a lunar day, or $12^h 24^m$ on the average.

Again, the sun, acting in the same manner, though with less force than the moon (in consequence of his distance more than counterbalancing his greater magnitude), produces two tides, which would follow each other, if uninterrupted, after an interval of half a solar day, or 12 hours.

911. But, instead of four separate tides produced by the independent actions of both bodies on the mass of waters in their original form, the effect produced is the same as if, after one of the bodies, as the moon for example, has given a form to the waters, the sun alters that form, the two separate actions thus producing a joint result. Hence the place at which it is high water is that at which the *sum* of the heights of the tides produced by the two bodies is greater than any where else.

912. When the sun and moon are on the meridian together, their actions concur, and the tide is higher than at any other time. The same holds when they are in opposition. These highest tides are called *spring-tides*, and occur after new and full moon. Again, when the sun and moon are 90° apart, their actions tend to neutralise each other; and the *neap-tides*, which occur after the first and third quarters of the moon, are the smallest of all. (See No. 919.)

913. Since the sun and moon act with greater force as they are nearer, the effect of each body in raising the tide is greater as its parallax is greater (No. 436). The highest spring-tides would occur, therefore, in January, about the time of the month when the moon's hor. par. is greatest. But the effect of both bodies is greater, generally speaking, as their alts. are greater, since when vertical the effect is greatest. This period, therefore, depends on circumstances.

914. If the actions of the sun and moon were, as we have hitherto supposed, uninterrupted by obstacles or forces of any other kinds, the tides would be regular, and their calculation certain. But from the unequal depth of the ocean, and the barriers presented by continents which stand across the natural progress of the tides, their motion is interrupted, and the *tide-wave* (as the accumulation of waters is called), abandoned by the forces which originated it, becomes subjected to the mechanical action proper to waves in general.

915. It is necessary to distinguish between the motion of a wave and that of a current. A wave is not an absolute transfer of the body of moving water in the direction of the motion of the waves, but is a motion perpendicular to the surface, or up and down. The

motion of waves is represented in the fluttering of a flag and the shaking of a sail. It is easy to see that this kind of motion is compatible with immense velocity, without any appreciable current in the water itself; thus the tide-wave appears to pass from the Cape of Good Hope to Cape Blanco in twelve hours.

916. The motion of waves is quicker as the water is deeper. Also, the largest waves are the swiftest; a fact illustrated by the superior velocity of a heavy sea over that of the rippling of a pool. When the water shoals, the wave is retarded and becomes steeper on the advancing side, as is seen in the approach of waves to a shelving shore, and in the bores of rivers. The velocity of waves is also considered to be greater as their length (or distance from hollow to hollow) is greater; thus the tide-wave, though inferior in height to the waves of an agitated sea, yet travels with prodigiously greater velocity. Waves of different size and velocity merge into one another, as is known to those who have endeavoured to follow with the eye the waves of the sea. Lastly, when the waves meet with obstacles, such as sand-banks or reefs, the directions of their motions, as well as their figures, are changed. Several of the anomalies which the tides present are attributed to these and like circumstances.*

917. The current which accompanies the tide, and changes its direction with the ebb and flow, is the effect of the alteration of the level of the water during the passage of the tide-wave. Also, when a body of water in a channel has been set in motion, the motion does not immediately cease with the cause that produced it. Hence the *tide-current* does not necessarily, and in all cases, change with the tide; and thus, under certain circumstances, the current of the ebb continues to run for some hours after the flood-tide has made.

It is considered probable that many of the anomalies in recorded times of tide have arisen from thus confounding the time of high or low water with the time of slack water.

Admiral Beechey, who bestowed much attention upon the complicated movements of the tides on our Western coasts, states that though each point of the coast in the Irish Channel has its proper time of high water, yet the turn of the stream takes place simultaneously to all, namely, about the time of high water at Morecombe Bay. This time is nearly that of Liverpool; accordingly, in order to know whether the stream is setting into the Irish Channel or out of it, it is necessary merely to find whether the tide is rising or falling at this place. Thus while the tide-wave, in coming in, is making it high water at the different places succeeding each other in its progress, the *stream* is, nevertheless, running out.†

* Among the most curious of these effects are those called *interferences*, whereby two distinct sets of waves may, in their combination, produce apparent rest. See *Phil. Trans.* 1832, p. 154. On this principle are explained, also, tides which occur at irregular intervals

† A Report of Observations made on the Tides in the Irish Sea, &c., by Capt. F. W. Beechey, R.N., *Phil. Trans.* 1848; see also *Naut. Mag.* 1849, p. 70.

918. The *height* of the tide is the difference between the level of high water and that of low water.*

The height of the tide in the open ocean is supposed to be very small; and the great heights observed on some shores are evidently due to the shoaling of the water and the narrowing of the channel.

The tides are insensible or very small in inland seas; as also in high latitudes, except from local causes.†

919. It is found, in general, that the tide is not due to the moon's transit immediately preceding, but to a transit which has occurred some time before. The time thus elapsed between the transit at which the tide originated and the appearance of the tide itself is called the *retard*, or *age of the tide*.

Thus the tide on the western coasts of Spain and France is a day and a half old; that at London is two days and a half old.

It appears certain that the age of the tide on the W. coast of Ireland is 2 days (p. 38), and on the S. W. coast $1^d\ 20^h$ (p. 110).‡

It would appear further that changes in the parallax and declinations of the sun and moon produce their several effects on the time and height of the tide after particular intervals.

It is thus constantly necessary to discriminate between a tide which may happen after any particular transit and the tide which really *corresponds* to that transit; thus, for example, if the moon passes the meridian at 4 P.M. to-day, and the high water occurs at 7 P.M., this tide will not in general be that which *corresponds* to the transit 3 hours before, but may have had its origin several transits back. The transit to which the tide really corresponds is found by examining the observations of the several preceding tides, the highest of which, being due to the united actions of the sun and moon, is known to correspond to the moon's transit at 12 o'clock, noon or midnight.

920. The *mean level* of the sea is the middle between the levels of high water and low water.

Though the heights of high water and those of low water may vary considerably, yet the mean level seems confined to very narrow limits. Thus, at Singapore, where the heights of two consecutive low waters differ sometimes six feet, the mean level varies only a few inches.—*Phil. Trans.* 1837.

Hence it follows that heights measured above the sea should be referred to the mean level as the standard or zero, instead of that of either low or high water.

It is not, however, to be supposed that the middle point between any two consecutive tides is the mean level. This will be the case

* The term *range* would be preferable to *height*, as it implies a distance between boundaries, as, for ex., the range of the barometer. The "height of the tide" is continually, in common discourse, used for the height of the water.

† Sir John Ross found a rise and fall of 8 feet in lat. 74° N.

‡ On the Law of the Tides of the Coasts of Ireland, by G. B. Airy, Esq., Astronomer Royal, *Phil. Trans.* 1845. This paper refers to a most extensive and complete series of observations made in 1842 under Gen. Colby, director of the Trigonometrical Survey chiefly for the purpose of referring the elevations observed to the level of the sea.

only when two tides in succession attain the same high-water level and the same low-water level, as at springs.

921. By the *Establishment of the Port* or *Tide-hour* has been commonly understood the apparent time of the first high water that takes place in the afternoon of the day of full or change. This Dr. Whewell has called the Vulgar Establishment.

922. The interval between the moon's transit and the high water next following is called a *lunitidal interval.*

The lunitidal interval varies from day to day during the fortnight between full and change.

923. The *correct establishment* is the lunitidal interval corresponding to the day on which the moon passes the meridian exactly at noon (with the sun) or at midnight. This is found by taking the mean of all the times of H. W. for a fortnight. The Vulgar Estab. may thus be an hour, or considerably more, in error when used as representing the H. W. on *any* day of the fortnight.

The tide caused by the united actions of the sun and moon, when each of these bodies is in one of the positions most favourable for raising the water, is identified by its superior height. And it is thus found (as observed in No. 919) that the interval by which the tide follows the moon on the day when the full or change occurs at 12 o'clock, or the lunitidal interval *corresponding* to that particular transit, is not the interval actually observed *on* that day.

The establishment of the port, and also the height of the tide, appear to be subject to change.

924. The difference between the lunitidal interval at each transit of the moon and the correct establishment is called (by Sir J. Lubbock), from the period of its recurrence, the *semi-menstrual inequality.*

This inequality is found to be different for different places; hence the time of high water at any place cannot, generally, be accurately deduced from that at any other place by merely applying the difference of time between the two establishments.

925. The tide is subject, in like manner, to a semi-menstrual inequality in the height. This inequality being, like that in the time, different for different places, the height of a tide at any one place cannot always be correctly inferred from the given height at any other.

926. It has been found that the morning and afternoon tides do not rise to the same height; the difference is called the *Diurnal Inequality.*

This irregularity is the consequence of the sun and moon not being always on the equator. Thus, suppose the moon in 20° N. declin.: then the summit of the superior tide is in 20° N. lat., and of the inferior tide in 20° S. lat., each alternate tide having thus its greatest elevation in the other hemisphere. The diurnal inequality is subject to steady rules, and may be predicted.

927. The maximum of the diurnal inequality *corresponds* to the moon's greatest declination, though it may not appear till after the

time of the greatest declination. In like manner, it disappears with the moon's declination, but not till some time after she has crossed the equator. For example, the age, as it may be termed, of this inequality is, at Liverpool, six days; at Singapore, a day and a half. A diurnal inequality appears in the times, as well as in the heights, of the morning and afternoon tides.

928. The *Diurnal Inequality* is a feature in tidal phenomena, which, being particularly small in British waters, has not received the attention it merits from the English sailor, for in the Indian seas,* and indeed in most other parts of the globe, this diurnal inequality is a regular change, considerable in amount, and almost universal in prevalence.

In consequence of the diurnal inequality, it sometimes happens that the day tides are higher than the night tides, or the reverse, for many weeks together. And hence it has sometimes been stated at such places, that the day tides are always the highest, or the reverse. But this is not the case. The rule of the diurnal inequality depending on the declination of the moon and sun, if the day tides are the highest at one time of the year, they are the lowest at another.

The diurnal inequality sometimes affects the time of high water as much as two hours, that of low water about forty minutes; at the same time a variation of twelve inches may be observed in the height of high water, and of thirty-six inches in that of low water. Such effects are far too great to be neglected, either in the prediction of tides or the reduction of soundings.

929. Strong winds affect the time and height of the tide, but chiefly the former, especially in rivers and narrow seas.†

The pressure of the atmosphere also affects the height of the tide, the water being in general higher as the barometer is lower.‡

930. Though high and low water may succeed each other regularly as to time, yet the water does not always rise and fall at the same rate. Thus, for ex., the water in some places falls faster during the first of the tide than afterwards.

Irregularities both in the duration of the tide and in the rate at which the water rises or falls, are, however, most conspicuous in rivers.§ At Limerick and New Ross, the fall of the water occupies a longer time than the rise; at most other stations the rise appears to occupy a little longer time than the fall. This last, however, appears less certain.—*Phil. Trans.*, 1845, "Law of Tides."

* See Tide Tables for the Indian Ports, by Captain S. G. Burrard, R.E., and Mr. E. Roberts, F.R.A.S., F.S.S., published yearly by the authority of the Secretary of State for India.

† Adm. Beechey acquainted me that he considered strong winds do not raise the water more than 2 feet, even in the Bristol Channel, where the range is above 40 feet.

‡ It has been established that a rise in the barometer of an inch is accompanied by a fall in the height of the water of 12 or 14 inches. This opposite motion of the water and the mercury due to the atmospheric pressure was established by Mr. Daussy in discussing the tide-observations made at Brest.

§ At Limerick, after low water, the water sometimes rises as much in ten minutes as it had previously dropped in two hours. Such irregularities cause considerable difficulty in ascertaining the true state of the case.

## II RULES FOR FINDING THE TIME OF HIGH WATER.

931. The first of the two following rules, which is the old method of finding the time of high water by the moon's age, affords merely a rough estimate, as it may be in error nearly two hours. The second, which involves the semi-menstrual inequality, will be found a tolerable approximation on our own coasts, being generally within $15^m$ or $20^m$; but as each place has a different semi-menstrual inequality, the degree of accuracy which it may possess as applied to other parts of the world than those for which the table is constructed, cannot be pronounced.

Complete rules for computing the time and the height of the tide involve, also, corrections for parallax and declination, and require special tables for each port.*

932. Rule I. for a *rough estimate*. (1.) For the moon's age. To the epact of the year, Table 14, add the epact of the month, and the day of the month. The result, if less than $29^d\ 13^h$, is the moon's age at noon; if it exceed $29^d\ 13^h$, subtract $29^d\ 13^h$.

In leap-years, in January and February, deduct 1 day.

(2.) For the moon's meridian passage.† Multiply her age, to the nearest day, by 8, and point off one decimal: the result is the time of the merid. passage nearly.‡

(3.) For the time of high water. To the time of merid. pass. add the establishment of the port (or tide-hour).

(4.) If the sum be less than 12 hours, it is the time of high water P.M.; if it exceed 12 hours, it is the time of high water next morning; and, to obtain the time for P.M. on the present day, subtract $12^h\ 24^m$.

If the sum exceed 24 hours, it is the apparent time of high water P.M. the next day; for the time P.M. on the proposed day, subtract $24^h\ 48^m$.

*Note.*—This rule supposes that the tide always follows the moon by the same interval; but this interval, generally speaking, is different for each day of the fortnight. See No. 923.

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* Such tables are given in the Tides published annually by the Hydrographic Office. The errors of the predicted times do not appear to exceed five or ten minutes, except in gales of wind, when the time of high water may be altered upwards of half an hour.

† This is often called *southing;* but as in south latitude the moon passes the meridian to the northward, this term is not adapted to general use.

‡ The moon's age thus found may be more than a day in error, but her merid. pass. will generally be less than an hour in error.

Ex. 1. Find the time of high water at Falmouth, Oct. 3d, 1891.

| | | |
|---|---|---|
| Epact 1891 | 20$^d$ | 9$^h$ |
| Do. Oct. | 7 | 5 |
| Days | 3 | |
| | 30 | 14 |
| | −29 | 13 |
| | 1 | |
| | 8 | |
| ☽'s Mer. Pass. | 0·8 = 0$^h$ | 48$^m$ |
| Tide-hour | +4 | 57 |
| Time of H.W. | 5 | 45 P.M. |

Ex. 2. Required the time of high water at Shields, March 31st, 1891.

| | | |
|---|---|---|
| Epact 1891 | 20$^d$ | 9$^h$ |
| Do. March | 29 | 11 |
| Days | 31 | |
| | 80 | 20 |
| | −59 | 2 |
| | 21 | 18 |
| | 8 | |
| | 16·8 = 16$^h$ | 48$^m$ |
| Tide-hour | +3 | 21 |
| | 20 | 09 |
| | 12 | 24 |
| Time of H.W. | 7 | 45 P.M. |

Ex. 3. Find the time of high water at Liverpool, March 10th, 1891.
Tide hour 11$^h$ 23$^m$ Time of H.W. 11$^h$ 23$^m$ P.M.

Ex. 4. March 30th, 1891, find the time of high water at Portsmouth.
Tide-hour 11$^h$ 41$^m$ Time of H.W. 2$^h$ 53$^m$ P.M.

Ex. 5. June 2d, 1891, find the time of high water at Liverpool.
Tide-hour 11$^h$ 23$^m$ Time of H.W. 7$^h$ 15$^m$ P.M.

933. Rule II. (1.) Take from the Nautical Almanac the M.T. of the moon's meridian passage, and correct it for the longitude by Table 28.

(2.) Take from Table 15 the semi-menstrual inequality corresponding to this time, and apply it to the reduced time of mer. pass. as directed in the table. To this result add the tide-hour, and the sum is the time of high water.

(3.) When this time exceeds 12 hours, it is the time of high water past midnight,—that is, A.M. the next day.

When, therefore, the P.M. tide preceding is required, it is necessary to employ the *inferior* transit of the moon.

Ex. 1. Aug. 6 h, 1891, find the time of high water at Shields. Long. 1° 25′ W.; tide-hour 3$^h$ 21$^m$.

| | | |
|---|---|---|
| ☽'s tr. 6th | 1$^h$ | 33$^m$ |
| Corr. for long. | 0 | 0 |
| Sem. ineq. | −0 | 21 |
| | 1 | 12 |
| Tide-hour | 3 | 21 |
| Time of H.W. 6th | 4 | 33 P.M. |

| | | |
|---|---|---|
| Inf. tr. 6th | 1$^h$ | 5$^m$ A.M. |
| Sem. ineq. | − | 14 |
| | | 51 |
| Tide-hour | 3 | 21 |
| Time of H.W. | 4 | 12 A.M. |

Ex. 2. Aug. 29th, 1891, find the time of H.W at Portsmouth.
Tide-hour 11$^h$ 41$^m$. High Water 29th, 7$^h$ 10$^m$ A.M. and 7$^h$ 54$^m$ P.M. on 29th.

Ex. 3. March 11th, 1891, find the time of high water at Cherbourg.
Tide-hour 8$^h$ 0$^m$. High Water 11th, 8$^h$ 32$^m$ A.M., 8$^h$ 53$^m$ P.M.

(4.) When the time of the moon's transit on the given day exceeds 12 hours, the transit occurs A.M. on the *next* day (civil

time). It is evident, therefore, that to obtain the times of high water on the same day, we must, in such cases, employ the transit of the preceding day.

Subtract $12^h$ from the time of transit, to enter the table of the semi-menstrual inequality.

To find the other tide, we must employ the inferior transit as already directed.

Ex. 4. April 8th, 1891, find the times of high water at Shields.

| | | | |
|---|---|---|---|
| ☽'s tr. April 7th | $23^h\ 49^m$ | For the A.M. tide preceding. | |
| Corr. for long. | 0 | Inferior trans. April 7th | $11^h\ 21^m$ |
| Sem. ineq. | + 2 | Sem. ineq. | + 8 |
| Tide-hour | + 3 21 | Tide-hour | + 3 21 |
| Time of H.W. April 7th | 27 12 P.M. | Time of H.W. April 7th | 14 50 P.M. |
| or April 8th | 3 12 P.M. | or April 8th | 2 50 A.M. |

Ex. 5. July 20th, 1891, find the times of high water at Tynemouth bar. Tide-hour $3^h\ 20^m$. High Water July 20th, $2^h\ 4^m$ A.M., and $2^h\ 28^m$ P.M.

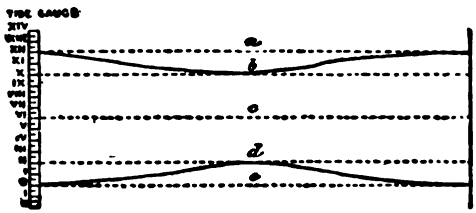
934. When the range of tide is considerable, and the depth not great, and it is required to identify the place of the ship by the soundings, or when about to enter a harbour in a vessel whose draught of water is nearly equal to the depth, it is necessary to find the height of the tide as exactly as circumstances permit. If the place is one of those of which particulars are given in the tide-tables published by the Hydrographic Office, the depth is found by the rules there given.* When such tables are not at hand, it may be found approximately by Table 16.

935. It is proper to remark that the age of the tide is necessary to the computation of its height. Thus, suppose it is H.W. at $2^h\ 30^m$ P.M. on Monday, the day of change. Now, if this H.W. is the tide *really corresponding* to the transit of the sun and moon together (No. 919), it will also be that which gives the spring range; the next range, therefore, will be less, and each range in succession will go on decreasing to the neap-tide. But if the age of the tide, in the supposed case, is 2 days, that is, if the highest tide does not follow till 2 days later, or till Wednesday afternoon, then the range on Monday will not be so high as on Wednesday; that is, the range, instead of *decreasing* continually to the neap-tide, will go on *increasing* for the next 2 days; after which it will begin to decrease until the neap-tide, which will take place 2 days after the 1st quarter, and not on the day of the 1st quarter.

* The soundings marked on the Admiralty Charts show the depth at Low Water ordinary springs; hence a correction has to be applied to the soundings obtained to compare it with these shown upon the chart to know the depth over a bar or in a harbour. See Table on p. 344.

## TIDES.

The following Diagram is intended to explain the terms Spring Rise, Neap Rise, and Neap Range, as made use of in this work.




*a* = Mean level of High Water Ordinary Springs.
*b* = „ „ „ Neaps.
*c* = Half Tide or Mean Level of the sea both at Springs and Neaps.
*d* = Mean Level of Low Water Ordinary Neaps.
*e* = „ „ „ Springs.

*Example.*

| | |
|---|---|
| Spring Rise (or Mean Spring Range) | = *e* to *a* = 12 ft. |
| Neap Rise . . . . . . | = *e* to *b* = 10 ft. |
| Neap Range . . . . . | = *d* to *b* = 8 ft. |

For ordinary purposes the following Table, for Reducing Soundings to the Mean Low Water Spring Tides, will be found sufficiently correct, except where the Tides are affected by a large diurnal inequality.

### At Spring Tides.

| | | | |
|---|---|---|---|
| At the 1st hour, before and after high water, deduct | $1\frac{1}{2}$ | Of the rise at springs. | |
| „ 2nd „ „ „ „ „ | $\frac{3}{4}$ | | |
| „ 3rd „ „ „ „ „ | $\frac{1}{2}$ | | |
| „ 4th „ „ „ „ „ | $\frac{1}{3}$ | | |
| „ 5th „ „ „ „ „ | $\frac{1}{8}$ | | |
| „ 6th „ „ „ „ „ | 0 | | |

### At Neaps.

| | | |
|---|---|---|
| At the 1st hour, before and after high water, deduct | $\frac{4}{5}$ | Of the rise at springs |
| „ 2nd „ „ „ „ „ | $\frac{3}{4}$ | |
| „ 3rd „ „ „ „ „ | $\frac{1}{2}$ | |
| „ 4th „ „ „ „ „ | $\frac{1}{4}$ | |
| „ 5th „ „ „ „ „ | $\frac{1}{5}$ | |
| „ 6th „ „ „ „ „ | $\frac{1}{6}$ | |

Trinity High-Water Mark, as established by Act of Parliament in 1800, is cut upon a large stone on the lower outer wing wall of the Hermitage entrance of the London Docks. Trinity high-water mark is 12·53 feet above the Datum used by the Ordnance Survey, *i.e.* Mean Level of the sea at Liverpool; therefore by obtaining from the Ordnance map the level of any Bench mark and applying 12·53 feet to it, the level of the Trinity high-water mark is found.

The Trinity high-water mark will be found cut upon the Tower Wharf, and also upon the front of the Fishmongers' Hall Wharf, next above London Bridge.

## III. Tide-Observations.

936. It is evident, from what has been said (Nos. 919, 922), that the establishment cannot be truly deduced from the notice of a solitary high water; and that observations, continued, at least through a semi-lunation, are necessary for even a tolerable approximation. But the true establishment cannot be successfully determined from a series of observations involving the semi-menstrual inequality, the various effects of changing declinations and parallaxes, with temporary and local circumstances, except by persons not only thoroughly versed in arithmetical operations on an extensive scale, but well exercised in the particular intricacies of these laborious calculations. We have, therefore, confined ourselves here to merely indicating the details which should accompany tide-observations.

(1.) The exact *spot of observation* must be specified.

(2.) The *instant* of both *high water* and *low water* should be stated, with the *height*, or difference of the two levels, in feet and inches. As the water hangs for some time towards the turn of the tide, and as the tide-current may be independent, it is necessary to note the instant at which the water passes a fixed mark, both in rising and falling; the means of these times are the instants of high and low water respectively. The marks should be fixed in some place to which the water passes slowly, because the waves, however small, continually washing over the marks, render it difficult to detect a small rise or fall of the water.

The observations of both low and high waters of the $24^h$ are necessary for determining the Diurnal Inequality; but as the time of this inequality is of less importance than the height, it will often be enough, in respect to this particular point, to note the height alone.

About mean water (or half tide) the surface rises or falls with greater velocity than at any other time, and accordingly the instant at which the water passes a fixed mark or a given horizontal line may be observed with greater precision than at any other time. Hence it has been recommended to notice the instant of passing one or two such marks, instead of the times of high and low water.—"On the Law of the Rise and Fall of the Sea's Surface during each Tide."—*Phil. Trans.*, Part II. for 1840.

It has been proposed to place the marks at half-tide, but this does not answer, especially where the diurnal inequality is consider-

able.* The intervals should be short on either side, of high and low water because the tides do not rise and fall with equal velocity.

(3.) The times of *slack water* should be noted.

(4.) The direction, and, in general terms, the force of the *wind*, should be stated, as, also, the height of the barometer.

As the effects of winds and atmospherical changes are not confined to the particular hours during which such causes are in action, it will be proper, when only a short series of observations can be obtained, to add further a brief notice of the state of the weather for some time previous.

Observations continued for a fortnight afford a first approximation to the Tide-hour; and when carried on for some months, this, with some other principal elements, may be obtained with considerable accuracy.

937. The custom has prevailed of noting the establishment as the *hour of the day;* but it obviously should, as recommended by Dr. Whewell (*Phil. Trans.* 1833, p. 229), be considered merely as an *interval.* Since the correct establishment is measured from twelve o'clock, it may, indeed, appear to be indifferent whether we call it an absolute time or an interval; but the *absolute time* of the tide is in all cases referred to the instant of the moon's transit, and it is absurd to talk of adding two absolute times together; as, for example, adding three o'clock of the day to five o'clock of the day. Also, by considering the establishment as an interval only, we avoid confounding mean and apparent times.

938. The soundings on the charts are the depths at "low water;" but this term may imply indifferently the mean low water of the whole year, or of the equinoctial spring-tides, of which the average is not always identical, or of those low waters only which were observed during the operations of survey. Since these may differ considerably from each other, the computed depth may be in error by the same difference. It might appear less equivocal if the lowest of all the low waters were understood; but this, though a natural phenomenon, and, so far, preferable to an imaginary standard, as an average, is still defective, since it is affected by winds. It would appear, therefore, as Capt. Beechey proposes,† that the standard low water should be identified as so many feet and inches below the mean level, which appears to be the only element nearly constant.

The mean level may, it appears, be found approximately by observations of four consecutive tides, which include the diurnal inequality.

* Adm. Bayfield (to whom I am indebted for some important remarks and corrections here and elsewhere in the former editions) informs me that in the St. Lawrence the alternate ebbs do not fall to the half-tide mark at all when the diurnal inequality is considerable. Also Adm. Beechey acquainted me, as the result of numerous observations, that at Plymouth the half-interval of time between the passages over the half-tide marks requires $\frac{1}{[illegible]}$ of the whole int. to be added to it for the correct time of high water, in consequence of the unequal rise and fall.

† "A Report of Observations," &c

# NAVIGATING THE SHIP

I. Shaping the Course. II. Place of the Ship. III. Determining the Current. IV. Storms. V. Making the Land.

939. In the preceding part of this volume each point of the subject has been treated separately. The present section, which will conclude the Practice, and to which the former chapters may be considered subservient, contains matters of general reference in conducting the navigation of the ship.

## I. Shaping the Course.

940. As soon as the ship is clear of the land, and circumstances permit, her head is put upon the course to be steered, the log hove, and the departure taken.

When the course is to be shaped for a distant port, recourse is had, in defect of personal experience, to the Sailing Directions,* in order to learn what point to steer for, so as to profit by particular winds or currents, or to avoid dangers. The bearing of such point is then worked for by parallel, middle latitude, or Mercator's sailing, according to the case; or, a ruler being laid on the chart over the place of departure, and the point in question shews the course, No. 381.

941. When the wind is foul, reference will be made to No. 299; but, in the case of a prevailing foul wind, the proper line of proceeding will be indicated in the Sailing Directions.

A steam-vessel will generally preserve her course without regard to the wind, except in long passages.

* The Sailing Directions contain descriptions of ports and anchorages, with accounts of the winds, currents, and tides, for various coasts and seas. Besides these and other particulars, necessary for navigation alone, works of this kind contain well-selected passages from voyages and travels, by which the reader may obtain clear ideas of the physical aspect of the shores, climate, and natural phenomena of most parts of the world, and derive considerable information respecting the manners and customs of the inhabitants, the productions, and articles of merchandise.

### 1. *Shaping the Course in a Current.*

942. When the whole or any part of the voyage lies through a current, having everywhere the same direction and velocity, it is proper to shape that course which shall keep the port on the same bearing (No. 294), because the ship will thus cross the current in the shortest possible time. But if the current be different in different parts of the voyage, this rule does not hold good. This point cannot be pursued further in this volume.

When the current, setting the ship away from her port, is so strong, or the wind so light, that the ship cannot preserve the bearing of the port unaltered, she will be kept so that the course made good shall not be more than eight points from the bearing of the port; because, though she cannot thus near the port till circumstances change, yet she will not increase her distance from it, as would result from shaping any other course.

The application of all such rules must, accordingly, depend upon the circumstances of the case.

943. When the ship, having a foul wind, is in a current of which the direction and rate are known, she should be kept as much as possible on that tack on which the current tends most to drift her to windward, or is least unfavourable in drifting her to leeward.

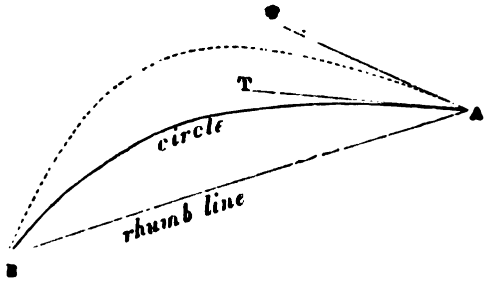
For example. Suppose the course to be steered is S.W., the wind S.S.W., the current S.S.E., 2 knots. Then, on the larboard tack, lying west, and going, suppose, 6 knots, she will make good S. 70° W. 5·5 miles, No. 292. On the starb. tack, lying S.E. and going 6 knots, she will make good S. 39° E., 8 knots. The distance made good *in the direction of the port* when her head is S.E. is 0·8 miles per hour, No. 285; when lying west, this quantity is 5 miles.

In this case the current tends to drift the ship to windward on both tacks; but the larboard tack is the most favourable.

### 2. *Shaping the Course on a Great Circle.*

944. When the ship sails on the arc of a great circle, the distance traversed in passing between any two points in her track is (as observed in Nos. 336, &c.) less than if she had sailed on a rhumb-line. A distinction of greater importance between these two tracks is, however, that every point of the great circle lies in a higher latitude than any point, having the same longitude, on the rhumb-line. Thus, if two ships sail from St. Helena to C. Horn, the one upon the great circle, and the other on the rhumb-line, altering their longitude by the same quantity, the ship on the circle will be 440 miles to the southward of the other, when the two vessels are most widely separated; that is, when the vessel on the circle is at the point of maximum separation latitude (No. 345). Now the difference of distance is only 76 miles in 3740 (No. 337, Ex. 1); whereas the difference of 440 miles in latitude may place the vessels in different winds.

945. A course taken anywhere between the great circle and the rhumb-line will always be attended with at least some saving of distance.




Thus, any course between A B and A T (the tangent of the circle at A, and shewing its direction at that point) gives a distance less than A B. Again, since the circle is the minimum distance between A and B, on the surface of the globe, we may take a series of tracks between A and B on the other or *polar* side of the circle, increasing in length as they lie further from it, till we come to the dotted line which represents a curve *equal in length* to the rhumb. Hence a ship sailing anywhere between A B and A U (the tang. which shews the direction of the dotted curve at A),—that is, through a space nearly *twice* as great as that between the rhumb and the circle,—will still have less distance to describe than that on the rhumb-line. On this principle a partially foul wind may often be turned into a fair one.

Thus, in the voyage alluded to above, the vessel on the circle, instead of passing 440 miles to the southward of the track on the rhumb-line, may pass at nearly this distance to the southward of the great circle, or between 800 and 900 miles to the southward of the rhumb-line; and yet, after all, she may make good a distance less than that on the rhumb-line, while the great difference of latitude may enable her to avail herself, for part of the voyage at least, of winds proper to regions far removed from those crossed by the rhumb-line.

946. When it is proposed to sail on a great circle the course is shaped with reference to the present place of the ship; and, therefore, when she is found to have got off the original line laid down, the course should, strictly speaking, be shaped anew. But, in practice, this will rarely be necessary, since moderate deviations from the course will not sensibly alter the bearing of a distant port, that is, the same course will serve as before.

947. In great circle sailing with a foul wind the ship will be put upon that tack in which she lays nearest the circle. The rule for windward sailing, which directs that she should be put on that tack in which she looks best up for her port (No. 299), is, therefore, strictly applicable. Indeed, it is only on laying down the great circle, which alone shews the real direction of the port, that it can be decided whether the wind is foul or not for a distant port.

If the rhumb-line differs more than two points from the circle, it is evident that, by shaping the course on the rhumb-line and then laying the ship on the wrong tack, she will head more than eight points away from the true direction of the port, while on the other

tack she would lie within less than 4 points of the course. Thus a seaman not acquainted with the principles of great-circle sailing may cause his ship to recede from her port instead of nearing it.

948. If the wind, when contrary, is in the direction of the great circle, one tack is as good as the other, and the selection must depend on the current, probable change of wind, or other circumstances. The ship should not, however, deviate from the circle so far as to have to shape a new course, for if she has much deviated from that line which was the shortest possible, she must have altered her position for the worse.

950. In navigating the ship on a great circle, in high lats., the course should be shaped anew at each 60 or 80 miles of distance.

The place of the ship is necessarily brought up by middle latitude or Mercator's sailing.

A modification of great-circle sailing has received the name of Composite Sailing. It presents itself whenever the great-circle track, by passing too close to the Pole, becomes dangerous or impracticable on account of the ice which pervades those high latitudes. When this occurs, some one parallel of latitude is fixed upon for the maximum; then the shortest route, under these circumstances, will consist of a portion of that parallel and of parts of the two great circles which touch it and which pass—one through the ship and the other through the destination. This combination of great-circle sailing and parallel sailing offers, therefore, no difficulty. *See* Davis's Star Azimuth Tables, p. 136.

*Log, Course, and Dead Reckoning. See Nos.* 956 to 969.

951. Dead reckoning has not always met with the attention it deserves. Dead reckoning is a fine art, dependent first upon a well determined position to start with; secondly a knowledge of the correct Variation and Deviation, or total error of the compass steered by; and thirdly on good steering and logging. to carry it on. Remember the remark of John Davis, the navigator, written in 1607, "*the stredge* * *may be so disorderly handled as that thereby the Pylote may be abused.*" Dead reckoning is also dependent on a correct knowledge of probable currents and tidal streams, on the winds that have been and are blowing.

952. *Good Dead Reckoning* can be attained by practice. See note (Rennel's) on p. 353, 359. Let the position by dead reckoning be considered a serious matter, to be carefully compared with the position obtained by observation. If there is a difference between the positions, let that difference be accounted for, and if it exceeds that probably caused by weather, or by known tides or currents, let it be considered that the distance has been wrongly estimated, or the errors applied to the compass courses incorrect, or the ship badly steered. (*The stredge disorderly handled.*) Let more care be taken the next day, and so on until a confidence is engendered in the dead reckoning that may be useful in closing the land in thick weather.

* "Stredge" may stand for stretch, a term for a ship's course.

## II. Place of the Ship.

### I. By Dead Reckoning. See Nos. 951, 952.

#### [1.] *Keeping the Dead Reckoning.*

954. *Latitude D. R.* The latitude by D. R. is deduced by applying the difference of lat. made good by the ship to the lat. by observation of the preceding noon.

When the latitude was not observed at noon, but at some other time it is proper to note the lat. D. R. as "brought up;" because the lat. by D. R., when employed for comparison with the observation, is of course considered as referred to the beginning of the day, unless the contrary is expressed.

When, however, there is no observation, the lat. by D. R. must be referred to the lat. D. R. at the preceding noon.

955. *Longitude D. R.* The longitude by D. R. is deduced by applying the difference of longitude made good to the long. D. R. of the preceding noon.

The long. by D. R. is usually carried on till a new departure is obtained, because the observations for longitude are not so decisive as those for latitude; for the chronometer may alter its rate, and the moon's distance from a star, or her R.A., may be much affected by a small error of observation. Hence, when the longitude by a single observation differs much from the account, it is not always considered safe to adopt it until it has been confirmed by another observation.* When, however, such confirmation is obtained, or two distances, observed at the same time on opposite sides of the moon, give results not differing much from each other,† the resulting

* In vol. i. of the East India Directory, Horsburgh gives an example of the danger of trusting to a single chronometer for a length of time, or to a single lunar, in the case of the Taunton Castle, which got aground in the Straits of Mozambique in 1791. A lunar 5 days before had agreed with the chron., but a lunar 12 hours before differed from it 1°. It was naturally considered that the former lunar confirmed the chron., and that the later observation was erroneous; the contrary, however, turned out to be the case.

† Horsburgh states that he has found the mean of two lunars, observed on opposite sides of the moon, nearly a degree in error. So strange a result would seem, however, to throw doubt on one of the observations.

The Rev. G. Fisher, in the Appendix to Captain Parry's second voyage, p. 282, states that the mean of 2500 lunars observed in December differed 14′ from the mean of 2500 observed in March following; and that the mean of the observations made in the same summer differed 10′ from these last, or 24′ from the first. Capt. King, in his survey of Australia, notices a discrepancy of a similar kind, to the amount of 12′, at the Goulburn Islands.

longitude should be taken as a departure from which to carry on the D. R.

Although it is recommended not to alter the long. by D. R. on slight grounds, yet it can answer no useful purpose to persevere in carrying it on after observations have proved it to be wrong.

[2.] *Errors of the Dead Reckoning.*

956. These are the errors of the course and distance, with their effects upon the lat. and long. by account.

An error of half a point in the course is equivalent to an error of $\frac{1}{10}$ in the dist. run, very nearly.

957. *Error of the Course.* The ship, besides moving in a path more or less serpentine from the action of the waves, and from imperfect steerage, is driven bodily by the wind, and often by currents and tides; hence the general direction of the ship's head is a very imperfect index of her course by compass. Again, the course by compass is affected by the variation and by the deviation; the latter, as already remarked, varies in different ships, and in different positions of the same ship.

960. *Error of the Distance.* The rate of sailing varies, from time to time, with the strength and direction of the wind, the quantity of sail set, the trim of the sails, the running of the sea, and, in a slight degree, on the skill of the helmsman. Hence, since the log can be hove at intervals only, while the compass is constantly inspected, the distance run, unlike the course steered, is left in a great degree to estimation.

While a vessel is steaming, her rate is, of course, less liable to change.*

961. The allowance to be made for the *heave of the sea* is doubtful. As regards the motion of the waves alone, it would appear that no such action takes place, and any effect of the kind must be referred to the progressive motion which the water at the surface acquires from the action of the wind, and which affects both the vessel and the log. The existence of a surface-current accompanying a strong wind is established by the falling over or breaking of the tops of the waves, which subsides accordingly with the wind, and disappears long before the swell goes down.

962. In steam-vessels the log is found to give too much distance. This is accounted for thus:—The water at the surface being continually urged astern by the paddle-wheels, preserves its motion for some time after the vessel is past; the log, therefore, unless thrown perfectly clear of this current, is carried in the direction opposite to that of the vessel. On this account it is proper to heave the log from the paddle-boxes.

* By practice seamen learn to estimate the rate of sailing within half a knot, and the number of revolutions in a given time of the engines of a ship under steam furnish a means of determining her speed very closely.

963. In consequence of the fore and after bodies of vessels in general being dissimilar, the resistance of the water to the rolling and pitching produces unequal actions on the bottom, from which results a slow motion of the vessel herself in the direction of her length. The nature and quantity of this motion is determined by the form of the bottom. Most vessels forge ahead, but some astern.*

964. *Error of the Latitude D. R.* This is composed of the errors of the course and distance.

If the lat. by D. R. does not agree with the observation, it is customary, when the course since the observation is nearly N. or S., to attribute the error to the distance; because, in this case, any small variation or error in the course will not affect the D. Lat. Again, when the course is nearly E. or W., such error is attributed to the course; because, in this case, a small error in the course will affect the D. Lat., while a small error in the Dist. will not.

These suppositions, though plausible, are not always true, and therefore are not to be implicitly adopted.

965. An error in the latitude is the same number of nautical miles in all parts of the world.

966. *Error of the Longitude D. R.* This error, when the long. is carried on by parallel or by mid. lat. sailing, is proportional nearly to the error of the Dep. When the long. is carried on by Mercator's sailing, the error is due to an erroneous course and distance, and also, in most cases, to using latitudes by observation inconsistent with the given course.

967. An error of a given number of minutes of longitude (′) is the same number of sea-miles† when the ship is near the equator; but in higher latitudes the same number of min. of long. is equal to a smaller number of sea-miles. Hence precision in the longitude is of less consequence to the safety of the ship in high than in low latitudes.

For the same reason the long. by D. R. will in general be kept more correctly in low than in high latitudes.

968. As regards the probable *amount* of the errors of the ship's place in latitude and longitude, it may be supposed that the error of the course will rarely amount to a point, and that the distance will not be in error more than $\frac{1}{10}$ of itself.‡ Such estimations, however, must depend entirely on circumstances.

The error, on the whole, will be that due to the sum or the difference of these errors; more frequently, however, to their differ-

* Capt. W. Ramsay informs me that the *Black Joke*, a very fast vessel which he commanded on the coast of Africa, always forged astern in a calm.

† Seamen are in the habit of calling minutes of longitude *miles*; but a mile is a measure of invariable length, while a min. of long. is different in different latitudes; the practice, therefore, should not be followed.

‡ Rennell ("Investigation of the Currents of the Atlantic," p. 70—London, 1832) quotes Flinders's opinion that the reckoning may be kept within 5 miles of distance, and half a point in the course.

ence, since experience establishes that, when several observations are taken together, their errors tend to compensate each other.

969. Under the head "D. R." is included the determination of the ship's place by bearing and distance of the land. When a point of land bears N. or S., the diff. lat. of the point and the ship is the distance; and consequently the error of the lat. is exactly equal to that of the distance, while a point or two of error in the bearing produces but small error in the lat.

On the other hand, if the place bears E. or W., the ship's lat. is that of the point itself, and an error in the bearing produces in the lat. an error proportional to her distance.

This applies to longitude by reading, in the above, long. for lat., and interchanging N. and S. with E. and W.

### [3.] *Variation of the Time at Sea.*

970. When the ship sails to the eastward, she meets the sun, and therefore anticipates the hour of the day by a portion of time equal to the diff. long. she makes good. In sailing to the westward, the contrary takes place. Hence in sailing eastward the apparent day is always less than 24 hours, and in sailing westward greater than 24 hours, by the diff. long. made good, in time.

Thus a ship, in sailing round the world to the eastward, gains a day in her reckoning of time: for each day in which her head is to the eastward is less than the common day of 24 hours by the diff. long. made good; and this goes on till the diff. long. has accumulated to 360°, or 24 hours. Hence, on completing the voyage (but without any relation to the time of performing it), the ship, by constantly gaining on the next day, is found to have completely anticipated it; so that, instead of finding it Wednesday, for instance, among the natives, it appears by her journal to be Thursday.

In sailing round the world westwards, the ship in like manner loses a day. In these cases the voyage is performed in days of a different length from the average of 24 hours, and the whole period is made up of a different number of days.*

971. This alteration of the date in the journals of ships crossing the Pacific is often attended with considerable embarrassment to the reader, especially if he does not bear in mind the direction of the ship's route. In order to provide against this ambiguity, the navigator should insert the Greenwich Date at full length, in every case in which a reference to the absolute time may be required.

972. The variation of time, or the irregularity in the length of the day, falls on the hour or half-hour preceding noon, the last glass

* Sir James Ross remarks that in crossing the meridian of 180° eastwards they made two Thursdays, and two Nov. 25ths, by which means their reckoning would correspond to that of Australia and England on their arrival.

A short rule to estimate day and hour of arrival for steamships crossing the Pacific is: Going West: Add one day to assumed time of length of passage, and subtract the Diff. Long. *in time* between the two ports. Going East: Subtract one day from assumed time of passage, and add the Diff. Long. *in time*.

or two not being turned. When there is no observation for some days, the time is thus liable to be considerably in error.

This uncertainty in the absolute time causes no difficulty in bringing up observations to noon, or to any other time, nor in connecting observations made A.M. with others made P.M., because the courses and distances marked on the log-board are those corresponding to the actual intervals elapsed.

973. It is evident, since the time at ship always has reference to the diff. long. made good subsequent to the observation for time, that the account of the time is more correctly kept in low than in high latitudes. (See No. 967.)

### [2.] *Place of the Ship by Observation.*

974. Besides the latitude and longitude of the ship by observation, we shall consider, under the above head, those observations from which the elements necessary in the calculation of her place at any time are obtained: as observations for Time, and for the Variation of the Compass.

#### [1.] *Latitude by Observation.*

975. In variable climates it is often advisable to take, early in the forenoon, an altitude of the sun, to be followed by another after the proper change of azimuth, No. 749, for a double altitude, in case the meridian alt. is not obtained.

If the second alt. is observed within the limits of Table 47, the operation is simpler, and the result more satisfactory. If it is near the meridian, and the time is not very much in error, the second alt. alone determines the latitude by the reduction to the meridian, p. 249.

In either of these cases the first alt. affords the apparent time, when the lat. has been ascertained.

976. (1.) The lat. will of course be obtained, when possible, by the meridian altitude of the sun. The short double altitude A.M. has the advantage of providing against the loss of this observation,* and it enables the navigator to determine the place of the ship before 12 o'clock.

The altitude of the moon on or near the meridian (Nos. 702, 703) may often be obtained during bright sunshine. Also, the moon's alt., combined with that of the sun, affords the lat. by double alt., No. 759, &c.

The planet Venus may often be observed during the day.†

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* The only observation disturbed by the ship's change of place (No. 548) is the mer. alt. Suppose, for ex., the ship is approaching the sun 12 knots, she raises him at the rate of 12″ in 1ᵐ. Hence he continues to rise till he is so far past the merid. as to have begun, by his motion in altitude, to fall at this rate. In high lats. where the motion in alt. is slow, the interval will be considerable; in lat. 60 he would appear to dip about 5 min. P.M., and in the same case, with the ship receding from him, he would dip about 5 min. A.M. To compute this time, see No. 622.

† Horsburgh states that he has observed the meridian alt. of Venus, at the Cape of

When the planet is not bright enough to be distinctly visible to the naked eye, it may generally be found, when near the meridian, thus:—Compute the merid. alt., No. 663; add to it the dip and refraction; set this angle on the sextant, put in the inverting telescope, screwing it close down to the plane of the instrument: then, directing the sight to the N. or S. point of the horizon, the planet should be seen in the silvered part of the glass.*

977. The lat. is found at night by observations of stars on or near the meridian, No. 687. The lat. by a star at night not only is useful in preventing the accumulation of error in the D. R., but also serves as a check on the lat. by the sun (note *, p. 249).

The observation of stars at night is, however, a very different observation from other altitudes by day, and, to ensure success, the observer should make it a matter of special practice.

It is, however, during the twilight that stars and planets may be most advantageously observed at sea, as the horizon at that time is strongly marked, and, when not sufficiently so, may be rendered distinctly visible by the inverting telescope. In favourable cases such lat. may be depended upon with as much confidence as that of the sun. In north latitudes above 20° or 30°, the pole-star may always be observed when the sky is clear.

[2.] *Time by Observation.*

978. The Time is generally found by a single altitude (p. 278), early in the forenoon, when the error of the ship's lat. produces no sensible error of time. It should also be found late in the afternoon. In certain cases it may be found by equal alts., No. 798, the result of which is apparent noon; and also approximately by the short double altitude (p. 285), and at sunrise and sunset (p. 283).

The time may likewise be deduced from one of the altitudes of a common double altitude (p. 276); but the latitude resulting from this observation not being very correct in general, and more especially when the reduction of the alts. to the same place of observation is large, the time deduced would not always be satisfactory.

979. When the sun and moon are both visible, and one of them is near the meridian, the lat. may be found, and also the time, which (Nos. 696, 757) thus has the advantage of being free from the errors of the reckoning. In like manner the alt. of a planet might be taken with that of the sun at the same instant, or some time afterwards (No. 764).

980. When the time is found at night by alts. of stars or of the moon (Nos. 782, 784), since the sea-horizon is often unfavourable for observation at that time, the result should be considered as of

Good Hope, during bright sunshine. Capt. Basil Hall, to whom I am indebted for several valuable suggestions, acquainted me that, on a voyage to Malta in H.M.S. Indus, in August 1841, he observed the mer. alt. of Venus every day for a fortnight. Capt. Wickham also tells me that he has found the lat. by Venus, in the tropics, at 3h in the afternoon.

* Capt. Hall informed me that he had often found the lat. in this way, both by Venus and Jupiter, when the planets were altogether invisible to the naked eye.

inferior value; or stars should be observed on both sides of the meridian, in order to diminish the effects of errors from this cause.

The remarks on the observations of planets or stars by twilight for lat. (in No. 977) apply to observations for time. Stars may often be obtained nearly on the prime vertical, and on opposite sides of the meridian (No. 787); and the alt. for time should always, if possible, be accompanied with another for lat., in order to avoid all reference to the reckoning.

981. An approximation to the apparent time may be conveniently obtained, during part of the six months that include the summer, by setting the index of the sextant to the apparent alt. of the sun's lower limb deduced from the true alt. of the centre, at the time of passing the prime vertical, Table 29; the hour-angle at which the limb attains this alt. is then taken out from the adjacent column.

982. Since the change of alt. of any celestial body is greatest at the equator and nothing at the pole, the time deduced by means of altitudes is more correctly determined in low than in high latitudes. (See Nos. 778, 779.)

983. Advantage should be taken of favourable opportunities of landing at well-determined places for good observations of time, because the diff. long. between the places will at once discover any considerable change in the rate of the chronometer, and afford the means of correcting it. Comparatively few places indeed are as yet laid down with sufficient accuracy for the general practice of this simple and decisive method; but, in proportion as the longitudes approach to precision, the differences of longitude will be employed by seamen as the means of obtaining, directly, the *sea-rates* of their chronometers, instead of waiting to obtain harbour-rates.*

984. *Error of the Time at Sea.* The time at sea, as found by a single altitude, can rarely be depended upon to less than $10^s$ (Nos. 778, 779). If, therefore, the ship's reckoning were correctly kept, her diff. long. applied to the time, as found by observation on a former occasion, would give the time at ship within about $10^s$ of the truth. But as the D. R. is always more or less in error, and as the error may be considered generally to increase with the time elapsed, the error of the time at ship may be considered as $10^s$ *plus* the error of the diff. long. accumulated since the observation.

[a.] *Longitude by Observation.*

985. The longitude by chronometer may be ascertained whenever the time is obtained. The long. by chron. is thus the most efficient check on the long. by account from time to time; but after a lapse of time it may be greatly in error, as the rate is liable to change. See No. 531.

* This important remark is due to Col. Sabine, "Account of Experiments," p. 401.

When there is no chronometer on board, the longitude by D. R. can be corrected only on making the land, or by a lunar observation, or sometimes by speaking another vessel.

986. When a satisfactory longitude is obtained by independent means, as by observation of the moon, it should be adopted as a new departure taken at the instant of observation, instead of carrying it back to the preceding noon or any other time; because this last process, which is attended with no advantage, impairs the value of the observation by mixing with it the errors of the run.

987. Since the object of the lunar observation is to find the mean time at Greenwich at the instant of observation, the simplest and most direct application of the method is to find at once the error of the chronometer on G. M. T.; because this process is not embarrassed by consideration either of the time at place, or of the change of long. in the interval between the lunar observation and the observation for time. This is the practice of the most experienced navigators.

988. When there is no chronometer on board, the longitude itself must be found for the instant of the mean of the observed distances. For this purpose the time at place is necessary. If, therefore, either of the altitudes observed for the lunar is favourable for determining the hour-angle corresponding, the time may be obtained from it, and being compared with the G. M. T. found by the lunar, the long. is determined, No. 827.

If neither of the altitudes is fit for the purpose, the time must be found as soon as possible afterwards. In this case, add the interval elapsed to the G. M. T. deduced by the lunar: the sum is the G. M. T. of the observation for time. This time, compared with M. T. at place, gives the longitude.

Ex. At $3^h\ 11^m\ 26^s$ by watch, obtained a lunar, which gave G. M. T. $2^h\ 14^m\ 32^s$. At $3^h\ 56^m\ 18^s$ by watch, obtained an observation for time. Find G. M. T. at this second observation.

| | | | |
|---|---|---|---|
| T. by watch, of lunar | $3^h\ 11^m\ 26^s$ | G. M. T. of lunar | $2^h\ 14^m\ 32^s$ |
| Ditto of obs. for time | 3 56 18 | | 44 52 |
| Interval | 44 52 | G. M. T. at 2d obs. | 2 59 24 |

989. In the Arctic regions, in summer, the presence of the sun at night prevents the stars from being seen; also frequent fogs obscure the moon. Hence the lunar observation is much less available there than in other climates, and the chronometer in consequence more valuable.*

990. The number of observations, either for latitude or longitude, which it may be proper to take for determining the ship's place, obviously depends on the distance of the land and on the state of the weather. For example, in making a passage with a trade-wind, a much less degree of attention will be necessary than in unsettled weather, when the D. R. cannot be kept with equal correctness,

* "An Account of the Arctic Regions," &c., by W. Scoresby, jun. 2 vols. Edinburgh, 1820.

or than when the ship is in the neighbourhood of the land or a danger.*

It is always advisable, when any observation is taken, to obtain, either at the same time or as soon as possible afterwards, another of such a kind that the same error may produce different effects on the result; whereby the two results being in error opposite ways, their mean will be preferable to either separately. The kind of observation proper for this purpose, in any case, has been generally noticed in the *Degree of Dependance*. See No. 999.

When the observation consists of one or more alts., the errors of observation may often be removed at sea by observing also the supplement of the alt. It is, however, proper to remark, that when the supplement is observed by an ordinary sextant or circle, it is, in consequence of its greater magnitude, much more affected by the error of parallelism (Table 54), when this is considerable, than the alt. itself.

[4.] *Observations for the Variation.*

991. The total error of the standard compass should be constantly observed and recorded, not only for the purpose of secure navigation, but with the view of determining the variation, and so helping to maintain, for the benefit of all seamen, a correct chart of its value.

993. The amplitudes of bright stars and planets may often be well observed, especially about twilight, when the horizon is strongly defined. The observation is most convenient at setting, because a star may be followed to the place of its final disappearance below the horizon; but it is not always easy to identify a star at rising.

With care the error of the course due to the compass alone should not exceed a degree: less accuracy is hardly compatible with good navigation in fast steam-ships.

[5.] *Combination of Results.*

997. As all observations are liable to errors, and as given errors of observation produce different effects according to the case, the results of different observations do not generally agree.

In some cases the same errors of observation will cause all the results obtained under the same circumstances to be in error the same way, instances of which occur in Nos. 702, 868. In other cases, the effects of errors will tend to compensate.

998. In general, when the particular errors with which the observation is affected are not known, the *mean* of the several results is employed, or the sum of the results divided by the number of observations.

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* Rennell remarks that the facilities afforded in these days for finding longitude may tend to diminish the *necessary attention to the reckoning*, on the ground that the next day's observations will set all right. P. 79.

Since one of two results may be nearly or exactly true, and since it will rarely happen that one is precisely as much too great as the other is too small, the mean of two results will generally be merely less in error than the worst.

999. In taking the result of observations affected by the same *constant error*, care must be taken not to mix those of opposite kinds, as N. and S., or E. and W., but to take the mean of the two different *results.* For Ex.: Suppose the lat. is 1° 28′ by each of two stars N. of the zenith, and the instrument has a constant error of 1′, then the lat. by one star S. will be 1° 26′, and the true lat., 1° 27′, is the mean of 1° 28′ and 1° 26′. But the mean of the *three* results, taken promiscuously, or one-third of 1° 28′, 1° 28′, and 1° 26′, is 1° 27′ 20″, which is not right.

The same would be true, however great the number of observations on one side, or however small on the other; and hence it is always proper to make this separation, which is also a means of detecting a constant error. For instance, if the moon's semidiameter in the Naut. Alm. is erroneous, the result of lunar observations of one limb will differ from that of observations of the other limb and the mean of the two results, not of the whole indiscriminately, will afford the true longitude.

1000. When the error of observation is given, the *amount* of the error of the result may be computed. Examples of this have already been given in most of the rules for the *Degree of Dependance* Again, the effect of a constant though unknown error of observation may sometimes be removed, as in No. 861, where the same error in each distance produces more or less error in long., exactly in proportion as the moon's motion in respect to each star is less or greater.

1001. When some of the several results of different observations are known from circumstances to be better than others, it is proper to give to the superior results a greater weight or influence in the general determination. This is effected by writing them down oftener than the others, and dividing the sum by the number of results thus augmented. For example, suppose a diff. long. by a chronometer A is $1^h\,11^m\,18^s$, and by another, B, it is $1^h\,11^m\,23^s$; and suppose the result of A is estimated from its superior performance, or other circumstances, as half as good again as that of B, that is, of superior value in the ratio of 3 to 2; then, writing down $18^s$ three times, and $23^s$ twice, and dividing by the sum of 3 and 2, or 5, gives $20^s$, or the estimated result, $1^h\,11^m\,20^s$.

The preference of any one result to another under the same or different circumstances, or the degree in which one may be supposed superior to another, must be left to that judgment or tact which is the result of experience and constant attention to a particular subject, as it is obviously impossible to lay down rules of certain application for such questions.

1002. Though it usually happens that the mean of several observations is near the truth, yet, as this is not certain, we must not

hastily assume that the mean of even a very considerable number is a definite determination.*

It is proper to bear in mind that the chronometers, when they agree, are either all right or all wrong; but that when they disagree, some of them must be wrong.† See No. 531.

1003. We shall here remark, also, that every determination whatever is liable to the suspicion of having been influenced by the premature adoption of an approximate mean. For ex.: an observer collects 6 or 8 observations; 2 or 3 of these differ widely from the rest, and they are rejected forthwith. Succeeding observations are compared with the mean, and admitted or rejected accordingly. Now these outlying observations may happen to be as good as the others, if not better; but by this partial suppression of evidence the question is prejudged, and the increasing number of observations only tends to fix the erroneous determination more firmly.

### 3. *Laying off the Ship's Place on the Chart*

#### [1.] *Position in Latitude and Longitude.*

1004. As the account of the ship's place is closed at noon, the ship is pricked off at that time; also at 8 P.M., when the course is shaped for the night.

The ship's place is laid down by observations, when these can be obtained; in other cases it depends upon the D. R., or frequently upon both.

1005. It is the practice of some seamen, besides taking the ship's place by obs., to mark also her place, as brought up by D. R., from her former position by observation; a line joining these two points stands thus as a leg apart from the ship's track. When the ship stands nearly on the same course, and carries the same wind for some time, this method has the advantage of exhibiting any constant effect produced by a current, or by local deviation, or arising from not making a proper allowance for lee-way.

1006. Since the determination of latitude is absolute and independent (No. 680), the lat. of the ship should be marked whenever a satisfactory observation is obtained.

1007. The longitude, when determined by chron., should be marked on the chart for the time at which the observation is taken, because thus it is unmixed with the errors of the run.

It may be prudent, when there is but one chronometer on board, and when observations of the moon are not practised, to assign a

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* Capt. Fitzroy's chronometric measures, the results of 20 or 25 chronometers, amounted, when added together, to $24^h\ 0^m\ 36$, or $36^s$ more than the entire circumference. This seemed to be considered, at the time, as a somewhat curious circumstance; but it is evident that some excess or defect was to be looked for, since nothing but accidental compensation of errors could produce, out of a number of discordant elements, the precise quantity $24^h\ 0^m\ 0^s$.

† Adm Beechey acquainted me that on one occasion all his chronometers agreed within 1′, being nearly 30′ in error, and that the single chronometer of the Starling, the tender, was right. As the large majority was considered conclusive, the error was near leading to serious consequences.

second track to the long. by D. R. alone, in intervals of making the land.

1008. As a tolerably good watch alters its rate but little from day to day, the ship's track, as laid down by chronometer, represents truly the relative positions of the ship at different times, and therefore exhibits nearly the true *figure* of her track for a few days together; while its absolute position in *long.* may, at the same time, be erroneous, if the error on G. M. T. is not well known.

On the other hand, since the longitude by lunar, though of undoubted value, is not susceptible of much numerical precision; the difference of two longitudes by lunar, separated by an interval of time, will not, in general, agree with the diff. long. as measured by a chronometer. Hence the track of a ship, as laid down by lunars, would exhibit violent irregularities of figure, while its absolute position in longitude would not be very far from the mean of all the lunar determinations.

Accordingly, when the long. by chronometer is proved by lunar observations to be much in error, and it is required to correct the position of the ship's track, it will be proper to take a mean position among the several positions by lunar, and the lat. at the last lunar. This point being assumed as a departure, the track for the time previous may be adjusted.

### *Sumner's Method.**

[2.] *Position on a Line of Bearing.*

1009. When the lat. by acc. is uncertain, the resulting long. by chron. is uncertain in a corresponding degree; but this long., far from being valueless, is capable of an important application, especially when the ship is near the land.

Suppose a second lat. by acc. near the first, as, for ex., 10′ greater, a second long. by chron. will be found corresponding; in like manner we may suppose a third lat., with its corresponding long., and so on. Now these positions are those points in different latitudes at which the *same alt.* is observed, and constitute the curve or *circle of equal altitude*, since the observer, moving over the globe so as to keep the sun always at the same alt., would move on a circle, the pole of which is that point where the sun is vertical.

The small portion of this curve passing through two positions near together would appear, on the chart, a straight line; and thus, if this line (being produced) passes through a point of land or other object, the *bearing* of such object is known, though the ship's *place* on the line of its direction is not known.

1010. The process of finding the line of equal alt. consists thus in

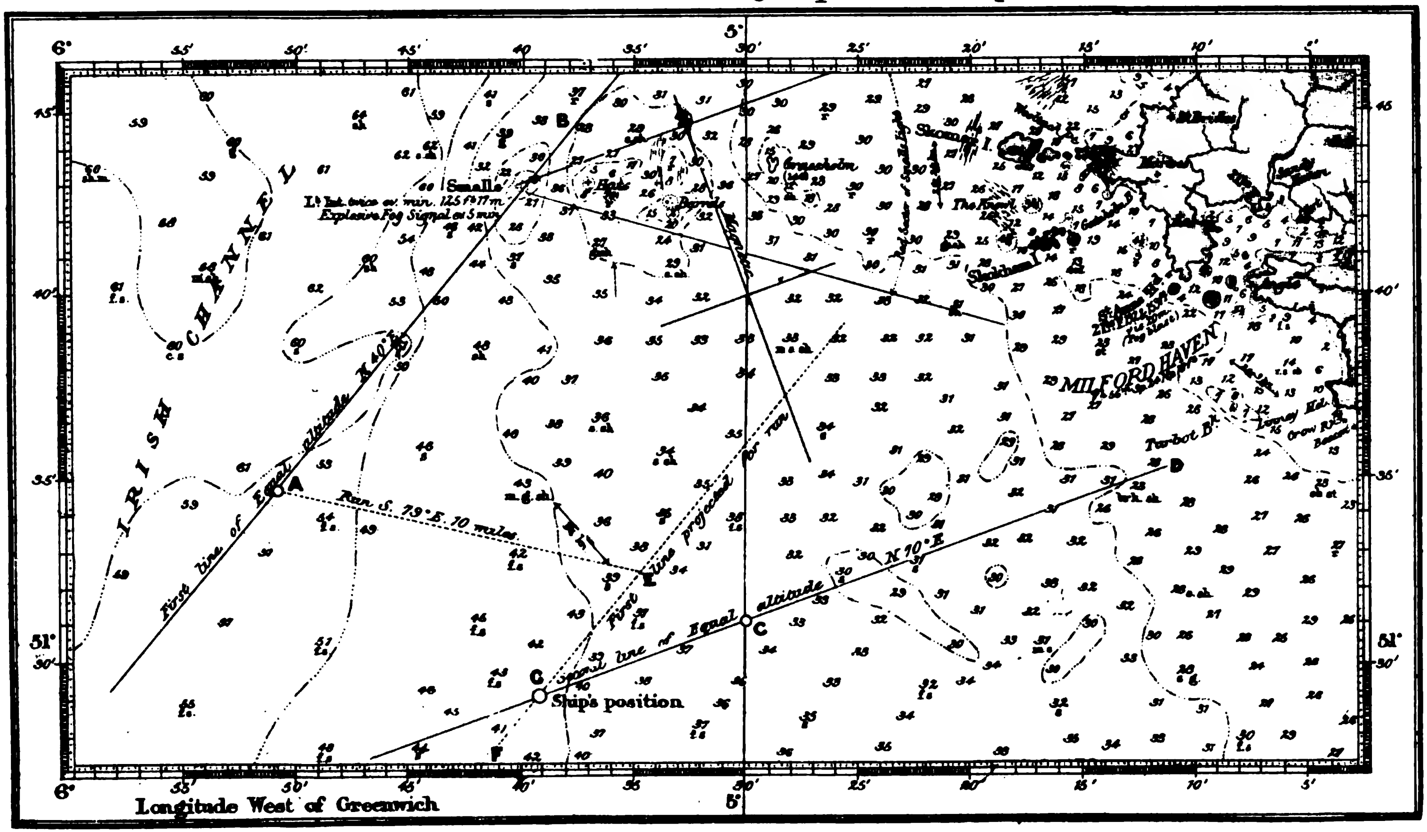
* "A New and Accurate Method of finding a Ship's Position at Sea," by *Capt. Thos. H. Sumner.* Boston, 1843.

In 1843, Commander Sullivan, R.N., not having heard of this work, found the line of equal alt. on entering the River Plate, and identifying the ship's place on it, in 12 fathoms, by means of the chart, shaped his course up the river. The idea may thus have suggested itself to others; but the credit of having reduced it to a method, and made it public, belongs to Capt. Sumner.

DIAGRAM

To illustrate Sumner's method for finding the position of a ship at sea.

To face p. 363.




ALL BEARINGS ARE TRUE

assuming two lats. by acc., finding the long. by chron. corresponding to each, laying off these two positions on the chart, and joining them by a straight line. But since the sun's bearing is 8 points or 90° from the direction of the line of equal alt., this line may be expeditiously obtained from one obs. only, by drawing a line through the assumed position of the ship at right angles to the sun's azimuth at time of obs., as found by Chap. VII. p. 240; or from the Azm. Tables of Burdwood or Davis.*

From a second obs. of the same or different bodies taken at a suitable difference of bearing, another line of equal alt. is similarly obtained. The intersection of these two lines gives the position of the ship supposing the ship not to have changed her position in the interval.

1011. When the ship changes her place the *true* course and distance made good must be laid off from the first assumed position. Through the point thus found a line must be drawn parallel to the first line of equal alt. Where this line cuts the second line of equal alt. will be the ship's position at the second obs.

The difference of bearings of the sun or bodies used at the two observations should not be less than 25°, or the lines of equal alt. will cut too acutely.

*Example, see Diagram.*

In the Irish Channel, August 18th, 1890, at $9^h\ 36^m$ A.M., in lat. by acc. 51° 35′ N. the long. by obs. was 5° 51′ W., and the sun's true bearing being N. 130° E., the direction of the line of equal alt. A B, drawn through position A, was N. 40° E.

At $11^h\ 8^m$ A.M., in lat. by acc. 51° 31′ N., the long. by obs. was 5° 30′ W., and the sun's true bearing being N. 160° E., the direction of the line of equal alt. G C D, drawn through position C, was N. 70° E.

The run of the ship in the interval (A E) was S. 79° E. *true*, distance 10 m.

Through E the line E F is drawn parallel to A B; this line cuts the line C D in G. G is the position of the ship at the second obs. in lat. 51° 29′ N., long. 5° 39′ 30″ W.

1012. As the ship must be somewhere on the line of equal alt. drawn upon the chart, if this line falls upon a well-sounded chart, her position may be approximately known from the depth of water obtained at the time of obs. Thus on the line A B a depth of over 50 fms. would shew the ship to be at a safe distance from the Smalls. Similarly on the line C D a depth of 40 fms. shews her to be about 23 m. from Linney Head. The line of equal alt. at the first obs. should therefore be drawn as soon as the observations are taken and worked.

When the coast trends parallel to the line of equal alt., the distance of the ship from the shore is ascertained, though her absolute position is uncertain.

1013. The lat. assumed should be as nearly correct as can be obtained by D. R.; this is important when the alt. is high. In low latitudes, when one obs. falls within the limits of the problem for finding the lat. by Reduction to the Meridian (see Table 47), this method should be used in preference to "Sumner's."

* The line of equal alt. may be found by the change in hour angle and consequent change in long. due to a change of one mile in lat. found by No. 615.

1014. As the sun rises and sets to half the globe, the circle of equal altitude at rising and setting is the entire circumference. On the other hand, when he is in the zenith, this circle is reduced to a mere point, or, for opposite points of the sun's disc, covers 32 sea-miles. When the alt. is 89° 50′, the radius of this circle is 10′, or its extent is 20 miles; when the alt. is 50°, the radius is 40°, or the extent 80°. Thus when the sun is low this circle is large, the small portion of it comprised between two assumed lats. very nearly a straight line, and the sun's azim. the same from both ends; but when he is high the circle is small, a small portion of it may be much curved, and the direction of the two extremities very different; that is, the bearing of the land, and the sun's azimuth, may be sensibly different from different parts of the same portion. An error in the assumed lat. has therefore most effect when the alt. is high, and least when it is low, which last is consequently always the preferable case.

As the change from or towards the object of 1 mile in the observer's place changes its alt. 1′, the effect of an error of alt. is shewn by moving the line parallel to itself through the same amount.

An error in the chronometer places the line of equal alt. too far E. or too far W., bodily, but does not alter its *direction*.

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## III. Determining the Current.

1015. The direction and rate of the current are found from the change of place of the ship, or from experiment.

In No. 297 examples are given of finding the current by the comparison of the place of the ship by D. R. with that by observation, and also by reference to the land. In consequence, however, of the unavoidable errors of the reckoning, such determinations must be far from conclusive; and there is no doubt that currents are often assumed to account for discrepancies between the D. R. and observation.* The only decisive method is, evidently, to determine astronomically the place of a floating body, or substance, not exposed to the action of the wind, at intervals of time.

1016. As currents are considered to prevail for a very small portion of the depth of the ocean, it has been recommended to sink a weight to a considerable depth to serve as an anchor for a boat, from which the current at the surface is determined by the compass and the log. This method, however, can obviously discover only the difference between the current at the surface, and that at the depth to which the weight is lowered.

* From good or carefully kept D.R. a reliable Current in 24 hours may, however, be often obtained.

## IV. Making the Land.

1029. When confidence cannot be placed in the correctness of the longitude, it is proper, if circumstances permit, to make the latitude of the port, and then to run on the parallel for it.

1030. On approaching the land it will be prudent to charge the ship's place with some inaccuracy; and the best reckoning can never supersede the necessity of a vigilant look-out.

1031. When the land is made, the ship's place should at once be laid off by the reckoning; for the reckoning may be good, and if so, the ship's position, as laid down, will be correct, or nearly so.

And, again, it is not uncommon, on making the land, especially in defective light, or on a new bearing, and consequently under an unaccustomed aspect, to mistake one point for another, or to make a considerable error in estimating the distance. Now the position laid down is that by which the ship's course is shaped on the chart, and if it depends on an erroneous bearing or distance, it may lead her too near the shore or a danger. The effect of moonlight is generally to make land appear more distant than it really is.

1032. Navigation among coral reefs is facilitated by the clearness of the sea-water. On the reefs on the east coast of Australia, a depth of 5 fathoms was seen from the mast-head, at the distance of half a mile; in 7 fathoms a patchy bottom was well made out from the boat's gunwale; but in 10 fathoms the bottom was scarcely distinguishable from the dark blue of the open sea.

1033. In navigating among coral reefs it is recommended, as essential to safety, that the day should be clear, the sun behind the ship, the water low, and, when the shoals are not clearly distinguished, that the ship should anchor if possible. When the sun draws ahead, coral patches become less distinct; and hence caution is necessary, when making for coral reefs with the sun ahead of the ship.

It is also remarked that the look-out, when placed half-way up the rigging on these occasions, sees better than from the mast-head, where the eye is dazzled by the glare.*

When approaching to round a point of land or shoal, and for that purpose bringing it on what appears a safe angle on the bow, care must be taken that the danger is brought aft—that is, that its angle on the bow is increased as the ship goes on. This is

* When looking out for a light at night, the fact is often forgotten that from aloft the range of vision is much increased. By noting a star immediately over the light a very correct bearing may be afterwards obtained from the standard compass. The intrinsic power of a light should always be considered when expecting to make it in thick weather. A weak light is easily obscured by haze, and no dependence can be placed on its being seen.

especially necessary with a tide or current on the off-bow. From want of due caution in this respect, a ship having only low speed may get into a position with reference to a danger from which it may be difficult to extricate her. The custom of handling ships from forward makes this caution the more necessary.

From No. 369 it will be seen that the seaman can certainly know when a vessel is outside any projecting or outlying shoal by an angle between two fixed marks on the adjacent land. Thus if A and B (fig. ex. 1) are two marks on the land, and the circle OBA passes through those marks and outside any off-lying danger, then, when the angle subtended by the two marks is less than the angle AOB (in this case 46°) the ship cannot be within the circle OBA. The angle AOB has been called the danger-angle.

Such angles may be most accurately measured with a sextant; but the angle between any two bearings taken with a compass, if the ship's head is kept in the same direction while they are taken, is also correct, the bearings being equally affected by variation and deviation. But if such bearings are plotted as cross-bearings, and either the estimated variation or deviation is erroneous, the position of the ship so obtained would also be erroneous.

When ships were navigated chiefly under sail, seamen were much less disposed to approach the land than now. The certain command of course and speed given by steam has led to closing the land, in order to save distance or for other purposes, in a way which would formerly have been considered unsafe. This practice has not been unattended with loss, from the fact that general charts are made from surveys which were not intended for such close navigation. Harbours and their immediate approaches are generally very closely sounded, but to survey every sea-coast in such detail would occupy very much more time than is generally available. The mere fact that vessels have frequently passed close to the land in certain positions without accident, is far from being such reliable evidence of the non-existence of danger as the close sounding of an accurate survey.*

1034. The supply of *water* is a matter of so great consequence as to justify a slight deviation from formal strictness of design in allusion to it. Most of the places at which water is procured are denoted in Table 10 by the letter w, but there are some general suggestions on the subject which may be highly important on occasions, and which it is, therefore, worth while to collect here for reference, more especially as the various works through which they are scattered cannot be generally accessible to seamen.

(1.) The water carried by rivers into the sea is often found at a considerable distance beyond the mouth. For, a cubic foot of fresh

* Further, though ships now better preserve any given course, and the distance run is estimated more accurately than formerly, there are in modern iron ships elements of uncertainty about dead reckoning which still make it perilous to close the land, unless there are means of knowing *with certainty* when the ship is in dangerous proximity thereto.

water weighs 1000 oz. avoirdupois, while a foot of salt water weighs 1028 oz.; the fresh water is thus lighter than salt in the ratio of 100 to 103, or by 1 part in 34 parts; and hence, when running into salt water, diffuses itself over the surface, where it remains till mixed by the agitating effect of the wind or other causes. Numerous instances are recorded of fresh water being thus found at considerable distances from the shore. Dampier, whose interesting voyages contain sagacious remarks on almost every circumstance that deserves the attention of seamen, relates that, being about 2 miles outside a small river, near Achen, in Sumatra, they "found the water of a muddy grey colour, and on tasting it found it fresh;" and he adds that in such cases "we must dip but a little way down, for sometimes if the bucket goes but a foot deep it takes up salt water with the fresh." A similar circumstance happened to the crew of the Alceste's barge, when conveying Lord Amherst to Batavia, after the wreck of the ship, on his return from his embassy to China in 1817. Ships have watered two miles outside one of the mouths of the Mississippi, the end of the suction-hose being carefully kept just below the surface. On the like occasions it has been observed that the water has been fresh on one side of the ship and salt on the other, the difference (which of course is only superficial) being due, no doubt, to the protection afforded by the ship on one side against the effect of the wind to mix the waters.

(2.) When rain falls on sand contiguous to the sea, the sand protects it from agitation, and it may remain a considerable time unmixed with the salt water. Accordingly, water is often found, especially after a shower, by digging in sand, taking care to remove it slowly; and advantage may no doubt be occasionally taken of the vicinity of a sandy shore or island to recruit water.

The troops being greatly distressed for want of water in Egypt, Sir Sidney Smith pointed out, that wherever date-trees grow, water was to be found; and a hole having been dug by his directions near some trees of this kind, and a cask sunk in it, a supply was obtained.

Adm. W. H. Smyth (in his Memoir descriptive of the Resources &c. of Sicily and its Islands, London, 1824, p. 112) states that on both sides of the Channel (the Faro of Messina), pure, though rather hard, fresh water, is procured, by digging a hole in the sand, within two or three feet of the margin of the sea; this supply is obtained by the filtering of the fiumare (torrents), the beds of which, though apparently dry, are never utterly so. The shores here alluded to are wide and flat, and consist of sand and gravel.

In the sailing directions for the North Atlantic, it is stated that water is always procurable near the Is. de Los, by digging near the root of a cocoa-nut tree. Adm. Beechey describes water as found by digging in the coral rock and recommends selecting the higher spots, distant from the sea. Lieut. Ruxton (Naut. Mag. 1846, p. 12) states that water is procurable, notwithstanding discouraging appearances, at a trifling depth in the sand, on the S.W. coast of Africa, to the northward of Walvisch Bay. Extensive

tracts of coast, in different parts of the world, are, however, described as absolutely without water.

(3.) Water is often found by following the track of animals, which, whether wild or domesticated, form paths to watering places. It was by following a path made by goats at Ascension, that Dampier discovered the spring which bears his name. Capt. Fitz Roy states that water was found on Charles and James Islands in the Galapagos by following the track of the terrapin.

(4.) Boats' crews or survivors of a shipwreck may find it useful to know that rain-water and dew collect round the stems of plants which shoot leaves upwards. Dampier (Voyages to the Bay of Campeachy, p. 56) remarks that it is often obtained from wild pines. "These take root and grow upright from trees. The leaves hold a pint and a half or a quart. We stick our knives into the leaves, just above the root, and that lets out the water, which we catch in our hats, as I have done many times to my great relief."

The cocoanut-tree, the fruit of which is found plentifully, but not everywhere, in the tropics, and chiefly near the sea,* and whose singular and beautiful form, reaching to the height of between 40 and 110 feet, renders it a conspicuous object as a mark, is denoted in Table 10, on account of its value to seamen, by a special symbol. The natives near Cape Grenville, Australia, carry with them, when travelling inland where they are not likely to find water, the juicy roots of a shrub (Naut. Mag. 1847, p. 178). Captain Stokes remarks that a pint of water has been collected by a sponge from leaves in the morning, even on the S. coast of Australia, where the dews are not so heavy as on the N.W. coast (Discoveries in Australia, &c., in H.M.S. Beagle, 1837-43," vol. ii. p. 12).

(5.) Ice islands are frequently composed of pure fresh-water ice, which is found in pools on the surface,† or running down the sides; and watering in this manner is a general practice of ships in icy seas. It is often, however, difficult to land on ice; and in such circumstances Admiral Bellingshausen cannonaded an ice island, and sent the boats for the fragments splintered off.

A peculiar danger is incurred by landing, for the purpose of cutting away a portion, upon ice which, from the advanced period of the summer, or the warmth of the air or sea, tends towards dissolution. A blow of an axe may split the whole mass, and the two portions, in turning over to acquire a new position for floating, may engulph the boat and the persons employed. (Scoresby, Journal of a Voyage to the Northern Whale Fishery in the Baffin, in 1822, p. 300.) A mass of ice is likewise often liable to turn over, to float in a new position, in consequence of having undergone a change of form by thawing irregularly.

The pools of water on the ice are often brackish in the autumn,

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* This has long been remarked. Dampier records that the finest he had ever seen grew on Trieste, a small island off Sumatra, overflowed at spring-tides.

† In about 62° S. the U. S. Expl. Exped. found on an iceberg a pond of excellent water, an acre in extent, and 3 feet deep, covered with a scum of ice 10 inches thick.

when the ice becomes porous, and the salt water is drawn up by capillary attraction (Narrative of an Attempt to Reach the North Pole in Boats, by Capt. W. E. Parry, 1827).

Though excellent water is often obtained from ice, it appears by no means certain that this is always the case. Mr. Rae, who left Fort Churchill in July 1846, to explore the coast from "Dease and Simpson's furthest," to Fury and Hecla Straits, states "that they had much difficulty in finding water that was drinkable" (Naut. Mag. 1847, p. 620). Baron Vrangel (Le Nord de la Sibérie, Voyage, &c., 1822, &c.), mentions that the salt left by evaporation on the surface of the ice, is mixed with the snow that falls upon it, and eaten as salt with food, though bitter and aperient. He found the green transparent ice brackish, the blue, fresh.*

### 1. *Indications of Land.*

1035. The neighbourhood of land is often indicated by the presence of birds, and its position inferred from the direction in which they take their flight at sunset. Birds, however, are often found attending floating masses of seaweed, which they follow for the sake of fish, and which is found at all distances from land.

The sudden appearance of birds flying round the ships at night aroused the attention of the officer of the watch, and was thus the means of saving D'Entrecasteaux's squadron from great danger near New Caledonia (M. D'Urville's Voyage in the Astrolabe, 1826; Paris, 1833, vol. iv.)

Adm. Beechey remarks that birds fly near reefs and islands in the Low Archipelago, and calls the attention of seamen to this circumstance.

1036. It has generally been supposed that the appearance of particular birds denotes the land to be near. Cook remarks (1st Voy. vol. i. p. 53), that "they had been so often deceived that they ceased to look upon aquatic birds as sure signs of the vicinity of land." He observes (1st Voy. vol. ii. p. 37), that shags and some other birds seldom fly out of sight of land, and adds that he believes gannets, boobies, men-of-war birds, seldom go far out to sea. Sir E. Belcher, however, met constantly with the gannet, frigate-bird, tropic bird, and booby, at considerable distances from the land, in the N. Pacific (Narrative of a Voyage round the World in H.M.S. Sulphur, 1840). Cook considered divers a sign of land (1st Voy. vol. i. p. 47). Admiral Bellingshausen makes a similar remark† (Voyage of the Mirny and Vostok, vol. i. p. 215).

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* It is a mistake to suppose that merely filtering the water removes all noxious matters, as the process merely arrests, mechanically, solid particles. The Chinese purify water which has become offensive, by mixing half an ounce of alum to one ton, and leaving it for some time. Sir E. Home tried this with complete success in H.M.S. North Star (Naut. Mag. 1846, p. 625). This use of alum has long been known; powdered charcoal, and stirring clay in the water, have also been used.

† The stormy petrel (Mother Carey's chicken of sailors) is supposed to foretell wind; Bellingshausen remarks, on the contrary, that this bird made its appearance (at least near 4° N. and 20° W) before continued calms. Vol. i. p. 89.

Adm. Beechey remarks that black and white tern fly 40 miles from uninhabited islands, but desert altogether those that are inhabited.

1037. Dr. Scoresby observes that in the Arctic regions birds desert closing spaces in the ice, and repair to others which are opening.

1038 As a current of water, interrupted by the rising of a shoal or coast from the bottom of the sea, is carried upwards by the pressure from behind, and as the water below is, in warm and temperate climates, considerably colder than that on the surface, a fall in the temperature of the surface-water has often been found on approaching a shoal or the land, and the thermometer has accordingly been confidently recommended as a guide in coming into soundings. But it is evident that this effect must depend upon the relative coldness of the water above and below, and also upon the depth and other circumstances of the current, and it has been found that the indication is neither so constant, nor so marked, as to be depended upon. Capt. Foster, and more recently Capt. Fitz Roy found no such change on the Abrolhos. Sir E. Belcher (Voy. in H.M.S. Sulphur, 1840–1, vol. ii. p. 292) found no perceptible change on entering soundings off the Cape of Good Hope, or in the N. Pacific.

M. Du Petit Thouars (Voyage autour du Monde sur la Frégate La Vénus, 1836–9, vol. iii. p. 419) paid particular attention to this indication, and remarks that the observations generally shew a lowering of the thermometer on approaching land, but they disprove that the water on a bank is *always* colder.*

1039. The temperature of the sea has been observed to change several degrees, in intervals of time varying from a few hours to a day and a half previous to a change of wind, the water becoming gradually warmer when the wind was about to blow from a warm quarter, and colder in the contrary case. In squally weather the temperature has fluctuated.†

1040. The temperature of both the sea and the air is, however, so much influenced by the vicinity of ice in considerable mass, that the indications of the thermometer in such circumstances are highly important, more especially as fog, arising from the condensation of aqueous vapour by the cold, frequently occurs at the same time.

When the vessel is to leeward of the ice the air is greatly cooled; and, on the other hand, when the ice is to leeward and not far distant, the water through which it has drifted will be found colder than elsewhere.

1041. Amongst the signs of a near approach to land, on some occasions, are breakers. The depth of water at which they appear seems, however, very uncertain; and it is sometimes difficult to

* In the Gulf-stream, and on the banks of Newfoundland, the thermometer is said to be regular in its changes. (Purdy's Sailing Directions for the N. Atlantic.)

† Adm. Beechey records having made observations of this kind in the North Pacific, off C. Horn, and near Spitzbergen. (Beechey's Voyage to the Pacific, 8vo. vol. i. p. 323; Appendix, p. 390.)

distinguish between breakers and topping seas. The late Commander Mudge observed that a heavy swell often breaks in 9 or 10 fathoms, and always in 4 or 6; he adds that the swell is often heavier in a calm than in blowing weather. The sea is reported to break on the bar of the River Senegal in 8 fathoms.*

Mr. Thomas, master of H.M.S. Investigator, says that in the gale of August 1833, at the Shetlands, the sea broke over all rocks having less than 8 fathoms on them (Naut. Mag. 1835, p. 309).

1042. The only certain indication, in the absence of external signs, is the depth of water, when soundings can be obtained. Hence *sounding is an indispensable precaution*; and *neglecting to sound* has, in courts of inquiry and courts-martial, always been deemed *inexcusable*. *See* pp. 343, 344.

## 2. *Illusory Appearances.*

1043. While it is necessary to be on the alert for the discovery of danger, it is scarcely less so to be prepared against false alarms. For ex.: in a moonlight night, when blowing fresh, it is easy to fancy breakers and shoals, especially when on the look-out for them. Effects of light and shade have so much resembled breakers as to raise alarm; and sunbeams in the horizon, seen through rain, have been taken for rollers.—(Voyage of H.M.S. Sulphur.)

1044. Clouds and fog-banks often resemble land so much as to deceive an experienced eye. Sir Jas. C. Ross observes, that the vapour-line near the margin of ice in the polar regions is always taken for land by novices.

1045. Many reported islands or shoals, of which the accounts given have been apparently circumstantial, have, doubtless, been trees, fish, alive or dead, or ice islands. Phipps (Voyage to the North Pole in the Racehorse and Carcase, 1773, p. 57) took a small piece of ice covered with gravel for an island. Weddell (A Voyage towards the South Pole, 1822) records that it was only on passing 300 yards from an ice island that they ascertained it was not solid land, but ice covered with black earth. He also mentions having taken the swollen carcase of a dead whale for a rock,—a mistake of frequent occurrence. Sir Jas. Ross met with an iceberg which had turned over unperceived, and presented a new surface covered with earth and stones, so like an island, that nothing but landing on it convinced them to the contrary (vol. i. p. 195). Lieut. Wilkes records that a supposed rock turned out on examination to be a large tree covered with weeds and surrounded by fish (U.S. Expl. Exped.).

1046. Whales have probably, as Horsburgh remarks, been taken for rocks. These fish float at the surface for a long time together, and, being covered with barnacles, grass, or seaweed, exhibit an

* The sea is stated to have broken in 40 fathoms on the coast of Syria, in the gale of Dec. 1840 (Naut. Mag. 1841, p. 233).

appearance so like that of a rock that it is often difficult to believe the contrary.*

1047. The sound of breakers or surf has often been found to be caused by a shoal of fish. Kerguelen (Relation d'un Voyage dans la Mer du Nord, 1767–8, Paris, 1770, p. 121) saw a large shoal of small red fish that had the appearance of a sandbank, of the extent of two leagues, on which the sea was breaking, and the illusion was rendered the more complete by the great numbers of birds that accompanied it. Capt. Fitz Roy observes, that a shoal of fish seen under the water may have given rise to a report of a bank, which it much resembles. Weddell records having been alarmed in a fog by a cry of breakers, for which a noise produced by fish was taken. Most seamen's experience will supply similar instances.†

It has been remarked that it is very difficult at a distance to distinguish straggling ice and breakers from each other.

1048. A sound like that of guns is produced by the splitting of large masses of ice. Cook records an instance (1st Voyage, p. 47), and it is familiar to those who have been in the polar regions.

1049. The surface of the sea, in some parts of the world, is occasionally found streaked, for leagues together, by a matter which produces the "discoloured" aspect of shoal water, and which sailors suppose to be the spawn of fish. Water having this appearance is not approached without anxiety by those who are unaccustomed to it; and in those seas especially where coral reefs rise perpendicularly from very great depths, an increase of vigilance is demanded on such occasions.‡

1050. In these days, when the ocean is traversed by innumerable ships, appearances which were strange or alarming to the first navigators have become familiar; and the dangers which the enterprising men who first ventured upon an unknown sea were naturally disposed to multiply have disappeared from our charts. But in earlier times, when the solitary vessel had either no chart at all, or one put together from imperfect or incongruous materials, the feeble state of navigation justified the excess of caution in reporting as a danger every suspicious appearance.

Accounts, therefore, of new land or dangers, which are published from time to time, are not to be received without extreme caution, unless they state some circumstance which is decisive.

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* Sir F. Beaufort tells me, that in approaching the River Plate, in command of H.M.S. Woolwich, a whale was reported as a rock, and believed to be so by every one on board. But knowing that no rock existed in the situation, he steered direct for it, and when about 30 yards distant it dived. In H.M.S. Tyne, in the South Pacific, we bore up for what seemed to be the wreck of a ship floating, with her quarter raised out of the sea, but which, on approaching it, turned out to be a whale.

† To these or other circumstances, which have given rise to reports of shoals, may perhaps be added the shocks which have been experienced by ships striking against whales or other large fish.

‡ In the Alceste, while among imperfectly known parts of the Eastern Seas, we frequently passed through water thus tinged with some colouring matter. Mr. Darwin (Voyages of the Adventure and Beagle, vol. iii.) considers the effect to be produced by animalculæ.

### 3. *Dangers.*

1051. When the ship, going free, is found to be running into danger, the proper tack to haul to the wind upon is, generally speaking, that on which she will most rapidly increase her distance from it, because thus time will be gained.

1052. In high latitudes ice islands are often met with towards the close of the summer, or earlier. The presence of ice at night is often indicated by a peculiar effect of light, and in fog by a kind of blackness in the atmosphere (Scoresby's Arctic Regions, p. 255).

On falling in with ice the ship is recommended to pass to windward of it. It is observed that the smaller portions drift more quickly than larger ones, and that pieces of a round figure drift nearly before the wind, while angular pieces move irregularly.

Ice islands have been met with to the southward of the parallel of 50° N., in the Atlantic, and in the Southern Ocean in 36° S. The Captain of the *s.s. Forfarshire* reports that, in Jan. 1891 icebergs were met with in the following localities:—From lat. 51° 30′ S. to 49° 50′ S., and long. 46° 0′ W., sixty-three icebergs, half a mile to 3 miles long, and 200 to 300 feet high, were seen. Also an ice island, estimated to be over 30 miles in length and 300 to 400 feet high, was passed at the distance of about 5 miles.

From reports received there is reason to believe that icebergs may often be found in the positions given, and mariners are warned to give the localities a wide berth. See Admiralty Ice Chart, No. 1241; also Wind and Current Charts.

A remarkable diminution in the strength of the wind is experienced when to leeward of ice, even of very small extent. This is noticed by Sir E. Parry and by other navigators.

1053. There is also another source of danger, which appears to have increased of late years, and one less easily guarded against, in vessels which have been abandoned by their crews, in some cases unnecessarily, and which, having become more or less waterlogged, remain drifting about.

1054. To these may be added *rollers*, which term is applied to a very heavy swell rising on particular coasts, without any known cause, generally very quickly, and subsiding very soon, and which constitutes a formidable danger. H.M.S. *Julia* was wrecked in a calm at Tristan d'Acunha in a few minutes. More recently very severe loss was experienced at St. Helena. Rollers are noticed as a great danger on the coast of Guiana, where they break in 5 or 6 fathoms (Commander Darley in Naut. Mag. 1844, p. 649). The U. S. Expl. Expd. anchored off St. Francisco Nov. 1, 1841, the *Vincennes* being in 7 fathoms, and 3 miles off shore. About 10 P.M. the rollers got up and broke with the continued roar of a surf. At midnight a sea broke heavily on board the *Vincennes*, a ship of 780 tons, displaced the booms and boats, and killed a man. The other ships, in deeper water, felt no inconvenience.*

* Though great danger is incurred from breakers in shoal water, yet there are coasts on which the gradual shelving of the bottom dissipates the swell by degrees without causing a

### 4. *Determination of Position of Danger.*

1055. *Out of Sight of Land.*—When a rock, a shoal, or an island, is unexpectedly met with at sea, its bearing and estimated distance are to be noted, with the time by chronometer. As the true position can be determined by astronomical observation alone, the following directions are inserted for reference, the calculations being deferred to a convenient time.

(1.) When the *sun* is visible. Observe his altitude, noting the time by chronometer (see the note, No. 726). This gives the lat., Nos. 681, 696, or 718, or the time, No. 776, or 791, and thence the long. by chronometer.

(2.) When the *sun and moon* are visible. Observe both alts. with all possible care, and the lunar distance; the lat. is hence found, Nos. 681 or 692, 696 or 703, or 759, &c., and thence the time, and the long. by chron. or by lunar.

(3.) When the *moon* is visible. See Nos. 692, 703. In favourable cases the alt. gives the long., No. 864.

(4.) When the *moon and stars* are visible. Obtain the lunar distance, and both alts. with care. See, also, Nos. 864 and 866.

(5.) When the *stars* alone are visible. Observe altitudes near the meridian, and on opposite sides of the zenith, for lat.; and near the prime vertical for time and long. by chron.

Of the dangers to which navigation is exposed none is more formidable than a reef or a shoal in the open sea; not only from the almost certain fate of the ship and her crew that have the misfortune to strike upon it, but also from the anxiety with which the navigation of all vessels, within even a long distance, must be conducted, on account of the uncertainty to which their own reckonings are ever open. No commander of a vessel, therefore, who might meet unexpectedly with any such danger, could be excused, except by urgent circumstances, from taking the necessary steps both for ascertaining its true position, and for giving a description as complete as a prudent regard to his own safety allowed.

1056. *In Sight of Land.* The position of a rock or a shoal may be determined by cross-bearings (No. 366) when the variation and deviation are known. It may be determined more accurately by taking the bearings of three objects, and using the angle between the bearings (No. 368). The sextant may be used, in preference to the compass, for convenience and accuracy; the face should be held horizontal, and the angles measured between points vertically under the objects, or determined by plumb-lines conceived to pass through the objects. No. 368.

#### [1.] *Report of New Discovery, or Correction of Position.*

1057. In transmitting an account of a new discovery, or the correction of a position, the first consideration is the lat. or long., or

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dangerous break. On the coast of Barbary, in H.M.S. Adventure, under the command of Capt. W. H. Smyth, we frequently, when the wind was dead on shore, ran to leeward out of the sea, till we found a convenient depth of water for anchoring.

the situation with respect to some other place. Attention should therefore be directed to the instructions at No. 835. It will, indeed, be evident on a moment's reflection, that the long. described merely, as is too often the case, as "long. by chron." without reference to some fixed point, is utterly valueless. Again, when such fixed point is mentioned, it is no less necessary to note the long. adopted: for ex.: "Long. by chron. from Callao," is little better than no allusion to place at all, as Callao appears in the tables in different longs. from 77° 10·5′ to 77° 15·7′.

When the determination depends on a lunar, notice should be taken, 1. of the skill of the observer; 2. of the instrument; and especially whether distances on opposite sides of the moon are observed; also, 3. of the probable error of the time.

1058. After the position the point next in importance is the *extent*, and general direction, if this can be assigned. Then follows height or depth, with notice of the appearance; and then anchorage, landing, supplies, and natives. The seaman will find these matters of detail passed in review, in the same constant order, in the symbolised descriptions in Table 10; and he may render much service by taking the opportunity of recording these particulars on passing any of the numerous places of which we have no very exact accounts.*

It will often be important to notice both the extent and appearance of islands, which have not been visited for a long time. Krusenstern, in alluding to the growth of many islands by submarine formations, which are continually extending themselves, as established by Fleurieu, Flinders, and Beechey, remarks that Capt. Carteret discovered a small flat island so nearly at the level of the sea, as scarcely to deserve the name of an island, which he called *Osnaburgh*. It was on this island that the Matilda was wrecked in 1792, as is proved by the agreement of her observations with those of Adm. Beechey, who found here the wreck of a ship. Thus the "small island" had, in 1827, an extent of 14 miles (Mém. Hydr. 1835, p. 94).

Again, in warm climates, reefs at the level of the sea are covered by degrees with a low vegetation, which, in due time, is succeeded by trees. Many places, therefore, now known merely as reefs, or not noticed at all, will probably become hereafter conspicuous islands.

1059. Whenever a position is noted, the bearings of headlands and islands should be observed as accurately as possible. The neglect of this is seriously felt in the arrangement of positions.†

Seamen may also supply very important elements for correcting

* If, in sending home such accounts, the writer uses symbols, he must be very careful to draw them in their perfect form, lest one may be taken for another. The great saving of time and space which they effect claims the necessary attention in writing them legibly.

† In the third and later editions of this work a discrepancy was admitted in the positions of Tanna, Annatom, and Erronan, from the want of bearings, though the places are in sight of each other. Capt. Denham, of H.M.S. Torch, removed the difficulty.

the charts by observing with care the bearing of two points of land when seen in a line, or *on with each other*, or of a summit seen over a point. Such bearings are called *transit bearings.*

1060. Views should accompany all hydrographic notices, when there is any one on board who can draw. On these should be marked one or more bearings (selecting, first, that of the nearest point), and the angles measured by a sextant between remarkable points or other objects; also the angular elevations of summits, as these last serve for the determination of heights.

It is also important, where the range is considerable, to note the time of tide, because the rise or fall of several feet in the water may cause a material change in the appearance of the shore, and has also the effect of altering the apparent dimensions of an island with shelving shores. Again, when the spectator is on shore, the place of the visible horizon varies with the height of the tide, being nearer to him and higher, when the water is higher (or when he is less elevated above it), and further off and lower, as the water falls (or as he increases his relative height). The consequence of this is, that an island beyond the visible horizon appears to the spectator on shore to be of different lengths at different times of the tide.

A small pamphlet entitled "Notes bearing on the Navigation of H.M. Ships," lately issued by the Admiralty, will be found to contain much practical and useful information.

# EXPLANATION OF THE TABLES.

In this division of the work the use and application, and, in some degree, the construction, of the Tables, are described.

Rules are given for computing the terms in the Tables. These rules will be found useful for the purpose of verification; for the computation of an intermediate term instead of the ordinary interpolation; and also when the computer may require, for a particular object, to employ a table on a more extensive scale than would be convenient for the general purposes of the collection.

## NAVIGATION *

### THE SAILINGS.

These tables are used chiefly in the methods, Chapter III.

#### Table 1.

This is called the Traverse Table from its use in Traverse Sailing.

##### 1. *Direct Application.*

Table 1 contains the Diff. Lat. and Dep. for the Course at every degree, and for each mile of distance to 600 miles, with the time corresponding to each degree.

When the Course is given in points, it should be turned into degrees (No. 216). If it is less than 4 points or 45°, the table is to be entered at the top; but from the bottom when it exceeds 4 points or 45°.

Ex. 1. Course $2\frac{1}{2}$ pts., Dist. 74 miles; find the D. Lat. and Dep.

In Table 1, at $28° = 2\frac{1}{2}$ points, and against 74 in the Dist. column, are D. Lat. 65·3, and Dep. 34·7.

Ex. 2. Course 68°, Dist. 241 miles; find the D. Lat. and Dep.

In Table 1, over 68° at the bottom, and against 241, are D. Lat. 90·3, and Dep. 223·5.

* The general division of the subject into Navigation and Nautical Astronomy naturally suggests the like division among the Tables. But, besides this, the computer cannot, in general, make proper use of the Astronomical Tables unless acquainted beforehand with his position on the globe. The Tables, therefore, relating to this last point, that is, those which are concerned in finding the position of the ship with reference to the place left, necessarily precede the others. The Table of Positions, which is usually found at the end of a collection of tables, is, according to this disposition, placed among those relating to Departures, since in actual navigation it is referred to only with reference to the place of the ship.

The author is indebted to many individuals whose opinions are entitled to every consideration for suggestions relative to the arrangement or order. It will, however, be obvious that no arrangement can be devised which shall be equally convenient for all persons at all times; and, perhaps, no plan is open to fewer objections of weight than one in which regard is paid both to the classification of subjects and to the successive stages of the computations.

In like manner, in taking out the Course corresponding to a given D. Lat. and Dep., when the D. Lat. is greater than the Dep., take the Course from the top; when less, from the bottom.

(1.) To take out the D. Lat. or Dep. to a fraction of a degree.

Ex. To find the Dep. to 11°¼ and Dist. 100.

The Dep. to 11° is 19·1, that to 12° is 20·8; ¼ of the difference 1·7, or ·4, added to 19·1 gives 19·5, the DEP. required.

In finding the D. Lat. this prop. part is subtractive.

(2.) To find the D. Lat. or Dep. for a fractional Dist., as, for example, for 59·3; find it for 59, and then for 3 (dividing the last by 10).

(3.) When the given Dist. exceeds 600 miles, divide it by 10, and multiply the D. Lat. and Dep. found by 10. So, likewise, when the given D. Lat. or Dep. exceeds the limits of the Table, divide it by 10, and multiply the resulting Dist. by 10.

Ex. 1. Course 31°, Dist. 1872 miles. The Course 31°, and Dist. 187, give D. Lat. 160·3, and Dep. 96·3; hence the required D. Lat. and Dep. are 1603 and 963 nearly.

Ex. 2. D. Lat. 660, and Dep. 165, to find the Course and Dist. D. Lat. 66, and Dep. 16·5, give Course 14°, and Dist. 68; the required Dist. is, therefore, 680 nearly.

This is near enough in general. For greater accuracy, in Example 1, take out the D. Lat. or Dep. for 600, and for the excess above 600.

## 2. *Trigonometrical Quantities.*

If the angle A C B, fig., No. 162, be considered the Course, and A C the Distance, then A B becomes the Dep. and C B the D. Lat.

Hence, by No. 162, the *Dep.* corresponding to the *Dist.* 100 is the *sine* for the radius 100.

The *D. Lat.* to the *Dist.* 100 is the *cosine* for the radius 100.

In like manner, the *Dep.* to the *D. Lat.* 100 is the *tangent* for the radius 100.

The *Dist.* to the *D. Lat.* 100 is the *secant* to the radius 100.

Thus also the *D. Lat.* to the *Dep.* 100 is the *cotangent;* and the *Dist.* to the *Dep.* 100 is the *cosecant* to the same radius 100.

The trigonometrical quantities (which are calculated for radius 1) are deduced from the numbers thus found in the Traverse Table by marking off two decimals.

Ex. 1. Find the Sine of 27°. At the arc 27°, the Dist. 100 gives the Dep. 45·4. The SINE is, therefore, ·454, the log. of which is 9·657 (Nos. 58 (2) and 59, p. 19). This is the log. given in Table 68.

Ex. 2. Find the Cosine of 56°. At 56°, the D. Lat. to the Dist. 100 is 55·9, the COSINE is ·559, the log. of which is 9·747.

Ex. 3. Find the Tangent of 38°. At 38°, the D. Lat. 100 corresponds to Dep. 78·2, the TANGENT is ·782, the log. of which is 9·893.

Ex. 4. Find the Secant of 42°. At 42°, the D. Lat. 100 corresponds to the Dist. 134·6, the SECANT is 1·346, the log. of which is 0·129, or in Table 68, 10·129 (No. 166, *Note*).

Ex. 5. Find the Cotangent of 54°. At 54°, the Dep. 100 corresponds to D. Lat. 72·7 the COTANG. is ·727, the log. of which is 9·861.

Ex. 6. Find the Cosec. of 18°. At 18°, the Dep. 100 corresponds to Dist. 323·4, the COSEC. is 3·234, the log. of which is 0·510.

### [1.] *Solution of Right-Angled Triangles.*

These tables are useful in solving approximately cases of right-angled triangles, as also in roughly verifying the results of questions of the kind when obtained by logarithms.

Ex. p. 48. Angle A 50°, CA 28 feet, find AB and BC.
At 50°, the Dist. 28 gives the D. Lat. 18, which is AB, and the Dep. 21·4, or CB.

Ex. p. 49, Case II. Angle A 30°, BC 171; find AB and AC.
Course 30° and Dep. 85·5 give Dist. 171, or BC 342, and D. Lat. 148·1, or AC 296·2.

Ex. p. 49, Case III. AB 220·3, AC 101·9; find the Angle B and BC.
Dist. 220 and Dep. 103·3 are the nearest, and give 28° for the Angle B, and the D. Lat or BC 194.

## 8. *Proportional Quantities.*

Mr. A. C. Johnson, R.N., in his valuable pamphlet on "Finding Latitude and Longitude in Cloudy Weather,"* has shown how Table I. may be used to correct the Longitude for error in Latitude.

With the complement of the object's bearing at sights as a course, and error in Latitude as a Diff. Lat., take out Dep. This converted into Diff. Long. will be the correction required.

| | |
|---|---|
| East: When the true latitude is South of the approximate, and azimuth of object between N. and E., or between S. and W. Or when the true latitude is North of the approximate, and azimuth of object between S. and E., or between N. and W. | West: When the true latitude is South of the approximate, and azimuth of object between S. and E., or between N. and W. Or when the true latitude is North of the approximate, and azimuth of object between N. and E., or between S. and W. |

Ex. In Lat. 45° S., sun bearing S. 55° W., ship by observation was in long. 3°·45 W., but the error in lat. was found to be 18 m. South.

Complement of Azimuth 35°. Then Course 35° and Diff. Lat. 18′ give Dep. 12′·6. Dep. 12′·6 and Lat. 45° give Diff. Long. 18′. True lat. South of approximate, and azimuth between S. and correction is E.

| | |
|---|---|
| Long. from Observation ... ... ... ... ... ... | 3° 45′ W. |
| Correction ... ... ... ... ... ... ... ... | 18 E. |
| True Long... ... ... ... ... ... ... ... | 3 27 W. |

* Published by J. D. Potter, Agent for Admiralty Charts, 145 Minories.

[To face p. 378.

(1.) To turn *statute miles* into nautical or *geographical miles.*

1 statute mile = 0·8684 geogr. 1 geogr. mile = 1·1515 statute miles.
At 61°, the Dist. and Dep. correspond to *statute* and *geogr.* miles.

(2.) To turn *feet per second* into *nautical miles per hour.*

At 36°, the Dist. and Dep. correspond to *feet* and *miles*; thus the rate of 19 feet per second is 11 miles an hour, nearly.

The measures and soundings on foreign charts are reduced, in like manner, to our own scales.

### (1.) To turn *Danish Favne* into *English Fathoms.*

1 fav. = 1·0292 fath. 1 fath. = 0·9716 fav.

At 76°, the Dist. and Dep. correspond to *fathoms* and *favne*; thus, 100 favne are 103 fath. nearly.

### (2.) To turn *Danish Feet* into *English Feet.*

1 Dan. foot (*fod*) = 1·0270 Eng. feet. 1 Eng. foot = 0·9737 Dan ft.

At 77°, the Dist. and Dep. correspond to *English* and *Danish feet*; thus, 200 Danish feet are 205 English feet nearly.

### (3.) To turn *Dutch* (Amsterdam) *Feet* into *English Feet.*

1 Amst. foot = 0·9287 Eng. ft. 1 Eng. foot = 1·077 Amst. ft.

At 68°, the Dist. and Dep. correspond to *Dutch* and *English feet*. Thus, 300 Dutch feet are 278·2 English feet nearly.

### (4.) To turn *Dutch Palms* into *English Feet.*

1 palm = 0·3283 ft. 1 foot = 3·046 palms.

At 19°, Dist. and Dep. correspond to *palms* and *feet*. Thus, 100 palms are 32·6, or more nearly, 32·8 feet.

### (5.) To turn *French Brasses* into *English Fathoms.*

1 brasse = 0·888 fath. 1 fath. = 1·126 brasse.

At 62°, the Dist. and Dep. correspond to *brasses* and *fathoms*. Add 1 in 180. Thus 200 brasses are 176·6, or more nearly 177·6 fathoms.

### (6.) To turn *French Metres* into *English Yards.**

1 metre = 1·0936 yard. 1 yard = 0·9144 metre.

At 66°, the Dist. and Dep. correspond to *yards* and *metres*. Thus, 300 yards are 274·1 metres nearly.

### (7.) To turn *French Feet* (*Pieds*) into *English Feet.*

1 pied = 1·0658 ft. 1 foot = 0·9383 pied.

At 70°, the Dist. and Dep. correspond to *pieds* and *feet*. Thus, 200 pieds are 213 feet nearly.

### (8.) To turn *French Toises* into *English Fathoms.*

1 toise = 1·0658 fath. 1 fath. = 0·9383 toise.

At 70°, the Dist. and Dep. correspond to *toises* and *fathoms*. Thus, 200 toises are 213 fathoms nearly.

### (9.) For the *Prussian Foot* (*Fuss*), see *Danish.*

### (10.) To turn *Russian Arsheens* into *English Feet.*

1 arsh. = 2·3343 ft. 1 foot = 0·4284 arsh.

At 25°, the Dist. and Dep. correspond to *feet* and *arsheens*. Deduct 1 in 60. Thus 86 arsheens are 203 feet, or more nearly 200 feet.

### (11.) To turn *Russian Sashes* (*Sazhens*) into *English Fathoms.*

1 sazh. = 1·1671 fath. 1 fath. = 0·8568 sazh.

At 59°, the Dist. and Dep. correspond to *fathoms* and *sashes*. Thus, 300 fathoms are 257·1 sazhens. Thus, the *arsh.* = 28 in.; the *sazhen* = 7 f., and the *verst* (12) = 500 *sazhens.*

---

* The following French measures occur frequently :—

| | | | |
|---|---|---|---|
| 1 Myriametre | = 10,000 metres. | Metre | = 39·37079 Eng. in |
| 1 Kilometre | = 1000 | Decimetre = 1-10th met. | = 3·937079 |
| 1 Hectometre | = 100 | Centimetre = 1-100th met. | = 0·393708 |
| 1 Decametre | = 10 | Millimetre = 1-1000th met. | = 0·039371 |

To turn *Russian Versts* into *Nautical Miles.*

1 verst = 0·5759 mile. 1 mile = 1·7364 verst.

At 35°, the Dist. and Dep. correspond to *versts* and *miles*. Add 1 in 260. Thus, 300 versts are 172·1, or more nearly (adding ·6) 172·7 miles.

(13.) To turn *Spanish Brazas* into *English Fathoms.*

1 braza = 0·915 fath. 1 fath. = 1·092 braz.

At 66°, the Dist. and Dep. correspond to *brazas* and *fathoms*. Thus, 200 brazas are 183 fathoms nearly.

(14.) To turn *Spanish Varas* into *Yards*

1 vara = 0·9142 yard. 1 yard = 1·0964 var.

At 66°, the Dist. and Dep. correspond to *varas* and *yards*. Thus, 300 varas are 274·3 yards.

(15.) To turn *Swedish Feet* into *English Feet.*

1 Swed. foot (*fod*) = 0·9739 Eng. foot. 1 Eng. foot = 1·0268 Swed. foot.

At 77°, the Dist. and Dep. correspond to *Swedish* and *English feet*. Thus, 300 Swedish feet are 292·3 English feet.

*To compute a Term.* For the D. Lat. To the log. of the Dist. add the log cos. of the Course; the sum is the log. of the D. Lat

For the Dep. To the log. of the Dist. add the log. sine of the Course; the sum is the log. of the Dep.

## Table 3. Departure and Corresponding Difference of Longitude

This Table shews the number of minutes of Longitude in any number of nautical miles from 1 to 10, measured E. and W., in lats. under 70°.

Ex. 1. Lat. 49°, Dep. 27m.; find the D. Long.

| | | |
|---|---|---|
| 49°, | 20 (2 × 10) .......... | 30·48 |
| | 7 .................... | 10·67 |
| | D. Long. | 41·15 |

Ex. 2. Lat. 31° 30′, Dep. 8·7m.; find the D. Long.

| | | |
|---|---|---|
| 31°½, | 8 .................... | 9·38 |
| | 0·7 .................... | 0·82 |
| | D. Long. | 10·20 |

In general, interpolation for any fraction of a degree may be effected nearly enough at sight, as in Ex. 2; but when accuracy is required, find the D. Long. for the two whole degrees, including the fractional lat., take the diff. of the two results, and with it enter the col. headed D to 1°, take out the parts and *add* them.

Ex. 2, above.

| | | | |
|---|---|---|---|
| 31°, | 8 ........ | 9·33 | 9·33 |
| 32, | | 9·43 | |
| | D. to 1° | 0·10, for 30′, | + ·05 |
| | | | 9·38 |
| 31½, | 0·7 | | + ·82 |
| | | D. Long. | 10·20 |

The Table may often be useful in parallel and mid. lat. sailing; though, to be properly adapted to this purpose, it should be greatly extended. Its chief utility lies in the reduction or comparison of longitudes in plans not graduated.

*To compute a term.* To the log. of the Dep. add the log. sec of the Lat.; the sum (rejecting 10) is the log. of the D. Long.

## Table 4 Difference of Longitude and Corresponding Departure

This Table shews the number of nautical miles in any number of minutes of longitude from 1 to 10, in lats under 70°

Ex. 1. Lat. 64°, D. Long. 272′; find the Dep.

| | | |
|---|---|---|
| 64°, | 200 ................ | 88·0 |
| | 70 ................ | 30·7 |
| | 2 ................ | 0·9 |
| Dep. | | 119·6 |

Ex. 2. Lat. 22°½, D. Long. 4′·6; find the Dep

| | | |
|---|---|---|
| 22°, 4 ........... 3·71 | ........... | 3 71 |
| 23, 3·68 | | |
| D. to 1° 0·03, for 30′... | | — ·02 |
| | | 3·69 |
| 22½ 0·6 ........................ | | + ·56 |
| | Dep. | 4·25 |

The remarks on Table 3 apply to Table 4, except that the parts for the fraction of a degree are to be *subtracted*.

*To compute a term*. To the log. of the D. Long. add the log cos of the Lat.; the sum (rejecting 10) is the log. of the Dep

## Table 5. Spherical Traverse Table

This Table is named from its being used with the common or plane Traverse Table, in cases which involve Spherical Trigonometry.

The Table is entered with the *lesser* of two given arcs or angles at the top, and the other at the side; thus, to take out M and N for 64° and 15°, enter with 15° at the top and 64° at the side, then M is found 236·2, and N 54·9 *

Interpolation for a fraction of a degree is easy, because M and N always increase. In general, it is enough to take M or N at sight, as directed No. 19; thus, for ex., to find M for 59° 47′ and 66° 18′, that is, for 59¾ and 66¼, we may take 496.

For greater precision, take the differences between each two terms concerned, and proceed to proportion separately for each.

The Table solves by inspection, approximately only, but very expeditiously, several problems. This method, besides being near enough for many practical purposes, will often be useful as a check against mistakes in longer methods.

(1.) To find the Hour-angle from the alt. No. 613.

With the lat. and decl. find M and N. With the alt. as Course, and M as Dist. find the Dep.

When the lat. and decl. are of *contrary* names, take the *sum* of the Dep. and N. The course answering to this sum as D. Lat. and Dist. 100 is the Hour-angle required.

When the lat. and decl. are of the *same* name, take the *diff.* of the Dep. and N. When the Dep. *exceeds* N, the course answering to this Diff. as D. Lat. and Dist. 100 is the Hour-angle; but when the Dep. is *less* than N, the supplement of the said course is the Hour-angle.

Ex. 1. Lat. 15° 32′ N., decl. 8° 35′ S., alt. 15° 26′: required the Hour-angle.

| | | |
|---|---|---|
| 15°½ and 8°½, | M 104·9, | N 4·1 |
| 15°½ (alt.) and 105, | Dep. | 28·0 |
| | (*sum*) | 32·1 |

Hour-angle, $4^h 44^m$.

Ex. 2. Lat. 51° 10 S., decl. 19° 27′ N. alt. 11° 51′: required the Hour-angle.

| | | |
|---|---|---|
| 19°½ and 51°, | M 168·6, | N 44·7 |
| 11°¾ and 169, | Dep. | 34·4 |
| | (*sum*) | 79·1 |

Hour-angle, $2^h 31^m$.

* It will be perceived, on inspecting the examples, that after M and N are taken out to the given arcs, the arithmetical process is very similar in all the problems; very little practice will, therefore, render the several uses of the Table familiar. As the process of computation consists in the addition or subtraction of two numbers only, thus taken out by Inspection, it will be difficult, if not impossible, to find general solutions more concise. As M is always greater than N, they can never be confounded together.

It is because the Dep. always *increases* with the course, that it is used in preference to the D Lat. in the solutions by this Table, the rules being adapted accordingly

Ex. 3. Lat. 56° 50′ S., decl. 56° 10′ S., alt. 64° 47′: required the Hour-angle.

57° and 56°, M 328·3, N 228·3
65° and 328, Dep. 297·3
(*diff.*) 69·0

Hour-angle, $3^h\ 5^m$ (since the Dep. *exceeds* N).

Ex 4. Lat. 47° 3′ N., decl. 22° 37′ N. alt. 8° 20′: required the Hour-angle.

47° and 22°½, M 158·7, N 44·4
8°½ and 159, Dep 23·0
(*diff.*) 21·4

Course, $5^h\ 11^m$; or Hour-angle, $6^h\ 49^m$ (since the Dep. is *less* than N).

When the lat. or the decl is 0, N is 0, and the Dep. is to be taken as the D. Lat. to 100; the Course corresponding is the Hour-angle required.

Ex. 5. Lat. 0°, decl. 14° N. or S., alt. 27°: required the Hour-angle.

0 and 14°, M 103·1
27° and 103, Dep. 46·8
Hour-angle, $4^h\ 8^m$.

Ex. 6. Lat. 38° N. or S., decl. 0°, alt. 27°: required the Hour-angle.

0° and 38°, M 126·9
27° and 127, Dep. 57·7
Hour-angle, $3^h\ 40^m$.

(2.) To find the Hour-angle on the Prime Vertical, No. 618.

With the decl. and colat. find N; with 100 as Dist. and N as D Lat find the Course.

Ex. Lat. 31°, decl. 14°. 14° and 59° give N. 41·5; 100 Dist. and 41·5 D. Lat. give Hour-angle $4^h\ 22^m$.

(3.) To find the Hour-angle at rising and setting, No. 620.

With the lat. and decl. take out N. With the Dist. 100 and N as D. Lat. find the Course.

When the lat. and decl. are of *contrary* names, this is the Hour-angle required; when of the *same* name, take the *suppl.* to 12 hours.

Ex. 1. Lat. 51° N., decl. 27° N.: find the Hour-angle at rising or setting.

27° and 51° give N 62·9

Dist. 100 and D. Lat. 62·9 give Course $3^h\ 24^m$, and the Hour-angle required $8^h\ 36^m$.

Ex. 2. Lat. 31° N., decl. 40° S.: find the Hour-angle at rising or setting.

31° and 40° give N 50·4

100 and 50·4 give $4^h$, the Hour-angle required.

(4.) To find the effect of Refraction, &c. on the above, No. 638.

With the lat. and decl. take out M. With M as Dep. and the Hour-angle at rising or setting as Course, take out the Dist. Multiply this Dist. by the sum of 34′ and the depression to the height, Table 8; the product divided by 1500 is the portion of time required in min. and decimals.

Ex. 1, No. 638. Lat. 28° and Decl. 16° give M 117·8. Then Lat. 28° N. and Decl. 16° N. give Hour-angle at setting, $6^h\ 35^m$. The suppl. of this, as it exceeds $6^h$, or $5^h\ 25^m$ as Course, and Dep. 117·8, give Dist. 119.

Dist. 119 mult. by 34 + 117, or 151, is 17969; which, ÷ by 1500, gives $11^m$·9.

(5.) To find the Time of Twilight, No. 641.

With the lat. and the sun's decl. find M and N. With the Course 18° and the Dist. M find the departure.

When the lat. and decl. are of *same* name, *add* this dep. to N; the Course corresponding to the sum as D. Lat. and Dist. 100 is the A. T. of the beginning of twilight, A.M.

When the lat. and decl. are of *contrary* names, take the diff. between the above Dep. and N; the Course corresponding to this diff. as D. Lat. and Dist. 100 is the time twilight *begins*, A.M., when the Dep. is *greater* than N; and the time it *ends*, P.M., when the Dep. is *less* than N.

Each of these times is the supplement of the other to $12^h$.

Ex. Lat. 30° N., sun's decl. 20° N.: required Beginning and End of Twilight.

20° and 30° give M 122·9 and N 21. Course 18° and Dist. 123 give Dep. 38 (greater), same name) sum 59. Dist. 100 and D. Lat. 59 give Course $3^h\ 56^m$, the time it Begins A.M.; hence it Ends at $8^h\ 24^m$ P.M.

(6.) To find the altitude on the Prime Vertical, No. 664.

With 0 and the colat. find M. With the decl. as Course and M as Dist. find the Dep. With Dist. 100 and this Dep. find the Course.

Ex. Lat. 52°, Decl. 22°. 0 and 38° give M 126·9, 22° and Dist. 127 give Dep. 47·6. Dist. 100 and 47·6 give Course or Alt. 28°½.

Ex. 3, No. 665 (worked to the *nearest degree*), gives Dep. 100, equal to the Dist. which means that the Alt. is 90°, or it is an extreme case.

(7.) To find the Altitude, the Hour-angle being given, No. 666.

With the lat. and decl. take out M and N. With the compl. of the hour-angle to $6^h$ as a Course, and Dist. 100, find the Dep.

When the lat. and decl. are of *contrary* names, take the *diff.* of this Dep. and N. When the lat. and decl. are of the *same* name; if the hour-angle is *less* than $6^h$, take the *sum* of the Dep. and N; if *greater* than $6^h$, take the *diff.*

With this sum, or diff., as Dep. and M as Dist. find the Course, which is the alt. required.

Ex. 1. Lat. 15° 32′ N., decl. 8° 35′ S., Hour-angle, $4^h\ 45^m$: required the Alt.

8°½ and 15°½, M 104·9, N 4·1<br>
$1^h\ 15^m$ and Dist. 100 Dep. 32·2<br>
(*cont.* name), *diff.* 28·1

Dist. 105 and Dep. 28·1 give Co. 15°½ the Alt.

Ex. 2. Lat. 47° 3′ N., decl. 22° 37′ N., Hour-angle, $6^h\ 50^m$.

22°½ and 47°, M 158·7, N 44·4<br>
$0^h\ 50^m$ and 100 Dep. 21·6<br>
(*diff.*) 22·8

159 and Dep. 22·8 give Alt. 8°.

Ex. 3. Lat. 56° 50′ N., decl. 56° 10′ N., Hour-angle, $3^h\ 5^m$.

56° and 57°, M 328·3, N 228·3<br>
$2^h\ 55^m$ and 100. Dep. 69·0<br>
(*sum*) 297·3

164·1 and 148·6 give Alt. 65°.

Ex. 4. Lat. 22° S., decl. 3° N., Hour-angle, $2^h\ 15^m$.

3° and 22°, M 108·0, N 2·1<br>
$3^h\ 45^m$ 82·9<br>
(*diff.*) 80·8

Alt. 49°.

When the lat. or decl. is 0, N is 0, and the Dep. taken as Dep., with M as Dist. gives the course. When both lat. and decl. are 0, the alt. is the compl. of the hour-angle in arc.

(8.) To find the Azimuth, the Altitude being given, No. 673.

With the lat. and alt. take out M and N. With the decl. as course, and M as Dist., find the Dep.

When the lat. and decl. are of *contrary* names, take the *sum* of this Dep. and N; when of the *same* name, their *difference*.

With the dist. 100, and this sum or diff. as D. Lat., find the course, which is the azimuth required.

When the lat. and decl. are of *contrary* names, this azimuth is to be reckoned from the S. in N. lat. and from the N. in S. lat. When they are of the *same* name,—when the Dep. is *less* than N, reckon the azimuth from the S. in N. lat., and from the N. in S. lat.; when the dep. is *greater* than N, reckon the azimuth from the elevated pole, or from the N. in N. lat.

The azimuth is reckoned E. or W. as the celestial body is to the E. or W of the merid. at the time proposed.

Ex. 1. Lat. 10° S., alt. 58° 40′ to E-d., decl. 14° 24′ N. (*contrary* names).

| | | |
|---|---|---|
| 10° and 58°½ | M 195·8 | N 29·0 |
| 14°½ and 196 | | Dep. 49·0 |
| | (*sum*) | 78·0 |

100 and D. Lat. 78·0 give 39°½, the Azim. req., which (in S. lat.) is N. 39°½ E.

Ex. 2. Lat. 51° 30′ N., alt. of Arcturus 40° 25′ to W-d., decl. 20° 2′ N. (*same* name).

| | | |
|---|---|---|
| 51°½ and 40°½ | M 211·2 | N 107·3 |
| 20° and 211 | | Dep. 72·2 |
| | (*dif.*) | 35·1 |

100 and D. Lat. 35·1 give 69°½, or Azim. req., S. 69°½ W., as the Dep. is the *lesser*

When the Lat. is 0, N is 0, and the Dep. itself becomes the D. Lat., which, with Dist. 100, gives the Course.

When the Declin. is 0, the Dep. is 0, and N becomes the D. Lat., which, with Dist. 100, gives the Course.

Ex. 3. Lat. o, declin. 21° N., alt. 61°.

| | | |
|---|---|---|
| Lat. o and 61 | M 206·3 | N o |
| 21 and 206·3 | Dep. 73·8 | |

100 and D. Lat. 73·8 give 42°½, the Azimuth.

Ex. 4. Lat. 48° S., decl. o, alt. 34°.

| | | |
|---|---|---|
| 48° and 34° | M 180·3 | N 74·9 |
| o and 180·3 | Dep. | o |

100 and 74·9 give Course 41°½, the Azimuth.

*To compute M and N.** For M, add together the log. secants of the given arcs, add 2 to the index, and reject the tens; the sum is the log. of M. For N, add together the log. tangents, and proceed as for M.

Ex. Find M and N for 15° 40′ and 69° 11′.

| | | | | |
|---|---|---|---|---|
| 15° 40′ | log. sec. | 0·01644 | log. tan. | 9·44787 |
| 69 11 | log. sec. | 0·44931 | log. tan. | 0·41999 |
| M 292·2 | log. | 2·46575 | N 73·8 log. | 1·86786 |

## Table 6. Meridional Parts.

These are the number of minutes corresponding to each degree and minute of lat. on Mercator's chart. For ex., the mer. parts to lat. 39° 12′ are 2560.†

The mer. parts are given to each minute of latitude as far as 78°.

*To compute a Term.* Add 45° to half the latitude, and take out the log. tan. of this sum (rejecting 10), take away the decimal mark.

The process may now be completed *arithmetically*, thus:—Complete this number to 7 figures by annexing ciphers, or, if the index is 11, to 8 figures, and multiply by 0·00079157.

But it is more convenient to use logs. Consider the log. tan. thus prepared, as a natural number, and take out its logarithm. When the lat. is less than 13° 6′ prefix the index 5, when between 13° 6′ and 78° 34′ 44″ prefix 6, and when above this last, 7. Add the const. log. 6·898489; the sum is the log. of the mer. parts.

---

* By the plane Traverse Table. With the greater arc as a course, and D. Lat. 100, take out the Dist. and Dep. With the other arc as course, and the said Dist. as D. Lat., take out the Dist.; this is M. With the said Dep. as D. Lat. take out the Dep.; this is N.

When the D. Lat. 100 is not found exactly, take out the Dist. and Dep. for the next less, and add the Dist. due to the defect from 100.

Ex. Find M and N to 20° and 42°. The Course 42° and D. Lat. 100 give Dist. 134·6, and Dep. 90·0. Then 20° and D. Lat. 134·6, give the Dist. or M 143·2, and the D. Lat. 90 gives Dep. or N 32·8

All the methods by Inspection may thus be effected by the plane Traverse Table.

† The nearest unit is, of course, enough in navigation. In the construction of charts two decimals may be necessary, and recourse may be had to Dr. Inman's, or Mendoza Rios's Tables.

Ex. 1. Find the Mer. Pts. for the Lat. 3° 19′.

2) 3° 19

1 39½ } 46° 39′½ log. tan. 10·025154
45 }

Arithmetically. Annexing 2 ciphers gives 2515400, which multiply by 0·00079157 = 199·112.

| | | |
|---|---|---|
| By logs. 2515 | log. | ·400538 |
| 4 | | 70 |
| Index 5, | | 5·400608 |
| | Const. | 6·898489 |
| Mer. Pts. 199·11 | log. | 2·299097 |

Ex. 2. Find the Mer. Parts for Lat. 58° 50′

2) 58° 50

29 25 } 74° 25
45 } log. tan. 10·554565

| | | |
|---|---|---|
| 5545 | log. | ·743902 |
| 6 | | 47 |
| 5 | | 4 |
| Index 6, | | 6·743953 |
| | Const. | 6·898489 |
| Mer. Pts. 4389·77 | log. | 3·642442 |

Ex. 3. Find the Mer. Parts for the Lat 78° 36′.

The log. tan. is 11·000812, the index prefixed 7, Mer. Parts 7922·13.

The 6th figure in using tables to 6 places, will often be in error nearly 1; hence the mer. parts may be in error nearly ·01, or 1-100th of a mile, or nearly 60 ft.

Note.—If the Spheroidal Mer. Pts. are required, enter the Traverse table with the lat. as a Course and 21·4 as a Dist.: the Dep. will be the reduction required. Ex. lat. 51° has Mer. Pts. 3569: Course 51° and Dist. 21·4 has Dep. 17: then 3569 − 17 = 3552, Spheroidal Mer. Pts. for 51°.

## DEPARTURES.

These Tables are used in the methods, chap. iv. p. 137.

### Table 7. For finding the Distance of an Object by two Bearings and the Distance run between them.

The use of this Table is described in No. 350.

*To compute a Term.* To the log. sine of the difference between the course and the 1st bearing, add the log. cosec. of the diff. between the difference of the course and the 1st bearing and that of the course and the 2d bearing; the sum (rejecting tens) is the log. of the term.

### Table 8. True Depression of the Sea-Horizon.

This Table contains the Depression to each minute as far as 240, with its square, and the corresponding height in feet.

The Depression is the Distance of the visible horizon, No. 205.

The Table may be also useful for reference, as containing the squares and square roots of several numbers.

*To compute a Term.* Multiply the square root of the height in feet by 1·063. Or, for greater precision, to the const. log. 6·49034, add half the log. of the height in feet; the sum is the log. tangent (or log. sine nearly enough) of the depression.*

Approximately, the dist. visible in miles is the square root of the height in feet, an accidental relation easy to remember.

* As the lower latitudes are more frequented by shipping than the higher, 40° has been assumed as the average latitude. Also, as the curvature of the earth is different on the prime vertical and on the meridian, the circle of curvature, crossing the meridian at 45° of azimuth, has been employed. The depression is accordingly computed to the radius 20,909.577 feet which gives the length of the average nautical mile 6082 feet nearly. See Table 64A.

Ex. Find the True Depression for the height 107 feet.

By Table 8 the square root of 107 is seen to be 10⅓, or 10·3 nearly.

Then 10·3 × 1·063 = 10·9 the Tr. Depr.

| | | |
|---|---|---|
| Square root of $\frac{2}{20909577}$ | = Const. | 6·4903 |
| Log. of 107, | 2·0294., | 1·0147 |
| Tr. Depr. | 11′ 0″ | sin. 7·5050 |

## Table 9. Number of Feet subtending an Angle of 1′.

This Table gives, by simple proportion, the number of feet subtending an angle of any number of minutes and seconds within 3° or 4°, for any distance in nautical miles. It is very convenient for finding approximately the distance in miles of an object of given dimensions, as also the dimensions of an object seen under a given angle at a given distance.

The simplest way of using the Table is to find from the question the number of feet subtending 1′.

Ex. 1. The angular height of a mast-head, 138 feet high above the water-line of the vessel, and no horizon intervening, is 9′: required the Distance of the Vessel.

138 ÷ 9 gives 15·3 feet, which subtends 1′ at nearly 9 miles, the Dist. required.

Ex. 2. The distance between two vertical lights is 60 feet, and the angle it subtends is 4: required the Distance of the Light-house.

60 ÷ 4 gives 15 feet for 1′, and Dist. required 8½ miles.

Ex. 3. The length of a vessel from the stern to the jib-boom end is 198 feet, and she subtends (when seen exactly, or nearly, broadside on), 27′: required her Distance.

198 ÷ 27 gives 7·3 feet to 1′, and Dist. required 4 miles.

Ex. 4. A cliff distant 5½ miles subtends a vertical angle of 39′ (above the water or surf line): required its Height.

At 5½ miles 9·72 feet subtend 1′, and 39 × 9·72, 379 feet, the Height required.

The number of feet in the Table corresponds nearly to the number of miles increased by ¾ of itself; thus, 8 miles gives 14 feet.

*To compute a Term.* To the log of the dist. in feet add 30103 (the log. of 2) and the log. tan. of half the angle proposed (here 1′): the sum is the log. of the term required.

## Table 10. Maritime Positions.

*Order of Places.* The places follow each other in their order along the coasts, except where it is convenient to pass to an island or shoal adjoining, after which the coast is again continued.

The Alphabetical Index at p. 540 removes the difficulty which would otherwise be experienced in searching for a particular place under any arrangement whatever of islands irregularly placed in the ocean.

*Names in the Side Columns.* The names of countries and seas inserted at the side of each column are intended merely to assist the forming of a general idea of the contents of the page, and are not to be considered as accurately defining geographical or political divisions.

*Mountains.* Mountains visible from the sea are inserted, as convenient for taking departures, and for the examination of the compass. The heights

of summits (to the tops of trees) are given in feet; when the height is considerable, and not accurately known, the distance in *leagues*, at which it is visible, is given instead of the height. The height may on many occasions be the means of identifying the land.* When the height precedes the point of which the position is given, it applies to the summit of the island or cape.

*Lights.* The descriptions of lighthouses are in most cases given. In the case of two lights, the height, and also the position, relate to the highest. See also pp. 402, 403.

*Heights.* All the heights taken from the latest Admiralty charts are reckoned from *high water*, in order to throw the error due to a difference in the height of the tide on the safe side. For ex., a light 120 feet above high water, seen at a certain (angular) altitude, places the ship 2 miles off. Now, at any other time of tide, the height exceeds 120 feet, and, in order to view it under the same angle, the ship must be more than 2 miles off; that is, the ship is really further off than is supposed, which is as it should be.

*Secondary Meridians.* These are the places in small capitals. See p. 392.

*Latitudes and Longitudes.* The Latitudes of ports are given to the nearest tenth of 1′; that is, to 6″. The error due to this manner of notation cannot exceed 3″, which is a quantity not worth dispute, except in fixed observatories.

The Longitudes of ports are given to those tenths only of 1′ which correspond to the nearest *second of time.* These are ·25, ·5, and ·75; the ·05 being dropped, ·2 stands for $1^s$ (or 15″), ·5 for $2^s$ (or 30″), and ·7 for $3^s$ (or 45″); that is, the seconds of time are, in round numbers, *half* the number of tenths: thus, 27′·2 is read 27′ 15″, or $1^m\ 48^s$ and $1^s$, or $1^m\ 49^s$. The 2 and 7 used thus are distinguished by a dot below. By this slight change in the notation, we are enabled to employ at once the diff. long as deduced by the Traverse Table in minutes of arcs and tenths, while we preserve the utmost precision that can ever be required in practice.†

As 1′ of long is $4^s$ of time, the error of neglecting the seconds in the longitude cannot exceed $2^s$.

The omission of the tenths in the longitude, when those of the latitude are given, implies that such longitude is not well determined. The *tenths* of 1′ noted in several longitudes do not, however, always imply precisely this degree of accuracy in the position, but serve to indicate stations to which the longitudes of places, not very distant, may conveniently be referred.

The positions of headlands, which are generally passed at the distance of some leagues, are given to the nearest minute only, in order to relieve the

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* It does not consist with the design of this volume to give rules for determining the height of the land from the observation of its altitude with a sextant. But when the distance of the ship from the land is known, it will always be easy, by observing the altitude and *assuming* a height, to find whether the assumed height agrees or not with the known distance, by means of the rules in chap. iv. p. 139, and thus by a trial or two the true height will be obtained nearly. As the height of the land is a very important element in navigation and maritime geography, seamen may render essential service by taking advantage of favourable opportunities of determining heights in this way.

† Admiral W. F. W. Owen has employed this method of notation in his Table of latitudes and longitudes, as more convenient in actual navigation, than that of seconds

computation from useless details. When the position falls on a half min. it is marked ½ a min. to *seaward*, to throw the error on the safe side.

The position relates to the last-mentioned point (not in parentheses).

*Groups of Islands.* All groups of islands, and all single islands, rocks or shoals, recorded, are inserted. In many groups all the islands are noticed; where this is not necessary, those marking the limits are given.

*Submarine Volcanoes.* Between the lats. 7° N. 1° S., and long. 16° and 24° W., several ships have met with ashes or experienced shocks. Krusenstern, on May 9th, 1806, saw, in 2° 43′ S., 20° 33′ W., a column of smoke, which shot up at intervals. There is little doubt, therefore, that the region is volcanic; and though Capt. Wickham, in H.M.S. *Beagle*, found no bottom at 190 fathoms in 1° 55′ S., 23° W., it is not unlikely that a shoal may at some time appear, and on this account the attention of seamen is directed to this region in column (41).

It may be remarked here, that land suddenly thrown up has quickly sunk again.

*Orthography.* In the names of places, of which the native alphabet does not correspond to ours, or where the language is unwritten, the reader must expect some trifling inconsistencies, owing partly to our own irregular orthography. We have followed chiefly the Hydrographic Office, which employs the Italian vowels, with some modification. Thus, *a* as in *father*, *ai* as i (English) in *shine*; *au* as ow (English) in *cow* (Dutch ow); *e* as a (English) in *face*; *u* (or *ou* in some cases) as oo (English) in *fool*, or u in *sure* (French *ou*, Dutch *oe*). For ex., *Apia*, pronounced Ah-pee-a; *Mitiéro*, pronounced Mee-tee-air-o; *Manua*, pronounced Man-oo-a, not Manyúa. Cook's "Whytootackie" is spelt *Aitutaki*, as by the missionaries, who, wherever they have instructed the Pacific islanders in writing, have wisely given them the Italian vowels. Some names we preserve in forms already known to our seamen, as Nareenda, Toofooa (pronounced *Narínda*, *Toufoua*), &c., as also Otaheite (*Tahiti*), in which the *o* is not, however, absolutely, erroneous.

We have sometimes marked the pronunciation by an accent, as Battantá, Galápagos, Tongatábou, &c.

It must, however, always be borne in mind that each different people calls the same place by different names; this accounts for the discrepancies in names given to numerous islands.

*Notation and Details.* Everything in parentheses is additional information (to be explained under the Symbols), but which does not relate to the position.

Ex. Col. (30) C. Xyli (pk. 1040 f., N 1′·5) . . . denotes that there is a pk., &c., but the *position* is of C. Xyli.

Col. (55) Ras Gurdim ⊥ (rk S.E. 3m.) denotes there is a rock, &c., but the *position* is of Ras Gurdim.

Col. (81) Pt. Sipang, a $\overline{\text{rk}}$ (rks. 5m.) . . . denotes a rk. (awash) off Pt. S—, and rks. also 5m. out, but the *position* is that of the rock close off.

The seaman must draw no conclusions from the *absence* of details; he is not, for example, to infer that a place is safe merely because it is not marked dangerous.

*Uses of the Table.* This Table has, in navigation, two applications: 1st. It furnishes points of departure in leaving and in making the land, under which head are included, also, islands made in passages, and dangers to be

avoided in shaping the course; 2nd. It gives the positions of ports and anchorages for the more complete regulation of the chronometer. Places, therefore, not belonging to one or the other of these two classes are unnecessary, because, in such circumstances, generally, the ship is either in pilot-water, or is navigated by the chart alone.

Lights, however, are inserted in greater number, because a ship in a fog may pass an outer light unseen, and learn her position from an inner one.

### 1. *Arrangement of the Positions.*

It is proper here to describe the principles on which this Table has been constructed, and to which allusion was made in the preface to the first edition.

It will be admitted, as remarked (pref. p. viii), that the *relative* positions of places are of much greater consequence in navigation than their *absolute* positions. For no astronomical observations taken at sea can be implicitly depended upon within at least one minute, and the chronometer, in consequence of not preserving exactly the same rate, ceases, after some days, to afford the true longitude of the ship. Since, therefore, the absolute longitude of the ship herself cannot be determined with certainty, the knowledge of the precise longitude of any position, as a rock, or a shoal, which she may be near, is but of little service. But, on the other hand, a tolerably good account of the ship's change of place, in short intervals of time, is afforded by a chronometer even of inferior quality, and hence it becomes of paramount importance that the places which the navigator employs as points of departure should be rightly placed *with respect to each other*, whether they are in their true positions or not.

Previously to Cook's voyages, which may be considered as the commencement of modern hydrography, the only method (besides the rude and imperfect determination of the ship's run) of obtaining the longitude of every new land made, was the lunar observation. But as that method, from its inaccuracy, fails altogether in exhibiting truly relative positions (No. 1008), chronometers were employed in combining together the results of observations taken at different places, of which numerous instances are recorded by Horsburgh in his East India Directory. Since, however, the observations made at two places are not in general equally good, this method of combining observations with chronometric differences has the disadvantage of impairing the better determination of the two, and in consequence throws a difficulty over the connexion of either of them with a third place better known. Succeeding navigators, proceeding in the same way, have obtained other results of observation, and other chronometric differences; and, in consequence, the hydrographer who has not the means afforded him of instituting a critical examination of the several positions, or of their connexion with each other, is driven to the necessity of taking a mean between each new result and those adopted from former navigators, and thus the whole mass of positions is kept in a state of perpetual fluctuation, from which it is impossible that universal precision can ever be obtained.

In marine surveys, again, different meridians have been assumed, and different longitudes of the same meridian. In some cases the long. of the meridian assumed has not been given; in others, the meridian itself has not been specified at all.

If, however, instead of thus throwing open the discussion of every place at each new voyage of discovery or surveying expedition, and unsettling all that had previously been done, without any assurance that the new series of positions would not in its turn be unsettled again, navigators and hydrographers would agree to *consider*, for the time being only, certain important stations, as already established in longitude, whether really so or not, with the view of referring all the subordinate positions to them, the indistinctness which now hangs over absolute and relative position would be forthwith cleared up. The question would be narrowed into the determination of *chronometric differences* alone, until favourable opportunity occurred for the definitive determination of a fundamental position. Accurate chronometric measures would be no longer lost to the world by being merged in the uncertain results of a few astronomical observations; and the labours of each navigator would always maintain their proper value, instead of being set aside, as they must inevitably be, on the appearance of a new survey, in which the data are exhibited in a distinct form. The works of different navigators, and of the navigators of different countries, could be brought into immediate comparison, a task which is at present often difficult and unsatisfactory, if not impossible. The labours of the hydrographer would be materially simplified; and as the points to which inquiry should next be directed would, by this system, be distinctly brought into view, the whole subject would advance steadily to its ultimate perfection.

The following instances may be cited in illustration:—The long. of Rio de Janeiro (Fort Villagagnon) had been by some stated to be 43° 15′, by others 43° 9′, while both parties adopted 56° 13′ as the long. of Monte Video (Rat Island). Now the true D. Long. of these places is $52^m\ 18^s$, probably within $1^s$ or $2^s$, certainly within $4^s$; but the diff. of 43° 15′ and 56° 13′ is $51^m\ 52^s$, or an error is admitted on one side of $26^s$ in a run of about 10 days. Had attention been earlier directed to differences of longitude as measured from fundamental points, such inconsistencies would speedily have disappeared.

Accordingly, it was proposed (Naut. Mag. 1839, On the longitudes of the principal maritime points of the globe) to adopt certain points under the name of *Secondary Meridians*, this general term being used to distinguish them from the *prime* meridians, as Greenwich, Paris, &c., from which the longitudes in the tables or on the charts must be reckoned. The longitudes (from Greenwich) accepted for the *Secondary Meridians*, on which Table 10, and the Admiralty Charts now (1898) depend, have been amended from Telegraphic determinations to 1887.* The points selected are so far distant from each other that the errors of their relative positions could not be easily discoverable by the ship's chronometers; and they must themselves depend on astronomical observations, of which it is important to remark, the number necessary for an unimpugnable determination appears to be very great. The Secondary Meridians, with the districts for which they are intended generally to serve, and their adopted longitudes, *from Greenwich*, are as follows:—

* The number of Secondary Meridians in the last edition was 25; considerable corrections and additions have now been made.

## Table of Longitudes accepted for Secondary Meridians.

### SHORES OF ATLANTIC OCEAN, AND NEIGHBOURING SEAS.

| | ° ′ ″ | | h. m. s. | |
|---|---|---|---|---|
| Copenhagen (*Observatory*) | 12 34 48 E. | = | 0 50 19·2 | Kattegat, Coasts of Norway; Sweden. |
| St. Petersburg (*Pulkowa Observatory*) | 30 19 40 E. | = | 2 01 18·7 | Baltic, White, and Black Seas. |
| Paris (*Observatory*) | 2 20 15 E. | = | 0 09 21·0 | Coasts of France. West coast of Italy; Algeria. |
| Lisbon (*Dome of Royal Observatory*)* | 9 11 10 W. | = | 0 36 44·7 | Coasts of Spain and Portugal. |
| Cadiz (*San Fernando Observatory*) | 6 12 24 W. | = | 0 24 49·6 | |
| Pola Observatory | 13 50 45 E. | = | 0 55 23·0 | Adriatic. |
| Malta (*Spencer's Monument*) † | 14 30 40 E. | = | 0 58 02·7 | West coasts of Italy, Greece, Sicily; North coast of Africa. |
| Gibraltar (*Dockyard Flagstaff*) ⊕ | 5 21 27 W. | = | 0 21 25·8 | |
| Alexandria (*Lighthouse*) | 29 51 40 E. | = | 1 59 26·7 | Egypt and Syria. |
| Smyrna (*Mill on Daragaz point*) | 27 09 42 E. | = | 1 48 38·8 | Grecian Archipelago. |
| Constantinople (*St. Sophia*) | 28 58 59 E. | = | 1 55 55·9 | Black Sea. |
| Madeira, Funchal (*British Consul's House*)* | 16 54 30 W. | = | 1 07 38·0 | Azores, Madeira, Canary and Cape de Verde islands; West coast of Africa to Fernando Po. |
| Madeira (*Fort St. Jago*)* | 16 53 53 W. | = | 1 07 35·6 | |
| Madeira (*Pontinha*)‡ | 16 55 01 W. | = | 1 07 40·1 | |
| Porto Grande, Cape Verde Islands (*Flagstaff in front of Brazilian Submarine Telegraph Co.'s Office*)* | 24 59 22 W. | = | 1 39 57·5 | |
| Newfoundland, St. John's (*Chain Rock Battery*) | 52 40 47 W. | = | 3 30 43·1 | Newfoundland and Labrador. |
| Halifax, Nova Scotia (*Naval Yard Observatory*)§ | 63 35 21 W. | = | 4 14 21·4 | British North America and Canada. |
| Boston, United States (*Cambridge Observatory*) | 71 7 39 W. | = | 4 44 30·6 | United States; North America. |
| Key (Cay) West, U.S. Naval Storehouse (*Observing Spot*)‖ | 81 48 24 W. | = | 5 27 13·6 | |
| Key (Cay) West (*Lighthouse*)‖ | 81 48 04 W. | = | 5 27 12·3 | |

* U.S. Telegraphic determination in 1878–9 from Greenwich. Published by U.S. Government, 1880.

† Telegraphic determination, 1875, from Berlin, by Professor Auwers and Dr. Gill

⊕ Telegraphic determination from Malta by H.M.S. *Sylvia*, 1886.

‡ Depending on being 1′ 8″ west of Fort St. Jago by chart.

§ Telegraphic determination in 1851 and 1872 from Washington, and from Greenwich.

‖ U.S. Telegraphic determinations in 1875–6 from Washington. Published by U.S. Government, 1877, No. 65.

| | ° ′ ″ | h. m. s. | |
|---|---|---|---|
| Vera Cruz (*San Juan de Ulloa Lighthouse*)* | 96 07 57 W. = | 6 24 31·8 | West Indies. |
| Havana (*Morro Lighthouse*)† | 82 21 30 W. = | 5 29 26·0 | |
| Santiago de Cuba (*Blança Battery. South angle*)† | 75 50 30 W. = | 5 03 22·0 | |
| Port Royal, Jamaica (*Fort Charles*)† | 76 50 38 W. = | 5 07 22·5 | |
| Aspinwall (*Aspinwall Lighthouse*)† | 79 54 45 W. = | 5 19 39·0 | |
| San Juan de Puerto Rico (*Morro Lighthouse*)† | 66 07 28 W. = | 4 24 29·9 | |
| Virgin Islands, St. Croix (*Lang's Observatory, centre of Transit Pier*)† | 64 41 17 W. = | 4 18 45·2 | |
| St. John, Antigua (*North tower of Cathedral*)† | 61 50 28 W. = | 4 07 21·9 | |
| St. Pierre, Martinique (*St. Marthe Battery*)† | 61 11 12 W. = | 4 04 44·8 | |
| Bridgetown, Barbados (*Flagstaff of Rickett's Battery*)† | 59 37 18 W. = | 3 58 29·2 | |
| Port Spain, Trinidad (*Flagstaff of Water Battery*)† | 61 30 38 W. = | 4 06 02·6 | |
| St. Thomas (*Fort Christian*)† | 64 55 52 W. = | 4 19 43·5 | |
| Para (*Portico of Custom House*)‡ | 48 30 01 W. = | 3 14 00·0 | East coast of South America; Brazil. |
| Pernambuco (*Lighthouse near Fort Picão*)‡ | 34 51 56 W. = | 2 19 27·8 | |
| Bahia (*San Antonio Lighthouse*)‡ | 38 32 05 W. = | 2 34 08·4 | |
| Rio de Janeiro (*Fort Villegagnon*)‡ | 43 09 29 W. = | 2 52 38·0 | |
| Monte Video (*Rat Island*)‡ | 56 14 00 W. = | 3 44 56·0 | |
| Monte Video (*S.E. tower of the Cathedral*)‡ | 56 12 15 W. = | 3 44 49·0 | |
| Buenos Aires (*Cupola of Custom House*)‡ | 58 22 14 W. = | 3 53 29·0 | |

## INDIAN OCEAN AND RED SEA.

| | | | |
|---|---|---|---|
| Cape of Good Hope (*Government Observatory*)§ | 18 28 40 E. = | 1 13 54·7 | South Africa, Madagascar, Seychelles. |
| Zanzibar (*British Consulate*)‖ | 39 11 08 E. = | 2 36 44·5 | Adjacent African Coast. |
| Aden (*Submarine Telegraph Office*)¶ | 44 58 57 E. = | 2 59 55·8 | Gulf of Aden. |
| Aden (*Local Telegraph Office*) | 44 59 07 E. = | 2 59 56·5 | |
| Aden (*Observation spot. Ras Mârbut*) | 44 58 31 E. = | 2 59 54·1 | |
| Suez (*Port Ibrahim*)** | 32 33 30 E. = | 2 10 14·0 | Red Sea. |
| Mauritius (*Martello tower, Fort George*)†† | 57 29 00 E. = | 3 49 56·0 | Madagascar — African Coast. |
| Bombay (*Observatory*)¶ | 72 48 58 E. = | 4 51 15·9 | Persian Gulf, West Coast of India & adjacent sea. |

* U.S. Telegraphic determinations, 1883–4, from Washington. Published by U.S. Government in 1885, No. 76.

† U.S. Telegraphic determinations in 1875–6 from Washington. Published by U.S. Government, 1877, No. 65.

‡ U.S. Telegraphic determinations in 1878–9 from Greenwich. Published by U.S. Government, 1880.

§ Telegraphic determinations in 1881, by Dr. Gill from Aden.

‖ Telegraphic determination, 1881, by Dr. Gill from the Cape of Good Hope.

¶ Telegraphic determination, India Trigonometrical Survey, 1878.

** Transit of Venus expedition, 1874.

†† Transit of Venus expedition, 1874 (meridian distance from Rodrigues).

| | ° ′ ″ | | h. m. s. | |
|---|---|---|---|---|
| Madras (*Observatory*)* - - | 80 14 51 E. | = | 5 20 59·4 | Bay of Bengal. |
| Andaman Islands. Port Blair (*Observatory, Chatham I.d.*) | 92 43 00 E. | = | 6 10 52·0 | Andaman Islands. |

## JAVA, CHINA, AND JAPAN SEAS.

| | | | | |
|---|---|---|---|---|
| Batavia (*Observatory*)† - - | 106 48 37 E. | = | 7 07 14·5 | W. Coast Sumatra, Java Eastern Archipelago. |
| Banjuwangi (*Fort Utrecht*)‡ - | 114 22 55 E. | = | 7 37 31·7 | Adjacent islands. |
| Singapore§ (*Green's transit pier in rear of Master Attendant's Office*)‖ | 103 51 15 E. | = | 6 55 25·0 | Malacca Strait, South part of China Sea, Palawan. |
| Cape St. James (*Lighthouse*)‖ - | 107 04 55 E. | = | 7 08 19·6 | Coast of Cochin China. |
| Manila (*Cathedral*)‖ - - - | 120 58 06 E. | = | 8 03 52·4 | Philippine Islands. |
| Hong Kong (*Cathedral*)‖ - - | 114 09 31 E. | = | 7 36 38·1 | Coasts of China. |
| Hong Kong (*Observatory Kaulung*) | 114 10 25 E. | = | 7 36 41·7 | |
| Hong Kong (*Palos Pier*) - - | 114 09 43 E. | = | 7 36 38·8 | |
| Amoy (*Kulangseu Signal Staff*)‖ | 118 04 03 E. | = | 7 52 16·2 | |
| Shanghai (*British Consulate Flagstaff*) ‖ | 121 28 55 E. | = | 8 05 55·7 | Yellow Sea and Korea. |
| Vladivostok‖ (*Scharnhorst's Station*) | 131 52 44 E. | = | 8 47 31·0 | Russian Tartary. |
| Nagasaki (*Minage Point*) ‖ - | 129 51 13 E. | = | 8 39 24·9 | Japan. |
| Yokohama (*Flagstaff English Victualling Depôt*)‖ | 139 39 13 E. | = | 9 18 36·9 | |

## AUSTRALIA, TASMANIA, AND NEW ZEALAND.

| | | | | |
|---|---|---|---|---|
| Sydney (*Observatory*)¶ - - | 151 12 23 E. | = | 10 04 49·5 | Australia and adjacent islands. |
| Sydney (*Fort Macquarie*)** - | 151 13 00 E. | = | 10 04 52·0 | |
| Moreton Bay (*Cape Moreton Lighthouse*)†† | 153 28 00 E. | = | 10 13 52·0 | Queensland. |
| Townsville (*Flagstaff Pilot Hill*) ⊕ | 146 49 54 E. | = | 9 47 19·6 | |
| Cooktown (*Boatshed at inner end of Jetty, Pilot Station*) ⊕ | 145 15 12 E. | = | 9 41 00·8 | |
| Cape York (*Sextant Rock*) - | 142 32 48 E. | = | 9 30 09·2 | Torres Strait and New Guinea. |
| Samarai (*Dinner I.*) *China Strait* (*Observation spot*)♦ | 150 39 47 E. | = | 10 02 39·1 | |
| Port Essington (*Site of old Government House*) | 132 09 18 E. | = | 8 48 37·2 | North-west Coast of Australia. |
| Port Darwin (*Transit pier, east extreme of cable House*)¶ | 130 50 37 E. | = | 8 43 22·5 | |
| Swan River (*Scott's Jetty*)†† - | 115 44 30 E. | = | 7 42 58·0 | West Australia. |
| Adelaide (*Snapper point*)‡‡ - | 138 30 50 E. | = | 9 14 03·4 | South Australia. |
| Port Phillip (*Melbourne Observ.*)‡‡ | 144 58 32 E. | = | 9 39 54·1 | Victoria. |

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* Telegraphic determination, India Trigonometrical Survey, 1878.

† Telegraphic determination from Singapore by Professor Oudemans in 1871, adopting U.S. determination of Singapore, 1881-2.

‡ Telegraph determination through Singapore and Port Darwin (in connection with Greenwich), in 1883. Communicated by Mr. Ellery, Government Astronomer at Melbourne, in letter dated January 8, 1885.

§ From Green's transit pier the old Observation spot in Fullerton battery, Singapore, bears S. 5° 37′ W. (true) distant 169 feet.

‖ U.S. Telegraphic determination, 1881-2., Published by U.S. Gov., 1883, No. 65b.

¶ Telegraph determination through Singapore and Port Darwin (in connection with Greenwich), in 1883.

** Depending on Fort Macquarie being 47″ E. of Sydney Observatory on chart.

†† Depending on Fort Macquarie, Sydney, being in 151° 13′ 00″ E.

⊕ Telegraphic determination from Sydney by H.M. ships *Dart* and *Lark*, 1886.

♦ Meridian distance from Townsville, H.M.S. *Dart*, 1886.

‡‡ Telegraph determination through Singapore and Port Darwin (in connection with Greenwich), in 1883.

| | ° ′ ″ | | h. m. s. | |
|---|---|---|---|---|
| **Tasmania.** Hobart (*Site of Fort Mulgrave*)* | 147 20 35 E. | = | 9 49 22·3 | Tasmania. |
| New Zealand. Wellington (*Pipitea point*) | 174 47 02 E. | = | 11 39 08·1 | New Zealand. |
| New Zealand. Mt. Cook (*Observatory*)† | 174 46 38 E. | = | 11 39 06·5 | New Zealand. |

PACIFIC OCEAN.

| | | | | |
|---|---|---|---|---|
| **Levuka, Ovalau** (*Site of old School-house*) | 178 51 00 E. | = | 11 55 24·0 | Fiji Islands, South-west Pacific Ocean. |
| Tahiti (*Point Venus extreme*) - | 149 29 00 W. | = | 9 57 56·0 | South-east Pacific Ocean. |
| Honolulu (*King's Cottage*)† - | 157 51 53 W. | = | 10 31 27·5 | North Pacific Ocean. |
| Esquimalt harbour (*Duntze Head, site of Observatory*) | 123 26 45 W. | = | 8 13 47·0 | Vancouver Island and British Columbia. |
| San Francisco (*Fort Point Lighthouse, south side of entrance*)‡ | 122 28 38 W. | = | 8 09 54·5 | California. |
| San Salvador, La Libertad (*Pier head*)§ | 89 19 22 W. | = | 5 57 17·5 | Mexico and Ecuador. |
| Panama (*Cathedral, South tower*)‖ | 79 32 12 W. | = | 5 18 08·8 | Mexico and Ecuador. |
| Panama (*North-east bastion*)‖ - | 79 32 03 W. | = | 5 18 08·2 | West Coast of South America. |
| Paita (*Cathedral tower*)§ - - | 81 07 17 W. | = | 5 24 29·1 | West Coast of South America. |
| Lima (*South tower of Cathedral*)§ | 77 00 02 W. | = | 5 08 10·6 | West Coast of South America. |
| Callao (*San Lorenzo Lighthouse*)§ | 77 15 44 W. | = | 5 09 02·9 | West Coast of South America. |
| Arica (*Church spire, Iglesia Matrix*)§ | 70 20 00 W. | = | 4 41 20·0 | West Coast of South America. |
| Valparaiso (*Cupola of Exchange*)§ | 71 38 36 W. | = | 4 46 34·4 | West Coast of South America. |
| Magellan Strait, Sandy point (*Boat-house*)¶ | 70 54 03 W. | = | 4 43 36·2 | Magellan Strait. |
| Magellan Strait, Port Famine (*Fitz Roy's Obs. spot*)** | 70 56 37 W. | = | 4 43 46·5 | Magellan Strait. |

*Meridians adopted in the construction of Foreign Charts.*

Russia, Sweden, Denmark, Norway, Holland, Austria, and the United States of America adopt the Meridian of Greenwich.

France adopts the Meridian of Paris, assumed to be in Long. $2° 20' 15'' = 0^h 09^m 21{\cdot}0^s$ E. of Greenwich.

Spain adopts the Meridian of San Fernando, Cadiz, assumed to be in Long. $6° 12' 24'' = 0^h 24^m 49{\cdot}6^s$ W. of Greenwich, or 05′ 22″ E. of Old Observatory.

Portugal adopts the Meridian of the Observatory, assumed to be in Long. $9° 11' 10'' = 0^h 36^m 44{\cdot}7^s$ W. of Greenwich.††

The Pulkowa Observatory of St. Petersburg (sometimes referred to in Russian Charts) is assumed to be in Long. $30° 19' 40'' = 2^h 1^m 18{\cdot}7^s$ E. of Greenwich.

The Royal Observatory of Naples (sometimes referred to in Italian Charts) is assumed to be in Long. $14° 15' 7''{\cdot}3 = 0^h 57^m 00{\cdot}5^s$ E. of Greenwich.

* Transit of Venus expedition of 1874.

† Telegraphic determination from Sydney, 1883.

‡ U.S. Telegraphic determination in 1870 from Washington.

§ U.S. Telegraphic determinations, 1883–4, from Washington. Published by U.S. Government in 1885, No. 76.

‖ U.S. Telegraphic determinations in 1875–6 from Washington. Published by U.S. Government, 1877, No. 65.

¶ From Professor Auwers (German Transit of Venus expedition), 1882. By meridian distances measured in H.M.S. *Nassau*, 1866–69, from Rio de Janeiro (Fort Villegagnon being considered in 43° 09′ 29″ W.), the longitude of Sandy Point is 70° 54′ 06″ W. By meridian distance measured in H.M.S. *Sylvia*, 1882, from Monte Video (Rat Island being considered in 56° 14′ 00″ W.), the longitude of Sandy Point is 70° 54′ 08″ W.

** Depending upon Sandy Point, being in 70° 54′ 03″ W.

†† The longitude of Lisbon castle deduced from the U.S. telegraphic longitude of the Lisbon Royal Observatory (in 9° 11′ 10″ W.) is 9° 07′ 55″ W

[1.] *Symbols denoting the Values of the Determinations.*

The symbols ○ ⊖ ⦶ ⊕ attached to certain places, indicate the degrees of precision with which their positions are supposed to be known.

The circle represents the horizon of the place; the line thus — a parallel of latitude; and the line thus | a meridian. Accordingly, the meaning of the symbols, generally, is as follows:—

1. ○ implies *undetermined* either in lat. or long.
2. ⊖ implies determined in *latitude* only, or the longitude wanting
3. ⦶ implies determined in *longitude*, or the latitude wanting.
4. ⊕ implies determined both in latitude and longitude.

A dot under the ○ implies *aggravated uncertainty*.

As very few places are *determined* in the strict sense of the word, while, on the other hand, no known place can be said to be absolutely *undetermined*, the sense attached to these two words must be defined by the purposes which the symbols are intended to serve in hydrography or in the navigation of a ship.

The different *degrees* of determination are indicated by the *position* of the symbol.

1. The symbol ○ denotes a doubt of not less than 2′ of lat., or somewhat more of long. It is used when the authorities differ from each other, or themselves: thus Capt. W. F. W. Owen places Cape Nun in 28° 41′ N., and Lieut. Arlett in 28° 46′, the long. not being well known.

This symbol placed after the name in the side column denotes that the district generally is imperfectly known, as parts of the Eastern Archipelago.

2. The symbol ⊖ indicates the latitude well enough determined for ordinary purposes, but the longitude defective. It occurs frequently.

3. The symbol ⦶ occurs rarely.

4. The symbol ⊕ *after* the name of a *point*, implies a tolerably precise determination.

It would have been prefixed to Pulo Aor, col. 67, but this island is 2 m. from E. to W., and the precise point of observation is not specified.

When placed *after* the name in the *side column*, it implies trigonometrical survey, subject to future, though probably small, correction; as, for ex., parts of our own coasts, the coast of Holland, Iceland, Greece, Italy, India, Corsica, R. St. Lawrence, Massachusetts, Rhode I., &c.

When placed *before* the name in the *side column*, it denotes final determination. The coasts so distinguished are part of our own, and it should have been attached to France.

This final characteristic cannot obviously be applied until the secondary meridian is fixed.*

When no symbol is attached either to the district or to the points of

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* The attention of seamen is particularly called to the considerations in the text. By having distinctions established, in the Table, between correct and uncertain positions, the navigator will have his circumspection awakened on approaching land of doubtful situation; and on leaving it again he will be enabled to avoid errors or perplexity in his reckoning consequent on adopting an erroneous point of departure.

It is also hoped that a further important end will be answered by the use of the symbols, and that intelligent individuals, thus made aware of the deficiencies or errors of the charts and tables, will, for the benefit of navigation and hydrography, avail themselves of opportunities to determine or verify doubtful positions.

the coast, it is implied that we are not in possession of such additional evidence as might serve to form a definite opinion on the accuracy of the several points.

The Secondary Meridians take no symbol, since, though not all finally determined, they are assumed as the leading points of the arrangement.

## 2. *Description-Symbols.*

The importance of abbreviations and symbols in saving time in writing is so generally felt that most persons who write much, habitually employ certain signs, intelligible to themselves, to save the tedious repetition of the same letters and syllables.

Suitable and expressive symbols are, however, not merely a convenience to the writer, but afford, in general, the advantages of distinctness, explicitness, and economy of time to the reader, together with another of still greater consequence, namely, certainty. This last assertion will not, perhaps, be so generally assented to as the former, but the truth of it is easily established. For example, a seaman in any particular part of the world opens a book to learn where he may find a good anchorage. His eye naturally looks for the word "anchorage" or "anchor," as it would for a sign or symbol. Having found the word, he is then obliged to read the entire sentence which contains it, in order thoroughly to comprehend the meaning; since, without a clear understanding of all that is said about anchorage, it is not safe to act. Now this sentence, though it relates, as we suppose, in some way to anchorage, may not contain at all the information that he requires; it may, for example, allude to some ship having partially or unsuccessfully searched for an anchorage, or it may merely intimate that no good anchorage has been found between some place in the neighbourhood and another more distant. Moreover, it is often difficult, from the arrangement of the matter, to know the precise point the account refers to, without reading back. If, on the contrary, the reader's eye catches the symbol ⚓, or this symbol so modified as to express with clearness "no anchorage," or "good anchorage," or "bad anchorage," or "anchorage at times only," or "confined to a small space," his work is done at once; he seizes in an instant the information that is given, and his mind is altogether unembarrassed by circumstances of narration, or the consideration of suppositions, inferences, and conditions, which often tend to obscure language in full development.

There are numerous other matters which, on like grounds, demand conspicuous indication: such as the dimensions of islands and shoals the leading particulars of dangers; the character and appearance of land, for the purpose of distinguishing one point from another; the class of vessels to which a harbour is adapted; channels; landing-places; as also notice of water, refreshments, and fuel, &c.

But, besides the mere notice or indication, it is often no less necessary to denote *quality*, or character, as good or bad; thus the seaman should know whether the inhabitants of a place he may visit are likely to assist his wants or to massacre his crew; that is, whether the character of the people is friendly or hostile.

The consideration of *quantity* has a powerful influence on the indications of language. One place has some trees upon it; another is well wooded; another densely wooded. It is entirely by increase of quantity that we pass from *trees* to *wood*, and from *wood* to *forest*. In like manner,

it is no less the abundance than the superior quality of the water, refreshments, &c., that determine the selection of the place at which to obtain supplies.

The following cases exemplify the great conciseness of expression and clearness of symbols which may be considered as appropriate.

$\square^{18}_{6}$ A harbour for smaller sized vessels (*i.e.* of which the depth is not always so much as 3 fathoms) having 18 feet water at high water, and 6 feet at low water, spring tides.

The symbols represent twenty words, in the space of two or three letters, besides indicating the rise of the tide, which is found by subtracting the lower depth from the upper.

$\blacksquare^{18}_{0}$ A harbour (as above), having 18 feet at high water, and dry at low water.

These symbols represent eighteen words.

ẉ′ Water, in abundance, and of good quality.

4m. Lying North-north-east and South-south-west, and extending 4 miles.

The last symbols represent twelve words; and the compass symbol exhibits to the eye, without reference to the names of the points, the two opposite quarters of the compass in which the line of direction is contained.

The reader must be distinctly informed that the symbols do not, in any way, interfere with the usual purposes of this Table, and therefore he may, if he please, disregard them altogether. He will, however, never do wrong in taking any known sign in its usual sense, as those symbols and abbreviations which have come into general use are here adopted as the groundwork of the system. The seaman who may find some little difficulty in learning to read these signs at first, may wish that the information they contain was printed at greater length. But there is no room for this, as the Tables are already too bulky; and it is only through the remarkable condensation afforded by the symbols that such information can be given at all. But when he has once taken the trouble to learn the system, which he will find very easy, he will, on the contrary, be induced to prefer the short and concise, positive, and unmistakable symbol to the tedious, indiscriminative, and not seldom obscure process of language written at length.

There is no doubt that proper symbols would be of great advantage to seamen in consulting books and tables relating to Maritime Geography, and also Charts; and we shall now enter on the system of which the first steps occurred to me while preparing the second edition of this work in 1841.

### [1.] *General Rules for the Employment of the Symbols.*

1. An abbreviation, or an appropriate symbol, is assigned to each point of information; as lt. light; ⚓ anchorage; w water.*

2. A zero, or cipher, below, and to the right, denotes *no*, or *none*; as $w_0$ *no* water, $⚓_0$ *no* anchorage.

*Note.*—This zero is of as much consequence as the symbol itself, and is the only secondary or subordinate sign that is so. It may, at first sight, seem awkward to write the symbol, and then to destroy it, as it were, by the zero; but it is the necessary process of thought: when we wish to say "no water," we necessarily direct the mind to *water* as the subject, and then add that there is *none* of it. To leave out the symbol altogether would not express the *privation* of the *thing*, but merely that we had nothing to say upon it.

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* In employing these signs it is essential that capitals and small letters should not be confounded.

3. A symbol inverted has its meaning reversed: thus the boathook, ⅃ *landing*, inverted, as ⅂, would denote *embarking*.

4. A hollow letter implies *temporary* or occasional, in opposition to the solid letter implying *permanent*; thus F (after lt.) denotes a *permanent* fixed lt.; F an *occasional* fixed lt.

5. The symbol repeated denotes the same thing at *different places*, or not everywhere; as ⚓ ⚓, anchorages, in *certain places*.

6. A symbol followed by the same with the zero sign denotes *at times*; as $ww_o$, water *at times* (literally, water and no water).

*Note.*—This is, in general, equivalent to the hollow letter above; but all symbols cannot conveniently be printed in the hollow form.

[2.] *Component Signs.*

These are used only in combination with others.

1. The line — denotes the *surface of the sea*; everything above this is, accordingly, conceived as above the level of the sea, and below it, below that level: as $\underline{\text{rk}}$. a rk. always *above* the surface; $\overline{\text{rk}}$. a rk. always *below* the surface, i.e. sunken.

A symbol between two such lines, that is, between *two levels*, denotes *awash*, as $\overline{\underline{\text{rk}}}$. Such is, for example, the Vrach, off Alderney, which shows only at low spring-tides.

2. A line thus | denotes vertical.

3. The cross +, with a number denoting the point in the proper quarter, constitutes the Compass Symbol; thus $+^{6}$ denotes ENE.

The cross with the N. pt. turned a little to the *right* would denote magnetic, as affected by *Easterly* Variation; turned to the *left*, as affected by *Westerly* Variation.

4. A square, or oblong, implies *enclosure*, whether partial or total; as ⚓ (in a square), an anchorage enclosed, represents *harbour*.

5. Brackets [1] imply *within limits*; as [⚓] anchorage confined to a narrow or limited space; [2] a shoal patch, with 2fms. on it, that is, 2fms. confined to a small space; [♣] trees confined to a small space, a clump.

When a letter denoting dimension (as c, f, m), with or without a number, and inserted in brackets, follows the word Id., or a term describing a danger, it indicates *extent*; thus [1m], "within the limits of 1 mile," that is, *extending* 1 mile. [c] A cable's length, or so, in extent. [3c] Three cables in extent.

[3.] *Subsidiary Signs.*

These are the dots under, the apostrophes over, and the accents or letters to the right of, the symbol.

*Note.*—The subordinate signs follow, and never precede, the symbol.

They denote, 1st, *Quantity*; and 2nd, *Variety*.

I. The *quantity-signs* are the dots and apostrophes.

(1.) The *dot* (below) denotes *plenty*, abundance; as $\underset{.}{w}$ plenty of water. The dot has this acceptation in the weather symbols, p. 156. Two dots denote a greater abundance, and three dots express the highest degree for which language has a term: thus ♣ a tree or trees; one dot would denote many trees; $\underset{..}{♣}$ wood (well wooded), and three dots would denote forest, or densely covered.

(2.) The *apostrophe* (above) implies *scarcity*; as $w'$ water not plentiful. This sign is adopted from its use in contractions, as in such words as

can't; whence it becomes associated with the idea of diminution. It is placed above in order still further to contrast with the plenty-sign or dot, and to prevent the possibility of confounding one with the other, even in the case of almost total obliteration. Two apostrophes would denote great scarcity, and three, the almost entire absence of the thing indicated.

II. The *variety-signs* are the letters, accents, or any other symbols as convenient, to the right of the symbol, and above or below it.

(1.) The most general of these is the accent, which denotes some variety of the thing symbolised: thus N, S, E, W, denoting the true points of the compass, N′, S′, E′, W′, denote the *magnetic* points of the compass.*

(2.) In things having quality, that is, which may be good or bad, the accent is placed *above* to denote *superior*, or good quality, as opposed to *inferior*, or *bad* quality, denoted by the accent *below*; as w′ good water, w, bad ditto; ⚓′ good anchorage, ⚓, bad ditto.

Two accents would denote the next, and three the highest, degree for which language has a term: as w″ water very good, w‴ ditto excellent; ⚓,, anchorage very bad, ⚓,,, the worst possible, or where a ship should anchor only in great distress.

(3.) The letters used for these secondary distinctions must obviously take their signification from the thing symbolised, and likewise their position above or below: as $w^R$ *river* water, good; or $w_R$ ditto, bad. $P_R$ people *run* (from ships), who are, generally, the worst characters.

As the subsidiary signs are independent of each other, any number of them may be employed at convenience: as ⸸′ water scarce, but good; ⸸, water scarce and bad; ⸸,, water by digging, in plenty, but very bad.

The notation is thus comprised in a primary or class *symbol*, a *quantity-sign*, and a *variety-sign*.

The vacant spaces following the names of places being, by this plan, turned to account, much important information is inserted without increasing the size of the volume.† It is also proper to observe that, as the signs represent ideas or things, and not words (with a few exceptions), the system is independent of any particular language.

The abbreviations and symbols used in the Table are, for reference, alphabetically arranged in the following

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* A special notation for this purpose is much required. In Purdy's "Sailing Directories," both the magnetic and the true bearing are given in order, as "the bearing and distance of the Capes Teulada and Malfatan are E. ¾ S. [*E.* ¾ *N.*] 8 miles."

Here *E.* ¾ *N.* refers to the *true* compass; but this can only be known by referring to the notice at the beginning of the book, unless the reader is aware that the variation at the place is westerly. The italic letters are already required for those passages in which, from the importance of the remark, the whole sentence is italicised; but the notation E′ ¾ S′ presents every advantage which a notation should possess: it is perspicuous, unequivocal, concise in the extreme, and elegant.

We must be careful to accent *all* the letters: thus N′ E′, not N E′; for this last combining true N. and magnetic E., presents no idea which occurs in practice.

A second accent denotes, further, local deviation, as N″E″, which shews, at once, that there are two corrections necessary to reduce it to true NE. This notation would remove much of the difficulty which often arises in endeavouring to combine bearings taken under different circumstances.

This notation need not, from the nature of the case, appear in ships' logs.

† It is no part of our design to enter all information which can be conveyed in symbols. A few leading points have been inserted where it seemed advisable; the reader must refer for other details to the Sailing Directions, or to voyages. The symbols, however, will answer the further purpose of affording the means of making extracts, or of taking notes, of certain particulars, in a very small space, and in a very short time.

## General View.

⚓ (Anchor) Anchorage for large vessels.
⚓′ good do. ⚓, bad do. ⚓₀ no do.
⚓ do. for smaller vessels.
⚓′ good do. ⚓, bad do.
▣ Harbour for large vessels, or having always 3 fathoms water.
▣ Harbour for smaller vessels, or having at times less than 3 fathoms.
The depth at H.W. and L.W. springs is denoted by the figures annexed above and below.
Ex. 1. ▣$^{20}_{12}$, 20ft. at H.W. and 12ft. at low.
Ex. 2. ▣$^{16}_{0}$, 16ft. at H.W. and dry at low water. When the depth at high water, of a harbour which dries at low water, is not known, it is expressed (for the present) by the letter n, implying some number not given; ex. Stonehaven, ▣$^{n}_{0}$.
Note.—In cases in which these details are not well known vacancies are left, which will be filled up on a future occasion.
♦ Ball.
♦ 1ʰ, Time ball dropped at 1 P.M.
bk. Bank.
B. Bay.
bll. Bell.
*bl.* blue.
*blk.* black.
⁓ Birds. As birds frequent some places in preference to others, they may afford a means of identification.
L (Boathook).—See Landing.
T Bold to.—See Component Signs, 1, 2.
[ ] Brackets.—See Component Signs, 5.
β Break, or breakers.
ββ₀ do. *at times*.
♣ Brushwood (a tree without a trunk).
b Burn (or *fuel*).
[b] (fuel enclosed), a coal depôt; coaling station for steam-vessels.
On some of the shores of the Polar Sea, and elsewhere, b denotes *drift-wood*. In some places *peat*, as at New I. Falklands. Where trees or brushwood occur, the symbol b is omitted, as, though many woods do not burn when green, fuel may be picked up in such places.—See Table 11.

C. Cape.
Cath. Cathedral.
c. Cable's length.
! (Note of admiration, surprise), denotes Caution, or calls attention, as Current !
‖ Channel, or passage, passages.
‖‖ Several channels; ‖35, chan. with 35fms.; ‖₀ no channel.
At a river the symbol relates to the entrance.
Chap. Chapel.
Ch. Church.
[b] Coal depot.
↑ Cocoa-nut tree, or trees; [ ↑ ] a clump of cocoa-nut trees; 2 [ ↑ ] two clumps do., and so on.
Compass symbol.—See Compon. Signs, 3.
crl. coral.
δ Danger, dangerous; δδ dangerous in different places.
δ₀ (no danger) safe.
d Days.
Depth of water, denoted by the no. under the mark —, as 4 four fms.; 3 f, 3 feet.
The depth is that at low water. The depth relates to the bar, where there is one.
Distance is expressed in leagues, or miles; as C. Lookout, rks. 1 l., implies rks. 1 league from the Cape; δ 2m., dangerous 2 miles out; δ₀ ½m., no danger, may be approached within ½ a mile, δ₀ ½ c., safe at ½ a cable distance; δ ✢ 2 l. a danger NE. 2 leagues.
Dk. yd. Dockyard.
Dry, or above water.—See Comp. Signs, 1.
E East. E′ magnetic E.
Entrance.—See Channel.
extr. Extreme, extremity.
F after a light, denotes that the flame has a fixed, not a changing appearance. —See lt.
F denotes a lt. (flame) of a fixed character, but only shewn occasionally. —See General Rules, No. 4, p. 399.
Fl. after a lt. denotes flashes.—See lt.
fl. Flag.
fl. st. Flag-staff.
Hd. Head.

*h* High.
ho. house.
hum. hummock.
I. Island.
The compass-symbol after an island shews the direction, or *lay*, of the longest diameter, and is followed by the length of this diameter in leagues, miles, or cables.
Ex. 1. NNW 3m. denotes NNW. and SSE. (true), and extending 3 miles.
Ex. 2. EW $6\frac{1}{2}$m. denotes lying E. and W. (true), extent $6\frac{1}{2}$ miles.
*Note.*—These bearings are all TRUE.
The bearing, though given to 2 points only, is near enough for the purposes required, as it can be in error only 1 pt. The distance is noted with more or less precision, according to the case, and is not always to be taken as an exact measure. When the extent is very small, the bearing or direction is omitted; as Rockal, [2c.], or 2 cables in extent.
I after a light, denotes intermitting.—See lt.
Is. Islands. The compass-symbol and distance following shew the extent and general direction of the group, as described above in Id.
The number after Is. denotes the number in the group, as Wallis Is. 9.
L Landing (a boathook, the hook to the ground); $L_o$ no landing; $LL_o$ landing at times; L′ good do.; $L_,$ bad.
l. Leagues. When a number of leagues follows next to the name, it denotes the number of leagues the place is visible—as Tiger I. 17 l., denotes visible 17 leagues. When the l. stands next after a compass indication, it implies of course a distance measured in the given direction; as Is. NW 5 l., islands NW 5 leagues.
*l* low.
lt. light. The capital letter next after the light denotes the *character of the flame*, as F fixed, I intermittent, R revolving, Fl. flashing or varied by occasional flashes, or rapid change in the intensity.
The number of feet (which stands the last among the particulars of the light) denotes the *height* of the lantern or flame above high water. Where this is not known, the range in miles is inserted.
When a lt. stands on a *summit*, the abbreviation sum. is inserted; when, therefore, sum. does not appear, the lt., however high, is usually not on the summit.
lts. The compass indication and no. of feet next after 2 lts., denote their *bearing and dist.* asunder—the spectator looking at them from the sea; thus, the Lizard lts., lying N 72° E and S 72° W, are seen in one, from a ship to the westward, or towards the ocean, in the direction N 72° E.
Note.—These bearings are all TRUE, and they are intended to afford a means of determining the state of the compass when the ship is in a line with the 2 lts. in one.
m. miles.
After a shoal or danger, denotes the distance; as rf. 3m., a reef 3 miles distant.
mid. middle.
Mk. or mk. mark.
mo. mouth.
Mt. mount.
N North. N′ magnetic N.
† Palm-tree.
( ) Parentheses, contains extra or additional information.—See p. 389.
Passage.—See Channel.
Patch.—See Compon. Signs, 5.
Penins. Peninsula.
P People—or peopled.
$P_o$ Uninhabited.
P′ People of favourable character.
$P_,$—of unfavourable do.
pk. Peak.
Pt. Point, being part of a name, as Hartland Pt.
pt. point.
R River. After a lt. denotes *revolving*.
*r* red.
rf. Reef.
rf, rf. always dry; rf, rf. always covered; rf, rf. awash.
r Refreshments, that is, vegetables, fruit, and meat.
As fish is often procurable where there are neither vegetation nor inhabitants, it is expressed by the separate symbol r̄, denoting r under the water.
Rising gradually. Rising in the middle, as I. Fuerte.
rk. Rock.
rk, dry; rk, sunken; rk, awash.
The number under a line, a 5, denotes the depth in fms. over a sunken rk.
rks. Rocks; a compass indication, with a number of miles or cables, denotes the extent, as described under Island.
rky. rocky.
S South. S′ magnetic S.
Saddle-shaped, as Huafo I., a valley.—See Sloping, Rising.
sd. Sand, or sandy.
This quality is noticed occasionally, as sand often affords water, it is used in cleaning, and turtles lay their eggs in sand.

shl. Shoal. A compass indication with m. or c., denotes the extent.—See Island.
The number under a line, standing next after shl. denotes the depth of water over the shoal, as Ridge ɪ.
Shoal patch.—See Compon. Signs, No. 5.
⦣ Sloping downwards, as Goose Cape.
⦣⊥ Sloping down to a bluff.
⌐ Sloping bottom, or change of soundings gradual, may be approached with safety by attention to the lead.
Sig. st. Signal staff, or station.
⊥ Steep, or precipitous (not absolutely vertical).—See Component Signs, 1, 2.
Note.—This is quite independent of *high*. A headland may be low yet precipitous.
T Steep to.
St. Saint.
Sta. Santa.
Tel. Telegraph.
♆ Tree, trees; [♆] a clump of trees; 2 [♆] two clumps; 3 [♆] three clumps.
♆ well wooded.
♣ (A tree without a trunk), brushwood.
Vert. Vertical.
W West. W′ magnetic West.
w Water (for drinking).
w′ good do., $w_{,}$ bad do.
$w_0$ no water, $ww_0$ water *at times*.
w̄ do. (under the surface) to be got by digging.
The bearing and dist. following the w point out the place with reference to the position given, as Koron w′ N. 2m. denotes good water North 2m. of Koron.
*w, wh.* white.

The following examples exhibit the method :—

Ex. 1. Island, ⨳ 7m., *h.* $♆_0$, $\|_0$E, ⚓′ SW 8, ♣′$r_0$, $P_,$. An island *lying* NE and SW, extending 7 miles; *high*; *no trees*; *no passage* to the *eastward*; a *good anchorage* on the *SW side* in 8 *fathoms*; where *water, scarce*, but *good*, is to be found, but *no other refreshments*; the *people* of *bad* character.

Ex. 2. Paddeway Bay, ⊞ [5m.] 10, r, $8_0$. A *harbour for large vessels*, extending 5 miles, having 10 *fathoms* water; *refreshments* to be had; *no dangers*.

Ex. 3. Shoal, ⨳ 4m., rk. at NW end, ⌒⌒$_0$, T, $L_0$. A shoal, *lying WNW and ESE* 4 *miles*; a *rock always above water* at the NW end, the *occasional* resort of *birds*, *bold* to, and no *landing* on it.

Ex. 4. N. Watcher, small, ♆, (Omega Shls. EbS′ ½m., 8, T) lt. R. 159f. N. Watcher, small, well wooded, Light Revolving 159 feet high. Omega shls. lie EbS magnetic, ½m., are dangerous, and steep to.

Ex. 5. Guase or Kena I., ⨳ 8m. *l*, ♆, ⌐, r, w̄, $P_,$. Low, covered with trees, or wooded, soundings gradual, refreshments, water to be obtained by digging, people of bad character.

### 3. *Lights, Characteristics, &c.*

The lights shewn in lighthouses are divided into several classes, Fixed, Flashing, Revolving, Occulting, and Alternating (*see* p. 925). The fixed light maintains the same appearance; the other classes change, some alternating by slow degrees between bright and dim, some flashing more or less suddenly, and others varied by eclipses. Colour is also employed partially as a means of distinction. Lights are distinguished from each other also by the different intervals of time in which the changes succeed each other.*

It is to be borne in mind that every light which varies its lustre is liable, when seen from a distance, to become altogether invisible during the period of lesser brilliancy; that is, a revolving light may seem to be eclipsed. Also, elevated lights are often entirely obscured by clouds.

As objects painted white frequently disappear in fog, while objects of a red colour remain visible, buildings serving for marks are often painted with red and white stripes, or bands.

* Seamen are generally content with the mere fact of revolution or intermission, and do not trouble themselves to measure the interval. This, therefore, is an occasion on which it is very useful to be able to count seconds, for all persons do not carry seconds watches, and it is not always possible for the same person to hold the watch to a lamp and to see the light at the same instant.

The lighthouse, or building, being useful as a guide by day, many lighthouses are accordingly painted in order to answer this second purpose.

All the distances given in the Admiralty Light Lists and on the charts for the visibility of lights are calculated for a height of an observer's eye of 15 feet. The table of distances visible due to height, at end of each Light List, affords a means of ascertaining how much more or less the light is visible should the height of the bridge be more or less. The glare of a powerful light is often seen far beyond the limit of visibility of the actual rays of the light, but this must not be confounded with the true range. Again, refraction may often cause a light to be seen farther than under ordinary circumstances.*

The power of a light can be estimated by remarking its order, as given in the Light Lists, and in some cases by noting how much its visibility in clear weather falls short of the range due to the height at which it is placed. Thus, a light standing 200 feet above the sea, and only recorded as visible at 10 miles in clear weather, is manifestly of little brilliancy, as its height would permit it to be seen over 20 m. if of any power.

The Admiralty Light Lists, corrected yearly, should always be consulted as to the details of a light, as the description in the Sailing Directions may be obsolete, in consequence of changes made since publication.

### 4. *Compass-names of Points of Land.*

Navigators and hydrographers have not hitherto adopted any constant rule in the application of *compass-names* to the projecting angles of land. Thus, Krusenstern says (Mém. Hydr. ii. p. 283), "The north point of Owhyhee, which Vancouver calls the west point," &c. This extreme diversity of expression establishes the necessity of a systematic employment of such terms.

The north point of an island may be considered, 1. as that point which is to the northward of the middle or *body* of the island; or, 2. as the northernmost or *extreme* north point. In a circular island both terms agree, but in irregular forms they are ambiguous; thus Krusenstern calls the S. extreme of Atooi, "the S.E. pt.," probably from its position S.E.-d of the body of the island.

It will, perhaps, be admitted, that, in a purely practical subject, such a

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* It is not unlikely that a light may be found sufficiently powerful, by the addition of a proper reflector, to illuminate the clouds, and, in a fainter degree, the atmosphere itself, over a lighthouse. The pale light in which a distant town appears enveloped at night; the distinctness of the forms of the clouds over a large city, illuminated by its ordinary lamps; and the vivid glare diffused over the heavens by a fire, show that the atmosphere renders the reflected light visible at a considerable distance. It is merely a question of intensity. If a sunbeam were admitted through a hole in the earth in a dark night, it would appear in the atmosphere as a column of astonishing splendour. As the light suggested would have a conical or shaft-like appearance, and would exhibit no flame, its proper designation would be a *shaft-light*. The shaft might, by the disposition of the reflector, be vertical, or inclined seawards or landwards, or be kept in motion, and the effect would be a great relief to the already exhausted resources for varying the appearance of lights.

This idea of Raper's is now carried out, and the illumination of the clouds by the new Electric Flashing Light at Ushant has been seen from a distance of 70 miles.

mode of expression should be selected as is best adapted to *application*. provided no error be thereby involved. But, in this question, both efficacy in practice and precision of language concur in directing the use of terms according to their *absolute significations*. Thus, if we call a southerly point of Atooi the "S.E. pt.," we leave it doubtful whether there is land to the southward or not; and, therefore, a ship could not, without reference to the chart, venture to run; but if we call the south point by the proper term, this doubt is not suggested, since the word "south" declares that no other part of the coast projects so far to the southward.

Accordingly, in this work, the compass-names N., S., E., or W., denote the extreme projecting point in that direction, without regard to the figure of the rest of the coast.

A point which is an extreme both in latitude and longitude, as, for ex., the S.E. projecting Cape of Samar (Philippines) we call what it is, namely, the South *and* East extreme, and so of the S. and W., N. and E., N. and W. points.

[1.] *Ambiguous Terms.*

Another case in which serious ambiguity may arise from the want of critical rules in such matters, and which may with propriety be noticed here, occurs in such phrases as "the Lizard lights in one clear the Manacles to the eastward." This is intended to imply that the ship passes to the eastward of the *rocks*; but, by omitting all mention of the ship, the bearing might be supposed to relate to the rocks, as would be the case if another verb were put for "cleared," as "saw the M. to the eastward," in which cases the ship is clearly to the westward. If the sentence ran "clear the ship to the eastward," no obscurity could exist, yet "clear the M. to the eastward," also puts the ship to the eastward. There must be something very defective in an expression which keeps the same meaning when reversed.

It would be well to adopt the rule that the bearing specified should relate to the thing mentioned, and not to anything else absent or understood; thus, in the above phrase, the term "eastward" should be held to relate to the rocks, and not to the ship, just as in "clear the ship to the eastward," it relates to the ship, and not to the rocks.

It might be dangerous to force a reform too suddenly in technical expressions, however vicious; but, on the other hand, no expression can maintain its ground when proved to be wrong. In the meantime it will be proper to use a fuller form of phrase, such as "clear the M., leaving them to the westward." In the course of time, "leaving them" would be dropped, and we should have the expression in its correct form, the bearing relating to the thing mentioned.

Some ambiguity necessarily attaches to the word "pass," because it is both active and neuter; thus, "passing an island to the westward," does not altogether declare whether the ship passes to the westward or leaves the island to the westward.

It is often, in like manner, a matter of doubt whether bearings given in the description of a light relate to the light itself or to the spectator: thus, "a light obscured from N. to E." may mean either "invisible from the N.E. quarter" (that is, when *bearing* S.W.-d), or "invisible to a spectator in the S.W. quarter" (or *bearing* N.E.)

This ambiguity is removed by the same rule, which supposes the spectator always in the centre of the compass, and, therefore, that the bearing specified relates to the point mentioned. The above phrase should, therefore, be held to mean the light invisible when bearing between N and E.

### Table 11. Places at which Docks, Wet or Dry, or Slips, may be found, Repairs made, Coals obtained, &c.

This Table has been corrected from the most recent information. For fuller details see the Admiralty Dock Book for 1890.

### Table 12. Navigable Distances.

This Table, in former editions, afforded the means of estimating approximately the length in days of passages from port to port, but steam having made the table obsolete, it has been replaced by one showing the Navigable Mercatorial Distances in Nautical Miles between the Principal Ports of the World, arranged geographically. The sailor, knowing the speed at which his vessel can be driven in fair weather and foul, also the probable force and direction of the winds and currents he is liable to meet during the voyage, will be able by Table 12 to quickly make a fair estimate of the time of arrival at the port or ports to which he may be bound.*

There is some difficulty in giving at sight the distances between ports lying in different oceans. An attempt has been made to connect the first-class ports by inserting auxiliary tables where the distances between London, Liverpool, &c., and the Chinese and Australian ports are directly given. In other cases a little addition will be necessary. Care has been taken to give prominence to the great corners or turning-points of the world, as Gibraltar, Aden, Galle, Cape Leeuwin, Pernambuco, Cape Verde, &c.

The Mediterranean tables are connected with the principal ports in both hemispheres by tables from Gibraltar and Port Said.

Required the distance between Vera Cruz and Brisbane by Cape of Good Hope; by Cape Horn; and by Suez Canal; also between Genoa and San Francisco; and Famagousta and Zanzibar.

| | |
|---|---|
| Vera Cruz to Pernambuco . . | 4,205 |
| Pernambuco to Cape of Good Hope | 3,346 |
| Cape of Good Hope to Brisbane . | 6,680 |
| | 14,231 |
| Vera Cruz to Gibraltar . . . | 5,044 |
| Gibraltar to Port Said . . . | 1,920 |
| Port Said to Brisbane . . . | 8,698 |
| | 15,662 |
| Genoa to Port Said . . . | 1,428 |
| Port Said to Hong Kong . . | 6,465 |
| Hong Kong to San Francisco . | 6,444 |
| | 14,337 |

| | |
|---|---|
| Vera Cruz to Pernambuco . . | 4,205 |
| Cape Horn to ,, . . | 3,289 |
| Brisbane to Cape Horn . . | 5,995 |
| | 13,489 |
| Genoa to Gibraltar . . . | 852 |
| Gibraltar to San Francisco . . | 12,569 |
| | 13,421 |
| Famagousta to Port Said . . | 250 |
| Port Said and Zanzibar . . | 3,108 |
| | 3,358 |

* It must be remembered that ships in sailing or steaming round the world, *gain a day* in their reckoning, going *East*; and *lose a day* going *West*. This alteration of date may be attended with some embarrassment if care is not taken to insure accuracy, by referring the days and hours of departure and arrival to Greenwich time by means of the Greenwich Date: *See* No. 481 and "Variation of Time at Sea," p. 354.

A short rule to estimate day and hour of arrival for steamships crossing the Pacific Ocean is: Going West: Add one day to assumed time of length of passage, and subtract the Diff. Long. *in time* between the two ports. Going East: Subtract one day from assumed time of passage, and add the Diff. Long. *in time*.

### TABLE 13. TIME SIGNALS.

This Table shews, for all parts of the world, where the Time Signals are made from which the error of the chronometers on Greenwich Mean Time can be obtained, and by which, if the length of stay permits, they can also be rated. For more detailed information see List of Time Signals, published yearly by the Admiralty.

### TABLE 14. EPACTS OF YEARS AND MONTHS.

The Table contains the Epacts for certain years, and for the first day of each month.

The Epact for the year is the moon's age on January 1st. The Epact for the month is her age on the first day of the month, supposing her to change on January 1st at noon.

As a mean lunation is $29^d\ 12^h\ 44^m$, the moon describes, in 365 days, twelve complete lunations, and $10^d\ 15^h$ of the thirteenth; hence, on each 1st of January her age is $10^d\ 15^h$, on the average, more than on the preceding 1st of January, and $11^d\ 15^h$ if the preceding year was leap year.

### TABLE 15. SEMI-MENSTRUAL INEQUALITY.

The Table contains the Semi-menstrual Inequality for the places enumerated. Its use is shewn in the examples, p. 342. The Table was constructed by combining together the several semi-menstrual inequalities of the places specified, together with a few observations at St. Helena, to which place, also, the Table therefore may be applied.*

### TABLE 16. RISE AND FALL OF THE TIDE.

The Table shews approximately the space through which the surface of water rises or falls at given intervals from high or low water. It is entered with the said interval at the top, and the range for the day at the side.

Ex. 1. It is high water at a dock-sill at $11^h\ 20^m$ A.M., and the water is 31 ft. deep, the range is 24 ft.: find the depth at $12^h\ 15^m$. From $11^h\ 20^m$ to $12^h\ 15^m$ is $55^m$ (or $1^h$); then under $1^h$, against 24 ft., is 1·6, which is the fall of tide in $1^h$, and being subtracted from 31 ft., leaves 29·4, the depth required.

Ex. 2. It is low water at $4^h\ 50^m$ P.M., and the depth is 2 ft. At a place where the range is 17 ft. find the depth at $8^h\ 30^m$. $3^h\ 40^m$ and 17 give 11·4, which, added to 2, gives 13·4, the depth required.

If the range for the day is not known, a rough estimate may be formed from the spring and neap ranges.

The Table may serve for reducing, approximately, the soundings taken at any particular time of the tide to the low-water depth. Thus, the depth 10 feet is obtained at $1^h\ 50^m$ after low water: the range between this low water and the succeeding high water is 11 feet; then $1^h\ 50^m$ and 11 give

* I am indebted for this useful table to the late Mr. Dessiou, of the Hydrog. Office, master in Her Majesty's navy, who was employed at the Admiralty in reducing the greater part of the tide observations made at our ports for many years; a task which Dr. Whewell considers, in the amount of labour and in the judgment displayed in the mode of proceeding, as not inferior to any discussion of large masses of astronomical or other observations by modern calculators, and of which some idea may be formed from the circumstance that London alone furnished 13,000 observations.

0·8, which, deducted from 10 feet, leaves 9·2 feet, the reduced low-water depth. The results are only approximate. It has been remarked, at least at some places, that the rise and fall do not correspond, and that the water falls more rapidly at first.* Care must be taken in using this Table where there is a large Diurnal Inequality (see Nos. 926–928).

*To compute a Term.* With the time from high or low water as a course, and the Range as dist., find the diff. lat., and subtract it from the range; the remainder is the rise or fall.

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# NAUTICAL ASTRONOMY.

## REDUCTION OF THE ELEMENTS IN THE "NAUTICAL ALMANAC."

THESE Tables are used in the rules from p. 205 to p. 228.

### TABLES 17 AND 18. ARC AND TIME.

These Tables contain the corresponding divisions of Time and Arc. Their use has been exemplified in Nos. 570 and 572.

### TABLE 19. CORRECTION OF THE SUN'S DECLINATION AT NOON AT SEA, FOR LONGITUDE AND TIME.

This Table contains the correction for the sun's declination at noon, as taken out of the Naut. Alm. or Table 60, for reducing it to any other long. than that of Greenwich, or to any other hour of the day than noon. The correction is the variation of the declination, and, as it depends chiefly on the declin. itself, the declin. is employed as the argument instead of the day of the month.

The Table is entered with the declin. at the top, and the Long., or the time, at the side. See examples, No. 579.

### TABLE 20. CORRECTION OF THE EQUATION OF TIME AT NOON, AT SEA, FOR LONGITUDE AND FOR TIME.

The Table is entered with the daily variation at the top, and the longitude, or the time, at the side; the correction, in the body of the Table, is in seconds of time. See the examples, No. 583.

### TABLE 21. FOR REDUCING DAILY AND 12-HOURLY VARIATIONS.†

This Table shews the proportional part for each half-hour of the $24^h$, or each $15^m$ of the $12^h$, corresponding to any daily or 12-hourly variation from 1′ to 30′, or 1″ to 30″.

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* With such irregularity will also be taken that called *tide and half tide*, in some places where the fall of the water is checked about half ebb, and a temporary rise takes place, as in the superior height of the night tides in the river Columbia, observed by Sir E. Belcher.

† For the design of this very convenient table I am indebted to Capt. W. Ramsay, R.N.

When the variation exceeds 30, take the parts for 30 and for the excess above 30.

Consider minutes of time above $0^m$ or $30^m$ as hours, and write the min. of the proport. part as seconds, and the seconds as thirds.

Examples are given in No. 580, and many others.

For extreme precision, the even columns (2′, 4′, &c.) only must be used, because the odd columns are often 0″·05 in defect, as are all those for 30″.

The Table serves for reducing the R.A. and Decl. of the sun and planets, the Equation of Time, the Moon's Horizontal Parallax, and Semi-diameter; and also for various other purposes, as proportioning for the rate of a watch, the drift of a current, &c.

## Table 21 A. Logarithms for reducing Daily Variations.

This Table contains logarithms for reducing 24-hourly variations. Its use is described in No. 597 (2).

*To compute a Term.* From the const. 3·15836( the log. of 1440, the number of min. in $24^h$, or of seconds in $24^m$) subtract the log. of the given time or arc; read hours or degrees as min., and min. as seconds.

Ex. 1. Find the Log. for $11^h 28^m$.

| | |
|---|---|
| Const. | 3·1584 |
| $11^m 28^s = 688^s$ log. | 2·8376 |
| Log. req. | 0·3208 |

Ex. 2. Find the Log. for 21′ 27′

| | |
|---|---|
| Const. | 3·1584 |
| 21′ 27″ = 1287″ log. | 3·1096 |
| Log. req. | 0·0488 |

## Table 22. For reducing the Moon's Declination.

The Table is entered with the difference for $10^m$ (from the Naut. Alm.) at the top, and the minutes of the Greenwich Date at the side.

Ex. Green. Date, $11^h 27^m$, Diff. for $10^m$, 136″.

| | | |
|---|---|---|
| $27^m$ and 130″ | 5′ | 51′ |
| 6 | | 16·2 |
| Proportional Part | 6 | 7·2 |

The parts may be taken out to the seconds of the Greenwich Date by reading minutes as seconds, and seconds as thirds.

## Table 23. Acceleration.

This is the change of the sun's mean Right Ascension in a mean solar day. It is employed in reducing the Sidereal Time at mean noon to the Green. Date, and in converting Mean Time into Sidereal Time.

The Acceleration is itself a portion of Sidereal Time.

## Table 24. Retardation.

This is the change of the sun's mean Right Ascension in a sidereal day. It is employed in converting Sidereal Time into Mean Time.

The Retardation is itself a portion of Mean Time.

For examples of the use of these two Tables, see Nos. 585, 602, &c.

## Table 25. For finding the Equation of Second Differences.

The use of this Table is described in No. 599. The column headed $1^h$ (which may be read 1° or 1′) is adapted to all tables in which the intervals are sexagesimally divided.

*To compute a term.* Multiply half the difference between the Tabular Interval and the proposed Interval by the latter, and divide the product by the square of the Tabular Interval.

Ex. Tabular Interval $12^h$, Proposed Interval $5^h\,40^m$, or $5^h{\cdot}7$

| | |
|---|---|
| Tab. Int. | $12^h$ |
| Proposed | 5·7 |
| | 6·3 |
| Half Diff. | 3·1 |

then $\frac{3{\cdot}1 \times 5{\cdot}7}{144} = 0{\cdot}1227$, the multiplier.

## TIMES OF CERTAIN PHENOMENA.

These Tables are employed in the methods, p. 205, &c.

### TABLE 26. APPARENT TIME OF THE SUN'S RISING AND SETTING.*

The Table is entered with the Latitude at the side, and the Sun's Declination, at the *top*, when these are of the *same* name; but at the *bottom* when of *contrary* names. Thus, in lat. 31° N., the sun, when in 4° S. decl., rises at $6^h\,10^m$ A.M., and sets at $5^h\,50^m$ P.M.

This is the *Civil Time* of the rising or setting of the sun's *centre*, to the eye at the level of the sea, and without the atmosphere. For greater exactness see No. 638.

*To compute a Term.* See Nos. 620, 621.

### TABLE 27. APPROXIMATE APPARENT TIMES OF THE MERIDIAN PASSAGES OF THE PRINCIPAL FIXED STARS.

### TABLE 27 A. CORRECTION OF THE TIMES IN TABLE 27.

The times are given in Table 27 for the 1st of each month, and the meridian of Greenwich. To find the time of passage for any other day, *subtract* the portion of time corresponding to the day of the month in Table 27 A from the time in Table 27. For an ex. see No. 625.

The Table is adapted to 1902, but will be within $2^m$ for many years.

### TABLE 28. CORRECTION OF THE MOON'S MERIDIAN PASSAGE.

The Table is entered with the Daily Variation at the top, and the Longitude at the side.

The Daily Variation in W. long. is the difference between the time of the moon's transit on the given day and the next; in E. long. it is the difference between the moon's transit on the given day and the day before.

In W. long. *add* the correction to the time of meridian passage on the given day; in E. long. *subtract* it.

* This is the apparent (not *mean*) time of the true (not the *visible*) rising or setting.

Ex. 1. May 9th, 1870, long. 51° W.: required the time of the Moon's Mer. Pass.

| | |
|---|---|
| Mer. Pass. N.A. 9th | $7^h\ 17^m$ |
| 10th | 8 9 |
| Daily Var. | 52 |
| Corr. for 51° W. | 7 |
| | 7 17 |
| Time req. | 7 24 P.M. |

Ex. 2. July 25th, 1870, long. 132° E.: required the time of the Moon's Mer. Pass.

| | |
|---|---|
| 24th | $21^h\ 29^m$ |
| 23d | 20 39 |
| Daily Var. | 50 |
| Corr. for 132° E | −18 |
| | 21 29 |
| | 21 11 |
| Time req. | 9 11 A.M. |

### Table 29. Hour-Angle and Altitude of a Body upon the Prime Vertical.

The Table is entered with the Declination at the top, and the Latitude (of the *same* name) at the side.

Ex. Lat. 50° and ☉'s Declin. 10°, give his Hour-Angle $5^h\ 26^m$, and Alt. 13°·2, or 13° 12′.

The alt. which, partly for space and partly for distinction, is noted to the nearest 0°·1, or 6′, will not be in error on this account more than 3′. Thus the alt. 13°·1, which is properly 13° 6′, may be between 13° 3′ and 13° 9′; but 13° 2′ is 13°·0, and 13° 10′ is 13°·2. Hence, taking 13°·1 as 13° 6′ cannot entail an error exceeding 3′. The error will generally be less.

This alt. being the *true* alt., the sun or a star will pass the prime vertical at an alt. *greater* than the alt. given, by the diff. between the true and obs. alts.; the moon, on the contrary, at a *lesser* alt., by this amount.

As no star of which the declin. is greater than the lat. passes the prime vertical, such cases do not appear in the table.

The Table shews at once, roughly, the effect of an error of 1° of lat. in determining the time by a single altitude in the most favourable case.

Ex. Lat. 45° N., Decl. 3° N., the times are the same for 3° or 4° of latitude; that is, a gross error of lat. is of no consequence in computing the time of passage. But if the body have 23° of declin. an error of 1° of lat. will cause an error of $3^m$ or $4^m$ in that time.

By reversing the lat. and declin., the hour-angle and altitude become those of a body at its greatest elongation, or azimuth, from the pole.

*To compute the Hour-angle*, see No. 619. *To compute the Alt.*, see No. 665.

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## ALTITUDES.

These Tables are used in the rules, p. 230, &c.

### Table 30. Apparent Dip of the Sea-Horizon.

This is the angular depression of the sea-horizon below the true level, in ordinary states of the atmosphere, and when the sea and air are of equal temperature.

The apparent dip is the true depression (Table 8), diminished by about $\frac{1}{14}$ of itself. As this correction varies with the state of the air near the horizon, altitudes taken at sea, especially low altitudes, are not to be depended on where great accuracy is required. See No. 208.

### TABLE 31. MEAN ASTRONOMICAL REFRACTION.

The Refraction is given for the barometer at 30 inches, and Fahrenheit's thermometer at 50°, according to Ivory.* The diff. to 10′ of alt. is inserted.

Ex. 1. The refraction at 20° is 2′ 39′.

Ex. 2. The refr. to the alt. 38° 35′ is 1′ 13″·3, deducting ·2, or 1′ 13″·1.

The tenths of seconds are omitted at altitudes below 35°, on account of the uncertainty at low altitudes.

*To find the Refraction approximately.* With the alt. as course and dep. 58, find the D. Lat.; this is the refraction in seconds. For the refr. is proport. nearly to the tang. of the zen. dist., and is 58″·2 at zen. dist. 45°

Ex. Alt. 10°, as course, and Dep. 58, give 329″, or 5′ 29″, the refr. required.

### TABLE 32. CORRECTION OF THE MEAN REFRACTION FOR THE HEIGHT OF THE THERMOMETER.†

The Table is entered with the Alt. at the top, and the degree of Fahrenheit's therm. at the side. When the therm. is *below* 50°, the correction is *added* to the mean refr.; when *above* 50°, it is *subtracted.*

Ex. Alt. 17° 10′, therm. 72°; the corr. is 8″, which, subtracted from the mean refr., 3′ 7″. gives the true refraction 2′ 59″.

*To find the Correction, nearly.* Multiply the mean refraction in seconds by 2, and by the difference between the height of the therm. and 50°, and divide the product by 1000.

Ex. Alt. 5°, therm. 38′. The mean refr. 9′ 54″, or 594″, mult. by 2 and by 12, is 14256, and this divided by 1000 gives 14″.

### TABLE 33. CORRECTION OF THE MEAN REFRACTION FOR THE HEIGHT OF THE BAROMETER.

The Correction is given to each tenth of an inch. The Table is entered like Table 32. When the barom. is *above* 30 inches, the correction is to be *added;* when *below, subtracted.*

Ex. Alt. 17° 10′, barom. 29·2 in.; the corr. is 5″, and true refr. 3′ 2′.

*To find the Correction.* Multiply the mean refr. in seconds by the difference between the height of the barom. and 30 inches, and divide the product by 30.

Ex. (Above.) 3′ 7″, or 187″, mult. by ·8, and divid. by 30, gives 5″.

---

* The refractions now used by astronomers are those according to Bessel. Ivory's exceeds these by 0·9″ at alt. 45°, by 2″ at alt. 20°, and 5″ at alt. 10°. The difference of the tables is scarcely worth a more extended notice.

† This correction involves the term $\frac{d\mathfrak{z}\mathfrak{t}}{d\tau}(\tau-50°)$. The term $\frac{d\mathfrak{z}\mathfrak{t}}{dp}(p-30)$ is omitted as insensible.—*Phil. Trans.* 1823, p. 476.

### Table 34. The Sun's Parallax in Altitude and Semidiameter.

These are given for convenience on some occasions, but not for extreme precision.

*To compute the Sun's Parallax in Altitude.* Take the hor. par. in the Naut. Alm. as dist., and find the D. Lat. to the app. alt. as course.

### Table 35. Dip of a Shore-Horizon.

The Table shews the Apparent Dip to be used instead of the dip in Table 30, when the distant sea-horizon cannot be seen, and the altitude is observed from the water-line on the beach. The distance of this line may either be estimated nearly, as it is always less than the true dip due to the height of the eye (Table 8), or it may be found by the method No. 550.

*To compute a Term.* Take the diff. between the depr. to the eye (Table 8) and the dist. of the beach-line, and divide by twice this last; add the quotient to the app. dip in Table 30.

### Table 36.*

This Table contains the scales of the Centigrade and Réaumur thermometers, corresponding (approximately) with that of Fahrenheit.

The zero of the two former, or the freezing point of water, being 32° of of Fahr., and their boiling points 100° and 80° respectively, while that of Fahr. is 212°; the following rules are derived for the conversion of the scales.

To convert the Centigrade into Fahrenheit. Multiply the degrees of the Centigrade by 9, and divide the product by 5. When the Centigrade degrees are above 0, add 32° to the quotient; when *below* 0 (or marked —), subtract it from 32°.

To convert Réaumur into Fahrenheit. Multiply the degrees by 9, and divide the product by 4. Apply the quotient as directed above.

Ex. Centig. — 11·7, find Fahr. 11·7 × 9 = 105·3, this ÷ 5 = 21·1, which *subtracted* from 32° gives 10°·9.

To extend the Table. For the Centigrade add 0·555, &c., and for Réaumur 0·444, &c., for each 1° of Fahr.

### Table 37.

This Table contains the English measures corresponding to the *Mètre, Kilomètre, Décimètre,* and *Millimètre.*† See p. 380. Thus 30 centim. are 11·81 inches; 3 kilom. are 1·618 nautical miles.

The barometer scale, in English inches, and millimètres (approximately), is annexed.

To reduce the French to the English barometer scale. Divide the millimètres by 25·4, the quotient is the number of English inches required.

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* As numerous valuable works relating to Navigation are published by the French, and as other Continental nations frequently employ the language of that country in hydrographic documents, Tables 36 and 37 are added, for the ready reduction of such French measures as most frequently occur.

† The quantities are taken from the *Annuaire*, for 1846. The mètre is the 10-millionth part of the quadrant of a meridian.

When the French scale is given in inches and lines (or 12ths of an inch), multiply the inches by 1·065, the product is English inches.

To extend the barometer scale, add 2·54 millimètres for each 0·1 of an inch.

### Table 38. Corrections of Altitude of the Sun and Stars.

The Table contains the gross corr. of alt., or the corrections enumerated in No. 644, exclusive of index error, to the nearest tenth of a minute, using Bessel's Mean Refractions.

For examples, see No. 648.

### Table 39. The Moon's Correction of Altitude.

The Table contains the Correction to each minute of horizontal parallax and every 10′ of alt.; for the barom. 30 inches, and Fahrenheit's therm. 50°.

Ex. The corr. to app. alt. 15° 30′ and hor. par. 56′, is 50′ 31″.

For seconds of parallax. Look among the columns on the right side of the page, and against the alt., and take out the seconds, which *add* to the correction.

For minutes of altitude. Take the seconds from the extreme right of the page, and apply them as there directed.

Ex. Moon's App. Alt. 35° 37′, Hor. Par. 57′ 32″; find the Correction of Altitude.

| | | |
|---|---|---|
| 35° 30′ and 57′ | | 45′ 3″ |
| | 32″, parts 26 | |
| 7′ | parts, −4 | 22 |
| Correct. req. | | 45 25 |

To correct for the Barom. and Therm. Take the corrections from Tables 32 and 33, but apply them to the correction of alt. the *contrary way* to that directed. Ex., No. 655.

*To compute a Term.* Correct the app. alt. (of the centre) for refraction To the log. sec. of this alt. add the prop. log. of the horizontal parallax; the sum is the prop. log. of the parallax in alt. From this subtract the refraction; the rem. is the correction of alt.

The Table does not give the correction with precision at low alts.*

### Table 40. Corresponding Horizontal Parallax and Semidiameter of the Moon.

As these two elements are generally required together, the Table renders it necessary to reduce the parallax alone to the Greenwich Date.

### Table 41. Diminution of the Moon's Horizontal Parallax for the Spheroidal Figure of the Earth.

The Table is entered with the Horizontal Parallax at the top and the Latitude at the side; the seconds corresponding are to be *subtracted* from the equatorial hor. par.

The compression employed is $\frac{1}{300}$.

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* In all these tables of refraction the eye is supposed at the level of the sea; when the observer is at very great elevations, low altitudes cannot be corrected with precision by the tables in common use. The refraction is in such cases too great.

### Table 42. Augmentation of the Moon's Semidiameter.

The Table is entered with the Moon's Semidiameter at the top and her Altitude at the side; the seconds corresponding are the excess by which her apparent semidiameter at her actual altitude exceeds that at which it would appear if seen from the centre of the earth. See Nos. 439 and 440.

### Tables 43 and 44. For converting True into Apparent Altitudes.

These contain the further correction necessary in reducing a true to an apparent altitude, after *adding* the refraction and *subtracting* the parallax See Nos. 657 and 658.

### Table 45. Parallax of the Planets in Altitude.

The Table is entered with the Planet's Horizontal Parallax at the top, and its Altitude at the side; and the corresponding seconds taken out.

*To compute a Term.* Enter the Traverse Table with the alt. as course and the hor. par. as dist., and take out the D. Lat.

### Table 46 Azimuth corresponding to the Change of Altitude in $1^m$ of Time.

The Table shews the Change of Altitude in $1^m$ of Time at any Azimuth in Latitudes below 66°. The azimuth is reckoned either from N. or S.

Ex. In lat. 50°, at the azim. 40°, reckoned either from N. or S., the change of alt. in $1^m$ is 6′ and some seconds.

The Table shews also, roughly, the true bearing when the change of alt in $1^m$ is given. See also No. 677.

The column of 6′ limits the azimuth for finding the time, No. 778.

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## LATITUDE.

These Tables are employed in the rules in Chap. V., p. 243.

### Table 47. Limits of the Reduction to the Meridian at Sea.

This Table shews how long before or after noon the sun's altitude may be observed, so that the Reduction shall not be *in error* more than 2′ when the *time* is $1^m$ in error. The Table, therefore, shews the Limits of this method for common practice at sea.

If the time be in error, or doubtful, $2^m$, $3^m$, &c., the Reduction will, at the limits, be in error, or doubtful, 4′, 6′, &c. In like manner, if the error of time be less than $1^m$, that of the Reduction will be less than 2′, in the same proportion.

If the time is doubtful $2^m$, $3^m$, &c., and we require that the error of the Reduction shall not exceed 2′, we must take for the limit ½, ⅓, &c., that set down; thus, if in lat. 48° N., decl. 10° N., the time be doubtful $3^m$, we must take the alt. within ⅓ of $28^m$, and that is, $9^m$ from noon.

When the time from noon, of observation, exceeds the limits set down, the error of the Reduction (caused by $1^m$ error in the time) will exceed 2' in the same proportion; thus, in the above case, if the alt. be observed $56^m$ from noon, the error of $1^m$ in the time will cause 4' error in the Reduction.

The time in the Table is that hour-angle, nearly, at which the number of minutes (of time) is equal to the number of minutes (of arc) in the Reduction.

*To find this Hour-Angle.* To the constant 0·4771, add the log. from Table 70; the sum is the prop. log. of the hour-angle required, in time.*

## Table 48. Value of the Reduction at which the Second Reduction amounts to 1'.

The Table contains, against each Mer. Alt. under 85°, that value of the Reduction at which the 2d Reduction amounts to 1'; and therefore shews whether it is necessary or not to compute the latter.

Ex. Suppose the mer. alt. 68° and the (first) Red. computed to be 47', then the error of omitting the 2d Red. cannot amount to 1'; but if the 1st Red. were 54', the omission of the 2d Red. would cause an error of more than 1'.

*One eighth* of the quantity in this Table is that (1st) Reduction at which the 2d Red. amounts to 1".

Thus, in Ex. No. 707, p. 252, the mer. alt. is 60°, the value of the 1st Red. in the Table is 1° 3', 1-8th of which is 8'; hence, if the Red. exceed 8', the 2d Red. will exceed 1".

*To compute a Term.* To the constant 6·7648 (the sin. of 2'), add the log. cot. of the mer. alt.; half the sum (preserving 10 in the index) is the log. sine of the reduction required.

| Ex. | Const. | 6·7648 |
|---|---|---|
| Mer. alt. 60° 50' cot. | | 9·7467 |
| | | 2)16·5115 |
| Red required 1° 2' log. sin. | | 8·2557 |

To find the time from noon, or the hour-angle. to which this (1st) Reduction corresponds: from the log. sine of the Red. subtract the log. in Table 70, the remainder is the log. sine square of the time or hour-angle required.

Ex. 1. Lat. 60° N., decl. 14° N. (mer. alt. 44°), Red. 1° 24'; 8·388 − 0·130 = 8·258, the sin. sq. of $1^h\ 1^m\ 53^s$, the hour-angle required.

Ex. 2. Lat. 29° N., decl. 17° S. (mer. alt. 44°), Red. 1° 24', gives $0^h\ 47^m\ 3^s$.

These precepts concerning the Reductions are, of course, merely approximations near enough in practice.

## Tables 49 and 50. For computing the Reduction to the Meridian in Seconds. *See* No. 707.

The seconds forming part of the 1st Reduction (Table 49) are taken out to the min. and sec. of the hour-angle. When the sun is observed in the forenoon, the Table is entered with the time from midnight, for convenience.

* Mr. Towson has constructed convenient tables for reducing an alt. observed near the merid. to the mer. alt., which are published by the Hydrographic Office (J. D. Potter, agent).

The seconds for the 2d Reduction (Table 50) are taken out for the hour-angle to the nearest 10ˢ.

*To compute a Term in Table* 49. To the const. 5·615455, add the log. sine square of the hour-angle; the sum is the log. of the number of seconds.

*To compute a Term in Table* 50. To the const. 5·6155 add twice the log. sine sq. of the hour-angle; the sum is the log. of the 2d Red.

Ex. Find the Reduction, and also the 2d Red., in seconds, for the hour-angle 28ᵐ 4ˢ

| | | | | | |
|---|---|---|---|---|---|
| | Const. | 5·61545 | | Const. | 5·615 |
| H. Ang. 28ᵐ 4ˢ | sin. sq. | 7·57341 | | sin. sq. × 2 | 5·147 |
| Reduct. 1544″·8 | log. | 3·18886 | 2d Red. 5″·8 | log. | 0·762 |

### Table 51. Correction of the Altitude of the Pole-Star at Sea.

The Table is entered with the Altitude of the star at the top, and the Right Ascension of the Meridian at the side. The quantity taken out is to be applied to the star's true alt. as directed, ex. No. 773.

The last column contains the variation in ten years, which is always *subtractive* from the correction in the Table.

As the observation at sea is imperfect, the correction has been computed to whole minutes only.

The quantity is the D. Lat. answering to the star's hour-angle as course and 77′ as dist. (the star's pol. dist. in 1890), together with a second correction computed in No. 774.*

### Table 52. Reduction of the Latitude.

This is the difference between the latitude as actually found by any astronomical observation and what it would be if the earth were a sphere, which last is called the *geocentric* latitude.

To reduce the lat. by observation to the geocentric latitude, *subtract* the reduction of latitude.

This quantity, which is also called the *angle of the vertical*, is 0 at the equator and at the pole, and is greatest in lat. 45°.

The compression assumed is $\frac{1}{300}$; that is, the polar radius is supposed to be shorter than the equatorial radius by $\frac{1}{300}$ of the latter.

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## LONGITUDE.

These Tables are employed in the methods, Chapter VII. p. 297

### Table 53. Correction of the Lunar Distance for the Contraction of the Vertical Semidiameter.

The Table is entered with the Alt. at the top and the Angle contained between a plumb-line through the body, and the line joining the other body.† See No. 852.

* The Nautical Almanac method strongly recommended.

† The argument in this table, in the usual form, is the angle which the semidiameter in the direction of the other body makes with the *horizon*; but it is difficult to imagine the horizon where it is not, whereas the plumb-line is an absolute standard everywhere.

### TABLE 54. ERROR OF OBSERVATION ARISING FROM AN ERROR IN THE PARALLELISM OF THE LINE OF SIGHT.

The Table shews the Error on any observed angle less than 120°, arising from the line of sight not being parallel to the plane of the sextant or circle. See No. 495 (3).

As the observer will not, knowingly, allow this adjustment to remain defective, or observe elsewhere than in the centre of the field when the adjustment is perfect, the Table serves rather to shew the consequence of such errors than for the purpose of applying a specific correction.

*To compute a Term.* To twice the log. sine of the error in the parallelism of the telescope, add the log. tan. of half the angle measured; the sum is the log. sine of the required error in the observed angle.

Ex. Error of parallelism 12′, angle measured 97°: required the Error of the Angle.

| | | | |
|---|---|---|---|
| 12′ log. sin. 7·5429 | | × 2 | 5·0858 |
| 97°, half, 48° 30′ | | tan. | 0·0532 |
| ERROR req. 2″·8 | | sine | 5·1390 |

### TABLE 55. FOR CORRECTING THE LUNAR DISTANCE FOR THE SPHEROIDAL FIGURE OF THE EARTH.

The Table is entered with the Latitude and the Moon's Altitude. The numbers are noted to the nearest 10. See No. 853.

*To compute a Term.* To the log sine of the red. of lat. add the log. sine of the mean horizontal parallax (in Table 40=57′), and the log. sine of the alt.; the sum is the log. sine of a small arc, which multiply by 100.

### TABLE 56. FOR COMPUTING THE MOON'S *SECOND* CORRECTION OF DISTANCE.

Enter the Table with the App. Dist. at the top or bottom, and the Moon's Corr. of Alt. at the side, and take out the seconds.

In the same column take out the seconds standing against the corr. of dist. (No. 842 or 844) at the side. The difference between the two numbers thus taken out is the 2d corr. required.*

When the Dist. is *less* than 90°, *add;* when *greater*, *subtract.*

Ex. App. dist. 48°; ☽'s corr. of alt. 46; corr of dist. 26′: find the Second Corr.

| | | |
|---|---|---|
| 48° and 46′ | 17″ | |
| 26 | 6 | |
| SECOND CORR. | 11 | to be *added.* |

*To compute a Term, approximately* (1.) To square an arc in minutes. Find the square of the number of min.; divide it by 60: the quotient is the number of seconds in the square required, roughly. For greater accuracy, increase the quotient by $\frac{1}{30}$ of itself.

(2.) With the app. dist. as Course, and the said square as Dep. find the D. Lat.; *half* this is the term required.

* This 2d corr. may be dispensed with altogether by repeating the work, No. 844, p. 306 using the mean of each true and app. alt. and the mean of the app. and first found dist. The result, with care, will agree very nearly with the rigorous process.

Ex. Corr. (of alt. or of dist.) 55′, app. dist. 31°.

| | |
|---|---|
| 55 squared (by Table 8) 3025, divided by 60 | 50″·4 |
| add 1-20th | 2·5 |
| Required SQUARE of 55′ | 53 |

Dep. 53 and Course 31° give D. Lat. 88; the term is 44″.

### Table 57. Correction of the Greenwich Mean Time for the Second Difference of the Lunar Distance.

This Table is entered at the top with the Approximate Interval, and at the side, with the Diff. of the Prop. Logs. standing against the two distances in the Nautical Almanac, which include the given true distance.

For an example, see No. 857.

*To compute a Term, approximately.* Multiply together the approx. interval in hours and tenths, its compl. to $3^h$, the diff. of the prop. logs. above (attending to the decimal point), and 1400.

Ex. Approx. interval, $1^h\ 10^m$, diff. prop. logs. 64;
then $1·2 \times 1·8 \times 0·0064 \times 1400 = 19^s$, the required term.

### Table 58. The Error of the Ship's Place and of the Longitude in Time, corresponding to an error of 1′ in the Lunar Distance.

The Table is entered with the Latitude at the top, and the Prop. Log. against the lunar dist. in the Nautical Almanac at the side.

Ex. Lat. 50°, prop. log. 2800; an error of 1′ in the lunar dist. will cause an error of 19 miles in the ship's place, in Departure, and $2^m\ 0^s$ ERROR OF LONG. IN TIME.

Since it is the actual distance of the ship from the shore that we are concerned with at sea, rather than the nominal diff. of long., this Table will afford a useful check on the supposed place of the ship in making the land by a lunar observation.

The error of long. in time is also the error of the G. M. Time, as determined by a lunar observation.

*To compute a Term.* Divide 2700 by the 3-hourly change in minutes; the quotient is the error in min. of long. in arc at the equator. For any particular latitude see No. 307.

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## TABLES FOR DETERMINING THE VARIATION OF THE COMPASS.

These Tables are employed in Chapter VIII. p. 326.

### Table 59. Amplitudes.

The Table shews the True Amplitude of the sun (or of any other celestial body, having the same declination), at rising or setting. It is entered with the Decl. at the top and the Lat. at the side.

To find the Amplitude by the Traverse Tables. With 0 and the lat.

find M. With M as Dist., and the Decl. as Course, find the Dep. With 100 as Dist. and this Dep. find the Course.

*By Computation.* To the log. sec. of the lat. add the log. sine of the Declin.; the sum is the log. sine of the amplitude.

Ex. Lat. 17°, Decl. 23°: find the Amplitude.

| | | |
|---|---|---|
| Lat. | 17° 0′ | sec. 0·0194 |
| Decl. | 23 0 | sine 9·5919 |
| AMPLITUDE, | 24° 7′ | sin. 9·6113 |

TABLE 59 A. CORRECTION OF THE OBSERVED AMPLITUDE.

The Table shews the Change produced on the Amplitude by the joint effect of the refraction at the horizon (assumed at 33′), and the height of the eye, supposed 16 feet. An example is given in No. 886.

To find the correction for any other height of the eye. To 33′ add the Dip, multiply the sum by the correction in the Table, and divide by 37; the quotient is the correction required.

Ex. Lat. 55°, decl. 23°, height of the eye 100 feet; 33 and 10 are 43, which, multiplied by 1·4 and then divided by 37, gives 1° 6, the CORRECTION required.

## TABLES TO SUPPLY THE PLACE OF THE NAUTICAL ALMANAC.

These Tables, which afford for several years approximate values of the quantities contained in them, are useful on various occasions, and may serve for the ordinary purposes of navigation. But when much accuracy is required, and whenever the moon is employed, recourse must be had to the Nautical Almanac.

TABLE 60. DECLINATION OF THE SUN.

The Table contains the Declination for each day of the years 1901, 1902, 1903, and 1904, to the nearest minute.

TABLE 60 A. CORRECTION OF THE SUN'S DECLINATION IN TABLE 60 FOR THE YEARS FOLLOWING 1901, &c.

The Table contains the Corrections by which the declination for any day on one of the four years enumerated may be converted into that for the same day on any following year, till 1928.

When the declination is *increasing, add the correction*; when *decreasing, subtract it.*

Ex. 1. Feb. 3rd, 1914, find the Sun's declination.

1914 answers to 1902.
1902, Feb. 3rd, 16° 42′ S. (decr.)
Corr. 1′·6, or −2
DECLIN. req. 16 40 S.

Ex. 2. Sept. 27th, 1920, find the Sun's declination.

1920 answers to 1904.
1904, Sept. 27th, 1° 34′ S. (incr.)
Corr. 2′·8 +3
DECLIN. req. 1 37 S.

If the correction when subtractive exceed the declination itself, take the less from the greater, and consider the remainder as the declination required, and of the *contrary* name to that given.

The correction is additive when the declination is increasing, and subtractive when decreasing, thus changing from one to the other at the equinoxes and solstices.

*To compute this Correction* for reducing approximately the declination of the sun for any year, by means of the declination for any four successive years, the following rule is given by Mackay, in his Complete Navigator.

Note the number of *fours* necessary to reduce the proposed year to one of the years in the table.

Take the difference of the declination (for the year thus found), to the given and following days. Multiply this difference by the number of fours, and divide by 33: the quotient is the correction required, in minutes.

Ex. (1. above.) 1890 reduced by fours gives 1878, the number of fours being 3.

The daily diff. of the decl. on the 3d and 4th is 18, which multiplied by 3 is 54, this divided by 33 gives about 1′·6, the CORR. required to be *subtracted*.

Since, at the equinoxes the correction changes suddenly from additive to subtractive, or from *sub.* to *add*, and since applying it wrongly would cause an error of double the amount of the correction, it is advisable, in case of doubt, to find the declin. for some days before the equinox, and to subtract from it the daily variation, which at this season varies uniformly for several days.

### Table 61. Sidereal Time and Right Ascension of the Sun.

The Table contains the Sidereal Time for the years 1901, 1902, 1903, and 1904, to the nearest tenth of a minute.

N.B.—The Sun's Right Ascension to the nearest tenth of a minute may be found by applying the Equation of Time in Table 62 to the Sidereal Time as there directed. See p. 209, and Note, p. 211.

### Table 62. The Equation of Time.

The Table contains the Equation of Time for apparent noon for 1901, 1902, 1903, and 1904, to the nearest second. The Equation for each year will serve very well for common purposes for the 4th or 8th year afterwards. The error will be greatest from the latter end of May to the middle of July, when it may amount to $2^s$ or $3^s$ in a period of 4 years, or about $7^s$ in four or five such periods. Towards the beginning or end of the year the error will not much exceed $2^s$ or $3^s$, even for a considerable number of years.

### Table 63. Mean Places of the Principal Fixed Stars.

The Table contains the mean places of sixty-six stars, for the 1st of January, 1900. The mean places may be reduced for any antecedent or subsequent year by applying, as directed in the Table, the annual variation in R.A., and in declination, multiplied by the number of years exceeding 1900.

To find the place for any year prior to 1900, the variation must be applied the contrary way to that directed.

The right ascension and declination of every star change during the year. The change of right ascension is, for most of the stars in the Table, between $4^s$ and $6^s$; that of declination between 15″ and 40″. Among the stars which change their right ascension least are Spica, and α Cygni, the

change being between $3^s$ and $5^s$. The stars Capella, $\alpha$ Pavonis, and $\alpha$ Triang. Austr., change their right ascension about $6^s$, $7^s$, and $9^s$, respectively, during the year. These stars are therefore less favourable than others for finding the latitude by double altitude, or the time. The star $\alpha'$ Crucis changes its declination $\frac{3}{4}$ of $1'$ from one part of the year to another. The variation of the right ascension of Polaris amounts to more than $2^m$; that of declination to nearly $1'$. In this Table + signifies *add*, and − *subtract*.

As the variations of right ascension occupy several months, their effects would not be sensible in rating a chronometer by the method, No. 821.

As the stars are given in this Table for the purpose of finding the latitude or time in different parts of the world at any hour of the night, they are selected nearly equally from all parts of the heavens, and the list does not necessarily include all stars above, or exclude all stars below, any particular magnitude,

The figures 1, 2, 3, indicate the first (or largest), second, and third magnitudes. The figures 1, 2, denote a magnitude between the 1st and 2d; and the figures 2, 3, a magnitude intermediate between the 2d and 3d.*

## LOGARITHMS

These Tables are used in those parts of the several computations which are effected by logarithms. The more general tables stand first, and the others follow nearly in the order already observed.

### Table 64. Logarithms of Numbers.

The Table contains the logs. of numbers from 1 to 9999, to six places, with differences and proportional parts.

The diff. D. is the mean of the diffs. between each log. and the succeeding one in the same line; and is near enough for most cases.

I. *Direct process;* to find the logarithm of a given number.

1. To find the logarithm to any number consisting of two or three figures. Look for the number at the side, and take out the log. against it. Thus, the log. of 717 is 855519.†

2. To find the logarithm of a number consisting of four figures. Look for the three first figures at the side, and the fourth at the top; thus, the log. of 7176 is 855882.

3. To find the logarithm of a number consisting of more than four figures. Find the log. of the first four figures; find the diff. D. in the lower part of the Table, in column D, and against it, under the 5th figure (or 6th, if required), are the parts, which add.

*Note.*—Observe to set down the parts correctly, carrying those for the 6th figure one place to the right of the parts above them, as a mistake frequently occurs here.

* Sir John Herschel having, soon after the appearance of this work, favoured me with a communication respecting the magnitudes or relative brilliancy of the stars, to which that distinguished astronomer has paid particular attention, I have altered the numbers marked against several of the stars in the first edition.

† This, however, is only part of the complete logarithm, as adapted to the purposes of computation by logarithms, and requires the *index*. See Nos. 57 and 58.

Ex. 1. (*Five figs.*) Find the log. of 26574.

| | | |
|---|---|---|
| 2657 log. | 424392 | D. 164 |
| Against D. 164, under 4 | 66 | |
| Log. req. | 424458 | |

Ex. 2. (*Six figs.*) Find the log. of 265748.

| | | |
|---|---|---|
| 2657 log. | 424392 | D. 164 |
| 4 (parts 66) | 66 | |
| 8 (parts 131 ÷ 10) | 13 | |
| Log. req. | 424471 | |

II. *Inverse Process;* to find the number corresponding to a given log.

1. When the natural number is not required to consist of more than four figures, it is taken out at once.

Ex. Given the log. 645820, required the natural number.

The nearest log. in the Table is 645815; the figures at the side are 442, annexing to which that at the top, or 4, gives 4424, the NUMBER required.

The placing of the decimal point is directed in No. 59.

2. When the Number is to consist of *five* figures. Take out the next less log. to the one given, and note down the four figures of the corresponding number. Note the diff. D.

Subtract this next less log. from the given one, and look for the remainder among the parts standing against D, in the lower part of the Table; note the figure at the top under which the remainder is found, and add it to the four taken out.

3. When the Number is to consist of *six* figures, the more direct and accurate method is to take the diff. between the given log. and the next less in the Table, annex 2 ciphers, and divide by the diff. between the next less and the next greater; the quotient is the number of figures to be annexed to the natural number, answering to the *next less* log.

The placing of the decimal point is directed in No. 59.

Ex. 1. (*Five figs.*) Find the No. to the log. 424471.

| | | |
|---|---|---|
| Given | 424471 | |
| Next less (2657) | 424392 | D. 164 |
| Rem. | 79 | |
| 5th fig. 4, next less | 66 | |
| Numb. req. | 26574 | |

Ex. 2. (*Six figs.*) Find the No. to the log. 424471.

| | | |
|---|---|---|
| Given log. | 424471 | |
| Next less (2657) | 424392 | 79 |
| Next greater | 424555 | 163 |

Then 7900 ÷ by 163, gives 48, and the numb. req. is 265748.

### Table 64a.

Spheroidal Tables; showing the length in feet of a degree, minute, and second of lat. and long.; the corresponding number of statute miles in every even degree of lat.; and number of nautical miles contained in a degree of long. under each even degree of lat.

### Table 65. Natural Sines, Cosines, &c.

These quantities are convenient for working problems such as that given in No. 254.

### Table 66. Log. Sines of Small Arcs to each Second.

The Table contains the log. sines from 0 to 1° 30′ (or log. cosines from 88° 30′ to 90°), to each second. Five places are given as far as 1° and six beyond. The Table is applicable to log. tangents, thus: to find the log. tan. add the log. sec. to the log. sine; to find the arc to a given log. tan., find it as for a sine, subtract from the given log. the log. sec., and consider the rem. as a sine

For 10ths of seconds proceed by proportion, or, in very small arcs, as directed for proportional logarithms. The last method is true in the 5th place for arcs under 5′.

TABLE 67 LOG. SINES OF SMALL ARCS TO TEN SECONDS.

The Table contains the log. sines from 1° 30′ to 4° 30′ (or the log cosines from 85° 30′ to 88° 30′), to each 10″, with parts for single seconds.

The parts are true for each 2′ and 7′ in the units' place of the arc, and very nearly for others, as the parts under 32′ serve from 1° 30′ to 1° 35′, and those under 37′, from 1° 35′ to 1° 39′. The error of using one column for the next will rarely amount to half a second.

The parts for the log. cos. are to be taken as for the sine of the compl. of the arc; thus, the parts for cos. of 87° 42′, being those for sine of 2° 17′ are found under 17′.

*Direct Process.* Find the sine or cos. for the next less 10″, *add* the parts for the sine, *subtract* those for the cosine.

Ex. 1. The log. sine of 2° 22′ 37″ is 8·617417 for 2° 22′ 30″, *adding* the parts under 22′ for 7″, or 356, which gives 8·617773. The log. cos. of 87° 46′ 14″ is 8·590181 for 87° 46′ 10″, *deducting* 218 (the parts for 4″ under 12′), or 8·589963.

*Inverse Process.* For the sine look for the next less; for the cosine look for the next greater; note the deg., min., and 10″.

Take the diff. between the sine or cos. taken out and the given one; look for it in the col. of parts; take out the corresponding seconds and add them.

Ex. 1. Find the arc to the log. sine 8·508462.

| | | | |
|---|---|---|---|
| | | Given | 8·508462 |
| Arc | 1° 50′ 50″ | Next less | 8·508321 |
| | 2 | Pts. at 32′ | 141 |
| Arc req. | 1 50 52 | | |

Ex. 2. Find the arc to the log. cosine 8·758561.

| | | | |
|---|---|---|---|
| | | Given | 8·758561 |
| Arc | 86° 42′ 40″ | Next gr. | 8·758688 |
| | 3 | Pts. at 17′ | 127 |
| Arc req. | 86° 42 43 | | |

For extreme precision proceed by proportion.

The Table is used for tangents by the rules in expl. Table 66.

TABLE 68. LOGARITHMIC SINES, COSINES, TANGENTS, COTANGENTS, SECANTS, AND COSECANTS.

The Table contains the terms to half-minutes, and to six places.

The second column and the last but one contain a time scale, corresponding to the upper and lower degree; thus 73° 33′ 30″ corresponds to $4^h$ $54^m$ $14^s$. This scale is very convenient for converting arc and time, but it is introduced to suit those rules in which the time itself is an argument.

The parts for each second are given, beyond 9°; from 4° to 9°, to each 10″; but under 4° the variation is too rapid for their insertion, and recourse will be had for precision to Tables 66 and 67.* The parts are true for the *middle* term of the argument; thus, the parts from 20° 30′ to 20° 45′, are true for 20° 37′½, and approximate for the rest, but the inaccuracy in the extreme case corresponds only to ⅛ of 1″.

It is, of course, the more correct way to take the parts with reference to the *nearest* term, and to apply them accordingly; thus, to find the sine of 9° 40′ 28″, find it for 9° 40′ 30″, and *subtract* the parts for 2″.

* The diff. D., in the early portion (inserted merely for uniformity), is not that of two consecutive terms, but corresponds to *half* the tabular interval on *both* sides of a term. This is done to avoid breaking the continuity of the horizontal lines, which must occur when actual diffs. are exhibited, and is teasing to the eye.

For greater accuracy proceed by proportion.

*Direct Process.* When the given angle is less than 45°, its log. sine, &c. are taken from the top; when greater than 45°, from the bottom; thus, the log. sine of 28° 17′ is 9·675624; the log. sine of 84° 3′ is 9·997654. In like manner, the log. sine 9·452060 corresponds to the arc 16° 27′, the cotangent 9·47714 to the arc 73° 18′.

The log. sine of an angle is the log. cosine of the complement of the angle to 90°, whether in excess or defect; so, likewise, the log. cosine is the log. sine of the complement; and the like holds of the tangent and cotangent, secant and cosecant.

When the given angle exceeds 90°, find the log. sine, tangent, or secant, for the supplement to 180°. But it is generally easier to find the log. *co*-sine, *co*-tangent, and *co*-secant, for the *excess* above 90°.

Ex. 1. The log. sine of 127° 50′ is the log. sine of 52° 10′, or the log. cos. of 37° 50′, which is 9·897516.

Ex. 2. The log. cos. of 163° 49′ is the log. cos. of 16° 11′, or the log. sine of 73° 49′, which is 9·982441.

Ex. 3. The log. cosec. of 97° 4′ is the log. cosec. of 82° 56′, or the log. sec. of 7° 4′, which is 0·003312.

In like manner to find the log. *co*-sine, *co*-tangent, or *co*-secant, of an arc above 90°, take out the log. sine, tangent, or secant, of the excess above 90°.

To find the log. sine, &c. of an arc given to seconds. Find the log. sine (or cosine, &c.) for the next less minute or half-minute; take out the part for the seconds, or for the excess above 30″.

For the sine, tangent, and secant, *add* the parts.

For the *co*-sine, *co*-tangent, and *co*-secant, *subtract* them.

Ex. 1. Find the log. sine of 53° 25′ 13″.

| | |
|---|---|
| 53° 25′ 0″ sine | 9·904711 |
| 13 parts | + 20 |
| Log. sine req. | 9·904731 |

Ex. 2. Find the log. tan. of 11° 19′ 54″.

| | |
|---|---|
| 11° 19′ 30″ tan. | 9·301624 |
| 24 parts | + 262 |
| Log. tan. req. | 9·301886 |

Ex. 3. Find the log. sec. of 38° 42′ 46″.

| | |
|---|---|
| 38° 42′ 30″ | 0·107716 |
| 16 parts | + 27 |
| Log. sec. req. | 0·107743 |

Ex. 4. Find the log. cosine of 72° 10′ 45″.

| | |
|---|---|
| 72° 10′ 30″ | 9·485879 |
| 15 parts | − 98 |
| Log. cos. req. | 9·485781 |

Ex. 5. Find the log. cotang. of 84° 3′ 22″.

| | |
|---|---|
| 84° 3′ 0″ cot. | 9·017959 |
| 20 parts 408 } | |
| 2 41 } | − 449 |
| Log. cotang. req. | 9·017510 |

Ex. 6. Find the log. cosec. of 68° 14′ 11″.

| | |
|---|---|
| 68° 14′ 0″ cosec. | 0·032124 |
| 11 parts | − 9 |
| Log. cosec. req. | 0·032115 |

In working to five places, the last figure of the parts must be dropped, the remainder being increased by 1 when the figure dropped exceeds 5.

In working to 1ˢ of time, the parts for 15″ are to be employed. In the earlier part of the Table, *half* the D. for 30″ may be conveniently employed.

It is convenient in dealing with parts of contrary application, to mark those *additive* with +, and *subtractive* with −; to sum each kind separately; and to take the diff. of the two sums, marking it with the sign of the greater. An example will be found, p. 264, top, the parts are, + 18, + 5, − 97, and + 35; the sum of the + ones is + 58, then the difference between 58 and 97 is 39, to be marked − 39, or subtractive.

*Inverse Process.* To find the Arc, to seconds, corresponding to a given log. sine &c.:

For the sine, tangent, or secant, take out the next *less*; for the *co*-sine, *co*-tangent, or *co*-secant, take out the next *greater*; and note the degree and minute, or half-minute, of the quantity thus taken out.

Take the diff. between this quantity and the given one; find the remainder in the column of Parts; take out the seconds corresponding and add them to the arc noted.

**Ex. 1.** Find the arc to the log. sine 9·202470.

| | | |
|---|---|---|
| | Given | 9·202470 |
| 9° 10′ 0″ | Next less | 202234 |
| 18 | Rem. | 236 |
| Arc req. 9 10 18 | | |

**Ex. 2.** Find the arc to the log. cosine 9·897796.

| | | |
|---|---|---|
| | Given | 9·897796 |
| 37° 47′ 0″ | Next gr. | 897810 |
| 8 | Rem. | 14 |
| Arc req. 37 47 8 | | |

When the parts are not given for seconds beyond 10 (as for the log. sine and tang. from 4° to 8°), if the remainder exceeds the parts given, take away the parts for 10″ or 20″; add 10″ or 20″ accordingly, and also the seconds corresponding to this last remainder.

**Ex. 1.** Find the arc to the log. tangent 9·127945.

| | | |
|---|---|---|
| | Given | 9·127945 |
| 7° 38′ 30″ | Next less | 127651 |
| | | 294 |
| 10 | Parts | 160 |
| 8 | Rem. | 134 |
| Arc req. 7 38 48 | | |

**Ex. 2.** Find the arc to the log. cosec. 10·881005.

| | | |
|---|---|---|
| | Given | 10·881005 |
| 7° 33′ 0″ | Next gr. | 881433 |
| | | 428 |
| 20 | Parts | 318 |
| 7 | Rem. | 110 |
| Arc req. 7 33 27 | | |

When greater precision than that afforded by the parts is required, the log. sine, &c., or the arc, may be found by means of the proportional part of the diff. between two terms, or for 30″.

The log. cosec. is the arith. compl. of the log. sine.

The log. cotan. is the ar. co. of the log. tan.

The log. sec. is the ar. co. of the log. cosine.

The log. tan. is the sum of the log. sine and log. secant; thus all may be obtained from the log. sine.

## Table 69. Log. Sine Square.*

The title is an abbreviation of *the logarithm of the square of the sine of half the arc.* The log. sine square is given to each 15″ of arc or 1ˢ of time. In order to lessen the bulk of the table, the index, and one or two figures, are taken up at the head of the column, unless these figures change, when the whole is given in full. Five places only are inserted as far as $0^h\ 44^m$, and six afterwards.

Each column contains 15′, or $1^m$; the minutes and quarters (of arc), above the next less 15′, are given on the left-hand side, and the seconds of time on the right. Thus the log. sine square of 143° 37′ 15″, or 9·955473, is found under 143° 30′ and against 7′ 15″, and corresponds to $9^h\ 34^m\ 29^s$

The parts for seconds, when not the same for the whole page, are given for the first and last columns; parts for intermediate columns are therefore between the given parts.

1. *Direct Process.* To find the log. sine square of an arc to the *nearest second.* Take the log sin. sq. for the next less 15″, and add the parts for the seconds.

To find the log. sine square for the *tenth of a second of time.* Consider

* This table is identical with the Log. Haversines of Inman's Tables.

the tenths as seconds of arc, take out the parts, increase them by half, and add the sum to the log. sine square of the whole second.

Ex. 1. Find the log. sine square of 38° 11′ 22″.

| | |
|---|---|
| 38° 11′ 15″ | 9·029400 |
| 7 parts | 43 |
| Log. sin. sq. req. | 9·029443 |

Ex. 2. Find the log. sine square of $3^h\ 42^m\ 57^s{\cdot}3$.

| | |
|---|---|
| $3^h\ 42^m\ 57^s$ | 9·339466 |
| parts to 3″, 12, 12 + 6 = | 18 |
| Log. sin. sq. req. | 9·339484 |

The log. sine square to seconds in the early part of the Table, where, on account of the great and irregular variation, no parts are given, is found by proportion.

Ex. Find the log. sine square of 1° 36′ 4″.

| | |
|---|---|
| 1° 36′ 0″ | 6·28991 |
| 1 36 15 | 29217 |
| diff. | 226 |

Then 15 : 226 :: 4 : 60, the parts, and the log. sine square required is 6·29051.

2. *Inverse Process.* To find the arc, to 1′, corresponding to a given log. sine square. From the given log. sine square subtract the next less in the Table, to which take out the arc, noting it down.

Find the seconds at the bottom corresponding to the difference, and add them to the arc.

Ex. Find the arc, to 1″, corresponding to 9·029443.

| | |
|---|---|
| Next less 9·029400, arc 38° 11′ 15″ | |
| given | ·029443 |
| diff. | 43 |

43 at D. 90 gives 7″, which added to 38° 11′ 15″ give the arc required, 38° 11′ 22″.

To find the time, to the tenth of a second, corresponding to a given log. sine square.

Find the time corresponding to the next less log. sine square in the table Take the diff. between the given and the next less logs. Find this diff. among the parts; take out the seconds of arc corresponding, and subtract from it 1–3d of itself. The rem. is the number of tenths, to be added to the time of the next less.

The above is correct enough for common practice, but for greater precision the difference between two terms must be employed, and the result deduced by proportion.

*To compute a Term.* Take the log. sine of half the arc and double it.

## Table 70. Logarithms for computing the Reduction to the Meridian at Sea.

The Table is entered with the Declination at the top and the Latitude at the side. The cases omitted are not eligible. See No. 700.

The cases which appear above the vacant spaces in Part I. are those in which the body passes the meridian between the pole and the zenith; those below the spaces are the more common cases, or those which occur between the tropics and the arctic circles.

*To compute a Term.* Add together 0·30103, the log. cosines of the lat. and decl., and the log. sec. of the meridian altitude.

The process of computing the meridian alt. may be avoided thus: when the lat. and decl. are of the *same* name, employ the log. cosec. of their *difference* (unless the body is below the pole, when employ the cosec. of their sum), when of *contrary* names, the cosec. of their *sum*.

Ex. 1. (*Same* name.) Lat. 9° N., Decl. 17° N.

| | | | |
|---|---|---|---|
| | | | 0·3010 |
| Lat. | 9° | cos. | 9·9946 |
| Decl. | 17 | cos. | 9·9806 |
| Diff. | 8 | cosec. | 0·8564 |
| Log. required | | | 1·1326 |

Ex. 2. (*Contrary* names.) Lat. 9° N., Decl. 17° S.

| | | | |
|---|---|---|---|
| | | | 0·3010 |
| Lat. | 9° | cos. | 9·9946 |
| Decl. | 17 | cos. | 9·9806 |
| Sum | 26 | cosec. | 0·3582 |
| Log. required | | | 0·6344 |

When the lat. exceeds 62° or the decl. exceeds 23°, the logarithm must be computed.

## Table 71. Logarithms for computing the Correction of the Latitude by Account.

The Table is entered with the two Azimuths, either of the same body at different times, or of two different bodies. See No. 752 (7).

The cases omitted are not eligible.

Part I. is used when both altitudes are taken on the *same* side both of the meridian and prime vertical, and Part II. when on *different* sides of either of these circles.

*To compute the Log. for Part I.* To 8·8239 add the log. cosecants of the azimuths, and the log. sine of their *difference*.

*For Part II.* To 8·8239 add the log. cosecants of the azimuths, and the log. sine of their *sum*.

Ex. 1. Azimuths S. 70° W. and S. 11° W. (or *same* side).

| | | | |
|---|---|---|---|
| | | | 8·8239 |
| Az. | 70° | cosec. | 0·0270 |
| Az. | 11 | cosec. | 0·7194 |
| Diff. | 59 | sin. | 9·9331 |
| Log. required | | | 9·5034 |

Ex. 2. Azimuths S. 70° W. and S 11° E., or N. 70° W. and S. 11° W. (or *different* sides).

| | | | |
|---|---|---|---|
| | | | 8·8239 |
| Az. | 70° | cosec. | 0·0270 |
| Az. | 11 | cosec. | 0·7194 |
| Sum | 81 | sin. | 9·9946 |
| Log. required | | | 9·5649 |

## Table 72. Logarithms for computing the Equation of Equal Altitudes.

These are given to each $10^m$. See No. 806 (4).

*To compute Log. A* To 3·28534 add the log. of the interval (in seconds of time), and the log. cosec. of half the interval; take the arith. compl. of the sum.

*To compute Log. B.* To 3·28534 add the log. of the interval (in seconds), and the log. cot. of half the interval; take the arith. compl. of the sum.

Ex. Interval $4^h\ 30^m$. Compute the logs. A. and B.

| | | |
|---|---|---|
| | | 3·28534 |
| $4^h\ 30^m = 16200^s$ | log. | 4·20951 |
| 2 15 | cosec. | 0·25526 |
| | | 7·75011 |
| | Log. A. | 2·24990 |

| | |
|---|---|
| | 3·28534 |
| | 4·20951 |
| $2^h\ 15^m$ cot. | 0·17511 |
| | 7·66996 |
| Log. B. | 2·3300 |

## Table 73. The Logarithmic Difference.

This quantity is given for Fahrenheit's thermometer at 50°, and the Barometer at 30 inches.

The Table is entered like Table 39. The parts for " of parallax and for ' of alt. are applied as directed in the Table.

The parts for the sun's or star's alt. are given at the bottom.

To correct the log. diff. for any other height of the thermometer and barometer than those given in the Table. Find the correction of the mean refraction for each body by Tables 32 and 33.

With the moon's alt. and her atmospherical correction, thus found, as seconds of parallax, take out the parts.

With the sun's (or star's) alt. as the moon's alt., and his atmospher. corr. as seconds of parallax, take out the parts.

When the atmospherical correction is +, *add* the parts to the mean or ordinary log. diff.; when —, *subtract* them.

Ex. (Mean state.) ☽'s app. alt. 27° 18′; hor. par. 60′ 42″; ⊙'s alt. 10° 20′.

| | | |
|---|---|---|
| 27° 10′ and 60′ | | 9·996721 |
| 8′ parts | −17 | |
| 42″ | −42 | |
| ⊙ 10° | − 8 | −67 |
| Required Log. diff. | | 9·996654 |

Ex. The same corrected for bar. 29·2, and therm. 84°.

| | | | |
|---|---|---|---|
| Mean log. diff. | | | 9·996721 |
| | | pts. −67 | |
| ☽ Th. 84° | −8″ | | |
| Bar. 29·2 | −3 | | |
| ☽ Atmos. corr. | −11 | −11 | |
| ⊙ Th. 84° | −20 | | |
| Bar. 29·2 | − 9 | | |
| ⊙ Atmos. corr. | −29 | −11 | −89 |
| Log. diff. | | | 9·996632 |

When a planet is employed, consider it as a star, and its horizontal parallax as seconds of moon's parallax. With its alt. take out the parts and *subtract* them.

*To compute the Log. Diff.* Add together the log. secants of the app. alts., and the log. cosines of the true alts.; the sum is the log. diff.

Ex. ☽ A. Alt. 27° 18′, Hor. Par. 60′ 42″. ⊙ A. Alt. 10° 20′: required the Log. Diff. for the mean state of the atmosphere, as also for the therm. 84°, and barom. 29·2 in.

Mean State.

| | | | | | |
|---|---|---|---|---|---|
| ☽ | 27° 18′ | 0″ | sec. | 0·051285 |
| | +52 | 5 | | | |
| | 28 10 | 5 | cos. | 9·945255 |
| ⊙ | 10 20 | 0 | sec. | 0·007102 |
| | −5 | 2 | | | |
| | 10 14 | 58 | cos. | 9·993014 |
| | | | Log. diff. | 9·996656 |

Corrected for Therm. and Barom.

| | | | | |
|---|---|---|---|---|
| ☽ | 27° 18′ | 0″ | sec. | 0·051285 |
| | +52 | 16 | | |
| | 28 10 | 16 | cos. | 9·945243 |
| ⊙ | 10 20 | 0 | sec. | 0·007102 |
| | −4 | 33 | | |
| | 10 15 | 27 | cos. | 9·993003 |
| | | | Log. diff. | 9·996633 |

The results by the two methods agree as nearly as can be expected from processes in which each of the several parts employed has its own particular inaccuracy.

## Table 74. Proportional Logarithms.

These logarithms are given to every second of time, or arc, for $3^h$ or 3° The Table is entered with the hour or degree and the minute at the top, and the second at the side; thus the prop. log. of 1° 2′ 27″ or of $1^h\ 2^m\ 27^s$ is 4597, that of $1^m\ 2^s$ is 2·2410. The index 0 proper to quantities above $19^m$ (or 19′) is suppressed for convenience.

To find the prop. log. of an arc under 18′, to the tenth of a second. Put the proper index, and find the decimal part due to ten times the arc.

Ex. Find the prop. log. of 7′ 13″·7; the index of 7′ 13″ is 1; the dec. part of the log. due to 70′ 137″, or 72′ 17″, is 3962, the prop. log. required is 1·3962.

So the prop. log. of an arc, under 1′ 48″ may be found to the hundredth of a second by multiplying by 100.

To find the arc or time to the *tenth* of a second to a given prop. log. exceeding 1·0000. Look in the Table till the decimal part again occurs, and divide the arc by 10.

**Ex.** Find the time to the prop. log. 2·5106. Look for 1·5106; the nearest found is 1·5110, against $5^m\ 33^s$, or $333^s$; hence the time required is $33^s·3$.

Four places are enough for common purposes; but since the fourth place ceases to change by 1 after $1^h\ 13^m$, a greater time than this cannot be found truly to $1^s$. So also, a time exceeding $2^h\ 25^m$ cannot be found truly to $2^s$. This defect may be avoided in some cases by employing the complement of the interval to $3^h$.

To convert a given log. sine of an arc less than 1° 30′ into a prop. log. add 8·7190 to its arithmetical complement. To convert a prop. log. of an arc into a log. sine, less than 1′½, add 8·7190 to its arith. compl.

Ex. 1. Convert the log. sine 8·3507 into a prop. log.

| | | |
|---|---|---|
| | log. sine | 8·3507 |
| | ar. co. | 1·6493 |
| | const. | 8·7190 |
| Arc 1° 17′ 5″ | Prop. Log. | 0·3683 |

Ex. 2. Convert the prop. log. of 0° 25 0″, or 8573, into a log. sine.

| | |
|---|---|
| pr. log. | 0·8573 |
| ar. co. | 9·1427 |
| | 8·7190 |
| Log. sine | 7·8617 |

When the terms of an analogy are all sexigesimals, the rules given in p. 20, Nos. 64, &c., apply to the proportional logarithms; but if two of the terms are not sexigesimals, the arith. complements of the logs. of these last must be used.*

*To compute a Prop. Log.* From 4·03342 (the log. of 10800, the number of seconds in $3^h$ or 3°) subtract the log. of the given time or arc in seconds; the result is the prop. log. required.

**Ex.** Find the prop. log. of $2^h\ 11^m\ 28^s$.

| | | |
|---|---|---|
| | const. | 4·03342 |
| $2^h\ 11^m\ 28^s = 7888^s$, | log. | 3·89697 |
| | Prop. log. | 0·13645 |

**The Tables close with the Abbreviations adopted in the Admiralty Charts, with explanatory notes. These should be committed to memory by sailors.**

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* The proportional logarithms are often convenient, but they might be replaced with advantage by common logarithms. The prop. logs., unlike the common logarithms, continually *decrease* instead of *increasing* with the argument. This progression is always repugnant to the mind, and should be avoided when the change involves no sacrifice Again, these logarithms require every factor with which they are combined to be inverted, that is, for ex., instead of multiplying by 2, they oblige us to divide by 2. This, even to an expert computer, is the cause of perpetual mistakes in the changing of constants; but to a beginner it has the mischievous effect of entirely destroying, in processes which may nevertheless be identical, every vestige of analogy.

If common logarithms, with the same scale and the index prefixed, were employed, the logarithm attached, in the Nautical Almanac, to the lunar distance, would involve the constant for $3^h$. Such logarithms would answer all the present purposes without being open to any of the above objections; the log. in the Nautical Almanac would then be additive instead of subtractive. The proportional logarithms, originally computed for the purpose of simplifying a single step in a single computation, are an example of the ill effects of sacrificing general utility to a partial end; and the substitution of others, at a favourable opportunity, is recommended as a reform deserving attention.

# TABLES.

## TRAVERSE TABLE TO DEGREES

1° 0h 4m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1·0 | 0·0 | 61 | 61·0 | 1·1 | 121 | 121·0 | 2·1 | 181 | 181·0 | 3·2 | 241 | 241·0 | 4·2 |
| 2 | 2·0 | 0·0 | 62 | 62·0 | 1·1 | 122 | 122·0 | 2·1 | 182 | 182·0 | 3·2 | 242 | 242·0 | 4·2 |
| 3 | 3·0 | 0·1 | 63 | 63·0 | 1·1 | 123 | 123·0 | 2·1 | 183 | 183·0 | 3·2 | 243 | 243·0 | 4·2 |
| 4 | 4·0 | 0·1 | 64 | 64·0 | 1·1 | 124 | 124·0 | 2·2 | 184 | 184·0 | 3·2 | 244 | 244·0 | 4·3 |
| 5 | 5·0 | 0·1 | 65 | 65·0 | 1·1 | 125 | 125·0 | 2·2 | 185 | 185·0 | 3·2 | 245 | 245·0 | 4·3 |
| 6 | 6·0 | 0·1 | 66 | 66·0 | 1·2 | 126 | 126·0 | 2·2 | 186 | 186·0 | 3·2 | 246 | 246·0 | 4·3 |
| 7 | 7·0 | 0·1 | 67 | 67·0 | 1·2 | 127 | 127·0 | 2·2 | 187 | 187·0 | 3·3 | 247 | 247·0 | 4·3 |
| 8 | 8·0 | 0·1 | 68 | 68·0 | 1·2 | 128 | 128·0 | 2·2 | 188 | 188·0 | 3·3 | 248 | 248·0 | 4·3 |
| 9 | 9·0 | 0·2 | 69 | 69·0 | 1·2 | 129 | 129·0 | 2·3 | 189 | 189·0 | 3·3 | 249 | 249·0 | 4·3 |
| 10 | 10·0 | 0·2 | 70 | 70·0 | 1·2 | 130 | 130·0 | 2·3 | 190 | 190·0 | 3·3 | 250 | 250·0 | 4·4 |
| 11 | 11·0 | 0·2 | 71 | 71·0 | 1·2 | 131 | 131·0 | 2·3 | 191 | 191·0 | 3·3 | 251 | 251·0 | 4·4 |
| 12 | 12·0 | 0·2 | 72 | 72·0 | 1·3 | 132 | 132·0 | 2·3 | 192 | 192·0 | 3·4 | 252 | 252·0 | 4·4 |
| 13 | 13·0 | 0·2 | 73 | 73·0 | 1·3 | 133 | 133·0 | 2·3 | 193 | 193·0 | 3·4 | 253 | 253·0 | 4·4 |
| 14 | 14·0 | 0·2 | 74 | 74·0 | 1·3 | 134 | 134·0 | 2·3 | 194 | 194·0 | 3·4 | 254 | 254·0 | 4·4 |
| 15 | 15·0 | 0·3 | 75 | 75·0 | 1·3 | 135 | 135·0 | 2·4 | 195 | 195·0 | 3·4 | 255 | 255·0 | 4·5 |
| 16 | 16·0 | 0·3 | 76 | 76·0 | 1·3 | 136 | 136·0 | 2·4 | 196 | 196·0 | 3·4 | 256 | 256·0 | 4·5 |
| 17 | 17·0 | 0·3 | 77 | 77·0 | 1·3 | 137 | 137·0 | 2·4 | 197 | 197·0 | 3·4 | 257 | 257·0 | 4·5 |
| 18 | 18·0 | 0·3 | 78 | 78·0 | 1·4 | 138 | 138·0 | 2·4 | 198 | 198·0 | 3·5 | 258 | 258·0 | 4·5 |
| 19 | 19·0 | 0·3 | 79 | 79·0 | 1·4 | 139 | 139·0 | 2·4 | 199 | 199·0 | 3·5 | 259 | 259·0 | 4·5 |
| 20 | 20·0 | 0·3 | 80 | 80·0 | 1·4 | 140 | 140·0 | 2·4 | 200 | 200·0 | 3·5 | 260 | 260·0 | 4·5 |
| 21 | 21·0 | 0·4 | 81 | 81·0 | 1·4 | 141 | 141·0 | 2·5 | 201 | 201·0 | 3·5 | 261 | 261·0 | 4·6 |
| 22 | 22·0 | 0·4 | 82 | 82·0 | 1·4 | 142 | 142·0 | 2·5 | 202 | 202·0 | 3·5 | 262 | 262·0 | 4·6 |
| 23 | 23·0 | 0·4 | 83 | 83·0 | 1·4 | 143 | 143·0 | 2·5 | 203 | 203·0 | 3·5 | 263 | 263·0 | 4·6 |
| 24 | 24·0 | 0·4 | 84 | 84·0 | 1·5 | 144 | 144·0 | 2·5 | 204 | 204·0 | 3·6 | 264 | 264·0 | 4·6 |
| 25 | 25·0 | 0·4 | 85 | 85·0 | 1·5 | 145 | 145·0 | 2·5 | 205 | 205·0 | 3·6 | 265 | 265·0 | 4·6 |
| 26 | 26·0 | 0·5 | 86 | 86·0 | 1·5 | 146 | 146·0 | 2·5 | 206 | 206·0 | 3·6 | 266 | 266·0 | 4·6 |
| 27 | 27·0 | 0·5 | 87 | 87·0 | 1·5 | 147 | 147·0 | 2·6 | 207 | 207·0 | 3·6 | 267 | 267·0 | 4·7 |
| 28 | 28·0 | 0·5 | 88 | 88·0 | 1·5 | 148 | 148·0 | 2·6 | 208 | 208·0 | 3·6 | 268 | 268·0 | 4·7 |
| 29 | 29·0 | 0·5 | 89 | 89·0 | 1·6 | 149 | 149·0 | 2·6 | 209 | 209·0 | 3·6 | 269 | 269·0 | 4·7 |
| 30 | 30·0 | 0·5 | 90 | 90·0 | 1·6 | 150 | 150·0 | 2·6 | 210 | 210·0 | 3·7 | 270 | 270·0 | 4·7 |
| 31 | 31·0 | 0·5 | 91 | 91·0 | 1·6 | 151 | 151·0 | 2·6 | 211 | 211·0 | 3·7 | 271 | 271·0 | 4·7 |
| 32 | 32·0 | 0·6 | 92 | 92·0 | 1·6 | 152 | 152·0 | 2·7 | 212 | 212·0 | 3·7 | 272 | 272·0 | 4·7 |
| 33 | 33·0 | 0·6 | 93 | 93·0 | 1·6 | 153 | 153·0 | 2·7 | 213 | 213·0 | 3·7 | 273 | 273·0 | 4·8 |
| 34 | 34·0 | 0·6 | 94 | 94·0 | 1·6 | 154 | 154·0 | 2·7 | 214 | 214·0 | 3·7 | 274 | 274·0 | 4·8 |
| 35 | 35·0 | 0·6 | 95 | 95·0 | 1·7 | 155 | 155·0 | 2·7 | 215 | 215·0 | 3·8 | 275 | 275·0 | 4·8 |
| 36 | 36·0 | 0·6 | 96 | 96·0 | 1·7 | 156 | 156·0 | 2·7 | 216 | 216·0 | 3·8 | 276 | 276·0 | 4·8 |
| 37 | 37·0 | 0·6 | 97 | 97·0 | 1·7 | 157 | 157·0 | 2·7 | 217 | 217·0 | 3·8 | 277 | 277·0 | 4·8 |
| 38 | 38·0 | 0·7 | 98 | 98·0 | 1·7 | 158 | 158·0 | 2·8 | 218 | 218·0 | 3·8 | 278 | 278·0 | 4·9 |
| 39 | 39·0 | 0·7 | 99 | 99·0 | 1·7 | 159 | 159·0 | 2·8 | 219 | 219·0 | 3·8 | 279 | 279·0 | 4·9 |
| 40 | 40·0 | 0·7 | 100 | 100·0 | 1·7 | 160 | 160·0 | 2·8 | 220 | 220·0 | 3·8 | 280 | 280·0 | 4·9 |
| 41 | 41·0 | 0·7 | 101 | 101·0 | 1·8 | 161 | 161·0 | 2·8 | 221 | 221·0 | 3·9 | 281 | 281·0 | 4·9 |
| 42 | 42·0 | 0·7 | 102 | 102·0 | 1·8 | 162 | 162·0 | 2·8 | 222 | 222·0 | 3·9 | 282 | 282·0 | 4·9 |
| 43 | 43·0 | 0·8 | 103 | 103·0 | 1·8 | 163 | 163·0 | 2·8 | 223 | 223·0 | 3·9 | 283 | 283·0 | 4·9 |
| 44 | 44·0 | 0·8 | 104 | 104·0 | 1·8 | 164 | 164·0 | 2·9 | 224 | 224·0 | 3·9 | 284 | 284·0 | 5·0 |
| 45 | 45·0 | 0·8 | 105 | 105·0 | 1·8 | 165 | 165·0 | 2·9 | 225 | 225·0 | 3·9 | 285 | 285·0 | 5·0 |
| 46 | 46·0 | 0·8 | 106 | 106·0 | 1·8 | 166 | 166·0 | 2·9 | 226 | 226·0 | 3·9 | 286 | 286·0 | 5·0 |
| 47 | 47·0 | 0·8 | 107 | 107·0 | 1·9 | 167 | 167·0 | 2·9 | 227 | 227·0 | 4·0 | 287 | 287·0 | 5·0 |
| 48 | 48·0 | 0·8 | 108 | 108·0 | 1·9 | 168 | 168·0 | 2·9 | 228 | 228·0 | 4·0 | 288 | 288·0 | 5·0 |
| 49 | 49·0 | 0·9 | 109 | 109·0 | 1·9 | 169 | 169·0 | 2·9 | 229 | 229·0 | 4·0 | 289 | 289·0 | 5·0 |
| 50 | 50·0 | 0·9 | 110 | 110·0 | 1·9 | 170 | 170·0 | 3·0 | 230 | 230·0 | 4·0 | 290 | 290·0 | 5·1 |
| 51 | 51·0 | 0·9 | 111 | 111·0 | 1·9 | 171 | 171·0 | 3·0 | 231 | 231·0 | 4·0 | 291 | 291·0 | 5·1 |
| 52 | 52·0 | 0·9 | 112 | 112·0 | 2·0 | 172 | 172·0 | 3·0 | 232 | 232·0 | 4·0 | 292 | 292·0 | 5·1 |
| 53 | 53·0 | 0·9 | 113 | 113·0 | 2·0 | 173 | 173·0 | 3·0 | 233 | 233·0 | 4·1 | 293 | 293·0 | 5·1 |
| 54 | 54·0 | 0·9 | 114 | 114·0 | 2·0 | 174 | 174·0 | 3·0 | 234 | 234·0 | 4·1 | 294 | 294·0 | 5·1 |
| 55 | 55·0 | 1·0 | 115 | 115·0 | 2·0 | 175 | 175·0 | 3·1 | 235 | 235·0 | 4·1 | 295 | 295·0 | 5·1 |
| 56 | 56·0 | 1·0 | 116 | 116·0 | 2·0 | 176 | 176·0 | 3·1 | 236 | 236·0 | 4·1 | 296 | 296·0 | 5·2 |
| 57 | 57·0 | 1·0 | 117 | 117·0 | 2·0 | 177 | 177·0 | 3·1 | 237 | 237·0 | 4·1 | 297 | 297·0 | 5·2 |
| 58 | 58·0 | 1·0 | 118 | 118·0 | 2·1 | 178 | 178·0 | 3·1 | 238 | 238·0 | 4·2 | 298 | 298·0 | 5·2 |
| 59 | 59·0 | 1·0 | 119 | 119·0 | 2·1 | 179 | 179·0 | 3·1 | 239 | 239·0 | 4·2 | 299 | 299·0 | 5·2 |
| 60 | 60·0 | 1·0 | 120 | 120·0 | 2·1 | 180 | 180·0 | 3·1 | 240 | 240·0 | 4·2 | 300 | 300·0 | 5·2 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

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## TRAVERSE TABLE TO DEGREES

1° 0h 4m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 301.0 | 5.3 | 361 | 360.9 | 6.3 | 421 | 420.9 | 7.3 | 481 | 480.9 | 8.4 | 541 | 540.9 | 9.5 |
| 302 | 302.0 | 5.3 | 362 | 361.9 | 6.3 | 422 | 421.9 | 7.4 | 482 | 481.9 | 8.4 | 542 | 541.9 | 9.5 |
| 303 | 303.0 | 5.3 | 363 | 362.9 | 6.3 | 423 | 422.9 | 7.4 | 483 | 482.9 | 8.5 | 543 | 542.9 | 9.5 |
| 304 | 304.0 | 5.3 | 364 | 363.9 | 6.4 | 424 | 423.9 | 7.4 | 484 | 483.9 | 8.5 | 544 | 543.9 | 9.5 |
| 305 | 305.0 | 5.3 | 365 | 364.9 | 6.4 | 425 | 424.9 | 7.4 | 485 | 484.9 | 8.5 | 545 | 544.9 | 9.5 |
| 306 | 306.0 | 5.3 | 366 | 365.9 | 6.4 | 426 | 425.9 | 7.4 | 486 | 485.9 | 8.5 | 546 | 545.9 | 9.5 |
| 307 | 307.0 | 5.4 | 367 | 366.9 | 6.4 | 427 | 426.9 | 7.4 | 487 | 486.9 | 8.5 | 547 | 546.9 | 9.6 |
| 308 | 308.0 | 5.4 | 368 | 367.9 | 6.4 | 428 | 427.9 | 7.5 | 488 | 487.9 | 8.6 | 548 | 547.9 | 9.6 |
| 309 | 309.0 | 5.4 | 369 | 368.9 | 6.4 | 429 | 428.9 | 7.5 | 489 | 488.9 | 8.6 | 549 | 548.9 | 9.6 |
| 310 | 310.0 | 5.4 | 370 | 369.9 | 6.5 | 430 | 429.9 | 7.5 | 490 | 489.9 | 8.6 | 550 | 549.9 | 9.6 |
| 311 | 311.0 | 5.4 | 371 | 370.9 | 6.5 | 431 | 430.9 | 7.5 | 491 | 490.9 | 8.6 | 551 | 550.9 | 9.6 |
| 312 | 312.0 | 5.4 | 372 | 371.9 | 6.5 | 432 | 431.9 | 7.5 | 492 | 491.9 | 8.6 | 552 | 551.9 | 9.6 |
| 313 | 313.0 | 5.5 | 373 | 372.9 | 6.5 | 433 | 432.9 | 7.5 | 493 | 492.9 | 8.7 | 553 | 552.9 | 9.7 |
| 314 | 314.0 | 5.5 | 374 | 373.9 | 6.5 | 434 | 433.9 | 7.6 | 494 | 493.9 | 8.7 | 554 | 553.9 | 9.7 |
| 315 | 315.0 | 5.5 | 375 | 374.9 | 6.5 | 435 | 434.9 | 7.6 | 495 | 494.9 | 8.7 | 555 | 554.9 | 9.7 |
| 316 | 316.0 | 5.5 | 376 | 375.9 | 6.6 | 436 | 435.9 | 7.6 | 496 | 495.9 | 8.7 | 556 | 555.9 | 9.7 |
| 317 | 317.0 | 5.5 | 377 | 376.9 | 6.6 | 437 | 436.9 | 7.6 | 497 | 496.9 | 8.7 | 557 | 556.9 | 9.7 |
| 318 | 318.0 | 5.5 | 378 | 377.9 | 6.6 | 438 | 437.9 | 7.6 | 498 | 497.9 | 8.7 | 558 | 557.9 | 9.7 |
| 319 | 319.0 | 5.6 | 379 | 378.9 | 6.6 | 439 | 438.9 | 7.7 | 499 | 498.9 | 8.8 | 559 | 558.9 | 9.8 |
| 320 | 320.0 | 5.6 | 380 | 379.9 | 6.6 | 440 | 439.9 | 7.7 | 500 | 499.9 | 8.8 | 560 | 559.9 | 9.8 |
| 321 | 321.0 | 5.6 | 381 | 380.9 | 6.7 | 441 | 440.9 | 7.7 | 501 | 500.9 | 8.8 | 561 | 560.9 | 9.8 |
| 322 | 322.0 | 5.6 | 382 | 381.9 | 6.7 | 442 | 441.9 | 7.7 | 502 | 501.9 | 8.8 | 562 | 561.9 | 9.8 |
| 323 | 323.0 | 5.6 | 383 | 382.9 | 6.7 | 443 | 442.9 | 7.7 | 503 | 502.9 | 8.8 | 563 | 562.9 | 9.8 |
| 324 | 324.0 | 5.6 | 384 | 383.9 | 6.7 | 444 | 443.9 | 7.7 | 504 | 503.9 | 8.8 | 564 | 563.9 | 9.8 |
| 325 | 325.0 | 5.7 | 385 | 384.9 | 6.7 | 445 | 444.9 | 7.8 | 505 | 504.9 | 8.8 | 565 | 564.9 | 9.9 |
| 326 | 326.0 | 5.7 | 386 | 385.9 | 6.7 | 446 | 445.9 | 7.8 | 506 | 505.9 | 8.9 | 566 | 565.9 | 9.9 |
| 327 | 327.0 | 5.7 | 387 | 386.9 | 6.8 | 447 | 446.9 | 7.8 | 507 | 506.9 | 8.9 | 567 | 566.9 | 9.9 |
| 328 | 328.0 | 5.7 | 388 | 387.9 | 6.8 | 448 | 447.9 | 7.8 | 508 | 507.9 | 8.9 | 568 | 567.9 | 9.9 |
| 329 | 329.0 | 5.7 | 389 | 388.9 | 6.8 | 449 | 448.9 | 7.8 | 509 | 508.9 | 8.9 | 569 | 568.9 | 9.9 |
| 330 | 330.0 | 5.8 | 390 | 389.9 | 6.8 | 450 | 449.9 | 7.8 | 510 | 509.9 | 8.9 | 570 | 569.9 | 9.9 |
| 331 | 331.0 | 5.8 | 391 | 390.9 | 6.8 | 451 | 450.9 | 7.9 | 511 | 510.9 | 9.0 | 571 | 570.9 | 10.0 |
| 332 | 332.0 | 5.8 | 392 | 391.9 | 6.8 | 452 | 451.9 | 7.9 | 512 | 511.9 | 9.0 | 572 | 571.9 | 10.0 |
| 333 | 333.0 | 5.8 | 393 | 392.9 | 6.9 | 453 | 452.9 | 7.9 | 513 | 512.9 | 9.0 | 573 | 572.9 | 10.0 |
| 334 | 333.9 | 5.8 | 394 | 393.9 | 6.9 | 454 | 453.9 | 7.9 | 514 | 513.9 | 9.0 | 574 | 573.9 | 10.0 |
| 335 | 334.9 | 5.8 | 395 | 394.9 | 6.9 | 455 | 454.9 | 7.9 | 515 | 514.9 | 9.0 | 575 | 574.9 | 10.0 |
| 336 | 335.9 | 5.9 | 396 | 395.9 | 6.9 | 456 | 455.9 | 8.0 | 516 | 515.9 | 9.0 | 576 | 575.9 | 10.0 |
| 337 | 336.9 | 5.9 | 397 | 396.9 | 6.9 | 457 | 456.9 | 8.0 | 517 | 516.9 | 9.1 | 577 | 576.9 | 10.1 |
| 338 | 337.9 | 5.9 | 398 | 397.9 | 6.9 | 458 | 457.9 | 8.0 | 518 | 517.9 | 9.1 | 578 | 577.9 | 10.1 |
| 339 | 338.9 | 5.9 | 399 | 398.9 | 7.0 | 459 | 458.9 | 8.0 | 519 | 518.9 | 9.1 | 579 | 578.9 | 10.1 |
| 340 | 339.9 | 5.9 | 400 | 399.9 | 7.0 | 460 | 459.9 | 8.0 | 520 | 519.9 | 9.1 | 580 | 579.9 | 10.1 |
| 341 | 340.9 | 6.0 | 401 | 400.9 | 7.0 | 461 | 460.9 | 8.0 | 521 | 520.9 | 9.1 | 581 | 580.9 | 10.1 |
| 342 | 341.9 | 6.0 | 402 | 401.9 | 7.0 | 462 | 461.9 | 8.1 | 522 | 521.9 | 9.1 | 582 | 581.9 | 10.1 |
| 343 | 342.9 | 6.0 | 403 | 402.9 | 7.0 | 463 | 462.9 | 8.1 | 523 | 522.9 | 9.2 | 583 | 582.9 | 10.2 |
| 344 | 343.9 | 6.0 | 404 | 403.9 | 7.1 | 464 | 463.9 | 8.1 | 524 | 523.9 | 9.2 | 584 | 583.9 | 10.2 |
| 345 | 344.9 | 6.0 | 405 | 404.9 | 7.1 | 465 | 464.9 | 8.1 | 525 | 524.9 | 9.2 | 585 | 584.9 | 10.2 |
| 346 | 345.9 | 6.0 | 406 | 405.9 | 7.1 | 466 | 465.9 | 8.1 | 526 | 525.9 | 9.2 | 586 | 585.9 | 10.2 |
| 347 | 346.9 | 6.1 | 407 | 406.9 | 7.1 | 467 | 466.9 | 8.1 | 527 | 526.9 | 9.2 | 587 | 586.9 | 10.2 |
| 348 | 347.9 | 6.1 | 408 | 407.9 | 7.1 | 468 | 467.9 | 8.2 | 528 | 527.9 | 9.2 | 588 | 587.9 | 10.2 |
| 349 | 348.9 | 6.1 | 409 | 408.9 | 7.1 | 469 | 468.9 | 8.2 | 529 | 528.9 | 9.3 | 589 | 588.9 | 10.3 |
| 350 | 349.9 | 6.1 | 410 | 409.9 | 7.2 | 470 | 469.9 | 8.2 | 530 | 529.9 | 9.3 | 590 | 589.9 | 10.3 |
| 351 | 350.9 | 6.1 | 411 | 410.9 | 7.2 | 471 | 470.9 | 8.2 | 531 | 530.9 | 9.3 | 591 | 590.9 | 10.3 |
| 352 | 351.9 | 6.1 | 412 | 411.9 | 7.2 | 472 | 471.9 | 8.2 | 532 | 531.9 | 9.3 | 592 | 591.9 | 10.3 |
| 353 | 352.9 | 6.2 | 413 | 412.9 | 7.2 | 473 | 472.9 | 8.2 | 533 | 532.9 | 9.3 | 593 | 592.9 | 10.3 |
| 354 | 353.9 | 6.2 | 414 | 413.9 | 7.2 | 474 | 473.9 | 8.3 | 534 | 533.9 | 9.3 | 594 | 593.9 | 10.3 |
| 355 | 354.9 | 6.2 | 415 | 414.9 | 7.2 | 475 | 474.9 | 8.3 | 535 | 534.9 | 9.4 | 595 | 594.9 | 10.4 |
| 356 | 355.9 | 6.2 | 416 | 415.9 | 7.3 | 476 | 475.9 | 8.3 | 536 | 535.9 | 9.4 | 596 | 595.9 | 10.4 |
| 357 | 356.9 | 6.2 | 417 | 416.9 | 7.3 | 477 | 476.9 | 8.3 | 537 | 536.9 | 9.4 | 597 | 596.9 | 10.4 |
| 358 | 357.9 | 6.2 | 418 | 417.9 | 7.3 | 478 | 477.9 | 8.3 | 538 | 537.9 | 9.4 | 598 | 597.9 | 10.4 |
| 359 | 358.9 | 6.3 | 419 | 418.9 | 7.3 | 479 | 478.9 | 8.4 | 539 | 538.9 | 9.4 | 599 | 598.9 | 10.4 |
| 360 | 359.9 | 6.3 | 420 | 419.9 | 7.3 | 480 | 479.9 | 8.4 | 540 | 539.9 | 9.4 | 600 | 599.9 | 10.5 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

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## TRAVERSE TABLE TO DEGREES

2° 0h 8m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1·0 | 0·0 | 61 | 61·0 | 2·1 | 121 | 120·9 | 4·2 | 181 | 180·9 | 6·3 | 241 | 240·9 | 8·4 |
| 2 | 2·0 | 0·1 | 62 | 62·0 | 2·2 | 122 | 121·9 | 4·3 | 182 | 181·9 | 6·4 | 242 | 241·9 | 8·4 |
| 3 | 3·0 | 0·1 | 63 | 63·0 | 2·2 | 123 | 122·9 | 4·3 | 183 | 182·9 | 6·4 | 243 | 242·9 | 8·5 |
| 4 | 4·0 | 0·1 | 64 | 64·0 | 2·2 | 124 | 123·9 | 4·3 | 184 | 183·9 | 6·4 | 244 | 243·9 | 8·5 |
| 5 | 5·0 | 0·2 | 65 | 65·0 | 2·3 | 125 | 124·9 | 4·4 | 185 | 184·9 | 6·5 | 245 | 244·9 | 8·6 |
| 6 | 6·0 | 0·2 | 66 | 66·0 | 2·3 | 126 | 125·9 | 4·4 | 186 | 185·9 | 6·5 | 246 | 245·9 | 8·6 |
| 7 | 7·0 | 0·2 | 67 | 67·0 | 2·3 | 127 | 126·9 | 4·4 | 187 | 186·9 | 6·5 | 247 | 246·8 | 8·6 |
| 8 | 8·0 | 0·3 | 68 | 68·0 | 2·4 | 128 | 127·9 | 4·5 | 188 | 187·9 | 6·6 | 248 | 247·8 | 8·7 |
| 9 | 9·0 | 0·3 | 69 | 69·0 | 2·4 | 129 | 128·9 | 4·5 | 189 | 188·9 | 6·6 | 249 | 248·8 | 8·7 |
| 10 | 10·0 | 0·3 | 70 | 70·0 | 2·4 | 130 | 129·9 | 4·5 | 190 | 189·9 | 6·6 | 250 | 249·8 | 8·7 |
| 11 | 11·0 | 0·4 | 71 | 71·0 | 2·5 | 131 | 130·9 | 4·6 | 191 | 190·9 | 6·7 | 251 | 250·8 | 8·8 |
| 12 | 12·0 | 0·4 | 72 | 72·0 | 2·5 | 132 | 131·9 | 4·6 | 192 | 191·9 | 6·7 | 252 | 251·8 | 8·8 |
| 13 | 13·0 | 0·5 | 73 | 73·0 | 2·5 | 133 | 132·9 | 4·6 | 193 | 192·9 | 6·7 | 253 | 252·8 | 8·8 |
| 14 | 14·0 | 0·5 | 74 | 74·0 | 2·6 | 134 | 133·9 | 4·7 | 194 | 193·9 | 6·8 | 254 | 253·8 | 8·9 |
| 15 | 15·0 | 0·5 | 75 | 75·0 | 2·6 | 135 | 134·9 | 4·7 | 195 | 194·9 | 6·8 | 255 | 254·8 | 8·9 |
| 16 | 16·0 | 0·6 | 76 | 76·0 | 2·7 | 136 | 135·9 | 4·7 | 196 | 195·9 | 6·8 | 256 | 255·8 | 8·9 |
| 17 | 17·0 | 0·6 | 77 | 77·0 | 2·7 | 137 | 136·9 | 4·8 | 197 | 196·9 | 6·9 | 257 | 256·8 | 9·0 |
| 18 | 18·0 | 0·6 | 78 | 78·0 | 2·7 | 138 | 137·9 | 4·8 | 198 | 197·9 | 6·9 | 258 | 257·8 | 9·0 |
| 19 | 19·0 | 0·7 | 79 | 79·0 | 2·8 | 139 | 138·9 | 4·9 | 199 | 198·9 | 6·9 | 259 | 258·8 | 9·0 |
| 20 | 20·0 | 0·7 | 80 | 80·0 | 2·8 | 140 | 139·9 | 4·9 | 200 | 199·9 | 7·0 | 260 | 259·8 | 9·1 |
| 21 | 21·0 | 0·7 | 81 | 81·0 | 2·8 | 141 | 140·9 | 4·9 | 201 | 200·9 | 7·0 | 261 | 260·8 | 9·1 |
| 22 | 22·0 | 0·8 | 82 | 82·0 | 2·9 | 142 | 141·9 | 5·0 | 202 | 201·9 | 7·0 | 262 | 261·8 | 9·1 |
| 23 | 23·0 | 0·8 | 83 | 82·9 | 2·9 | 143 | 142·9 | 5·0 | 203 | 202·9 | 7·1 | 263 | 262·8 | 9·2 |
| 24 | 24·0 | 0·8 | 84 | 83·9 | 2·9 | 144 | 143·9 | 5·0 | 204 | 203·9 | 7·1 | 264 | 263·8 | 9·2 |
| 25 | 25·0 | 0·9 | 85 | 84·9 | 3·0 | 145 | 144·9 | 5·1 | 205 | 204·9 | 7·2 | 265 | 264·8 | 9·2 |
| 26 | 26·0 | 0·9 | 86 | 85·9 | 3·0 | 146 | 145·9 | 5·1 | 206 | 205·9 | 7·2 | 266 | 265·8 | 9·3 |
| 27 | 27·0 | 0·9 | 87 | 86·9 | 3·0 | 147 | 146·9 | 5·1 | 207 | 206·9 | 7·2 | 267 | 266·8 | 9·3 |
| 28 | 28·0 | 1·0 | 88 | 87·9 | 3·1 | 148 | 147·9 | 5·2 | 208 | 207·9 | 7·3 | 268 | 267·8 | 9·4 |
| 29 | 29·0 | 1·0 | 89 | 88·9 | 3·1 | 149 | 148·9 | 5·2 | 209 | 208·9 | 7·3 | 269 | 268·8 | 9·4 |
| 30 | 30·0 | 1·0 | 90 | 89·9 | 3·1 | 150 | 149·9 | 5·2 | 210 | 209·9 | 7·3 | 270 | 269·8 | 9·4 |
| 31 | 31·0 | 1·1 | 91 | 90·9 | 3·2 | 151 | 150·9 | 5·3 | 211 | 210·9 | 7·4 | 271 | 270·8 | 9·5 |
| 32 | 32·0 | 1·1 | 92 | 91·9 | 3·2 | 152 | 151·9 | 5·3 | 212 | 211·9 | 7·4 | 272 | 271·8 | 9·5 |
| 33 | 33·0 | 1·2 | 93 | 92·9 | 3·2 | 153 | 152·9 | 5·3 | 213 | 212·9 | 7·4 | 273 | 272·8 | 9·5 |
| 34 | 34·0 | 1·2 | 94 | 93·9 | 3·3 | 154 | 153·9 | 5·4 | 214 | 213·9 | 7·5 | 274 | 273·8 | 9·6 |
| 35 | 35·0 | 1·2 | 95 | 94·9 | 3·3 | 155 | 154·9 | 5·4 | 215 | 214·9 | 7·5 | 275 | 274·8 | 9·6 |
| 36 | 36·0 | 1·3 | 96 | 95·9 | 3·4 | 156 | 155·9 | 5·4 | 216 | 215·9 | 7·5 | 276 | 275·8 | 9·6 |
| 37 | 37·0 | 1·3 | 97 | 96·9 | 3·4 | 157 | 156·9 | 5·5 | 217 | 216·9 | 7·6 | 277 | 276·8 | 9·7 |
| 38 | 38·0 | 1·3 | 98 | 97·9 | 3·4 | 158 | 157·9 | 5·5 | 218 | 217·9 | 7·6 | 278 | 277·8 | 9·7 |
| 39 | 39·0 | 1·4 | 99 | 98·9 | 3·5 | 159 | 158·9 | 5·5 | 219 | 218·9 | 7·6 | 279 | 278·8 | 9·7 |
| 40 | 40·0 | 1·4 | 100 | 99·9 | 3·5 | 160 | 159·9 | 5·6 | 220 | 219·9 | 7·7 | 280 | 279·8 | 9·8 |
| 41 | 41·0 | 1·4 | 101 | 100·9 | 3·5 | 161 | 160·9 | 5·6 | 221 | 220·9 | 7·7 | 281 | 280·8 | 9·8 |
| 42 | 42·0 | 1·5 | 102 | 101·9 | 3·6 | 162 | 161·9 | 5·7 | 222 | 221·9 | 7·7 | 282 | 281·8 | 9·8 |
| 43 | 43·0 | 1·5 | 103 | 102·9 | 3·6 | 163 | 162·9 | 5·7 | 223 | 222·9 | 7·8 | 283 | 282·8 | 9·9 |
| 44 | 44·0 | 1·5 | 104 | 103·9 | 3·6 | 164 | 163·9 | 5·7 | 224 | 223·9 | 7·8 | 284 | 283·8 | 9·9 |
| 45 | 45·0 | 1·6 | 105 | 104·9 | 3·7 | 165 | 164·9 | 5·8 | 225 | 224·9 | 7·9 | 285 | 284·8 | 9·9 |
| 46 | 46·0 | 1·6 | 106 | 105·9 | 3·7 | 166 | 165·9 | 5·8 | 226 | 225·9 | 7·9 | 286 | 285·8 | 10·0 |
| 47 | 47·0 | 1·6 | 107 | 106·9 | 3·7 | 167 | 166·9 | 5·8 | 227 | 226·9 | 7·9 | 287 | 286·8 | 10·0 |
| 48 | 48·0 | 1·7 | 108 | 107·9 | 3·8 | 168 | 167·9 | 5·9 | 228 | 227·9 | 8·0 | 288 | 287·8 | 10·1 |
| 49 | 49·0 | 1·7 | 109 | 108·9 | 3·8 | 169 | 168·9 | 5·9 | 229 | 228·9 | 8·0 | 289 | 288·8 | 10·1 |
| 50 | 50·0 | 1·7 | 110 | 109·9 | 3·8 | 170 | 169·9 | 5·9 | 230 | 229·9 | 8·0 | 290 | 289·8 | 10·1 |
| 51 | 51·0 | 1·8 | 111 | 110·9 | 3·9 | 171 | 170·9 | 6·0 | 231 | 230·9 | 8·1 | 291 | 290·8 | 10·2 |
| 52 | 52·0 | 1·8 | 112 | 111·9 | 3·9 | 172 | 171·9 | 6·0 | 232 | 231·9 | 8·1 | 292 | 291·8 | 10·2 |
| 53 | 53·0 | 1·8 | 113 | 112·9 | 3·9 | 173 | 172·9 | 6·0 | 233 | 232·9 | 8·1 | 293 | 292·8 | 10·2 |
| 54 | 54·0 | 1·9 | 114 | 113·9 | 4·0 | 174 | 173·9 | 6·1 | 234 | 233·9 | 8·2 | 294 | 293·8 | 10·3 |
| 55 | 55·0 | 1·9 | 115 | 114·9 | 4·0 | 175 | 174·9 | 6·1 | 235 | 234·9 | 8·2 | 295 | 294·8 | 10·3 |
| 56 | 56·0 | 2·0 | 116 | 115·9 | 4·0 | 176 | 175·9 | 6·1 | 236 | 235·9 | 8·2 | 296 | 295·8 | 10·3 |
| 57 | 57·0 | 2·0 | 117 | 116·9 | 4·1 | 177 | 176·9 | 6·2 | 237 | 236·9 | 8·3 | 297 | 296·8 | 10·4 |
| 58 | 58·0 | 2·0 | 118 | 117·9 | 4·1 | 178 | 177·9 | 6·2 | 238 | 237·9 | 8·3 | 298 | 297·8 | 10·4 |
| 59 | 59·0 | 2·1 | 119 | 118·9 | 4·2 | 179 | 178·9 | 6·2 | 239 | 238·9 | 8·3 | 299 | 298·8 | 10·4 |
| 60 | 60·0 | 2·1 | 120 | 119·9 | 4·2 | 180 | 179·9 | 6·3 | 240 | 239·9 | 8·4 | 300 | 299·8 | 10·5 |
| Dist. | Dep. | D.Lat | Dist. | Dep. | D.Lat | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

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## TRAVERSE TABLE TO DEGREES

2° 0h 8m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. La. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 300.8 | 10.5 | 361 | 360.8 | 12.6 | 421 | 420.8 | 14.7 | 481 | 480.7 | 16.8 | 541 | 540.7 | 18.9 |
| 302 | 301.8 | 10.5 | 362 | 361.8 | 12.6 | 422 | 421.8 | 14.7 | 482 | 481.7 | 16.8 | 542 | 541.7 | 18.9 |
| 303 | 302.8 | 10.6 | 363 | 362.8 | 12.7 | 423 | 422.8 | 14.7 | 483 | 482.7 | 16.8 | 543 | 542.7 | 18.9 |
| 304 | 303.8 | 10.6 | 364 | 363.8 | 12.7 | 424 | 423.8 | 14.8 | 484 | 483.7 | 16.9 | 544 | 543.7 | 19.0 |
| 305 | 304.8 | 10.6 | 365 | 364.8 | 12.7 | 425 | 424.8 | 14.8 | 485 | 484.7 | 16.9 | 545 | 544.7 | 19.0 |
| 306 | 305.8 | 10.7 | 366 | 365.8 | 12.8 | 426 | 425.7 | 14.9 | 486 | 485.7 | 16.9 | 546 | 545.7 | 19.0 |
| 307 | 306.8 | 10.7 | 367 | 366.8 | 12.8 | 427 | 426.7 | 14.9 | 487 | 486.7 | 17.0 | 547 | 546.7 | 19.1 |
| 308 | 307.8 | 10.7 | 368 | 367.8 | 12.8 | 428 | 427.7 | 14.9 | 488 | 487.7 | 17.0 | 548 | 547.7 | 19.1 |
| 309 | 308.8 | 10.8 | 369 | 368.8 | 12.9 | 429 | 428.7 | 15.0 | 489 | 488.7 | 17.0 | 549 | 548.7 | 19.1 |
| 310 | 309.8 | 10.8 | 370 | 369.8 | 12.9 | 430 | 429.7 | 15.0 | 490 | 489.7 | 17.1 | 550 | 549.7 | 19.2 |
| 311 | 310.8 | 10.8 | 371 | 370.8 | 12.9 | 431 | 430.7 | 15.0 | 491 | 490.7 | 17.1 | 551 | 550.7 | 19.2 |
| 312 | 311.8 | 10.9 | 372 | 371.8 | 13.0 | 432 | 431.7 | 15.1 | 492 | 491.7 | 17.1 | 552 | 551.7 | 19.2 |
| 313 | 312.8 | 10.9 | 373 | 372.8 | 13.0 | 433 | 432.7 | 15.1 | 493 | 492.7 | 17.2 | 553 | 552.7 | 19.3 |
| 314 | 313.8 | 10.9 | 374 | 373.8 | 13.0 | 434 | 433.7 | 15.1 | 494 | 493.7 | 17.2 | 554 | 553.7 | 19.3 |
| 315 | 314.8 | 11.0 | 375 | 374.8 | 13.1 | 435 | 434.7 | 15.2 | 495 | 494.7 | 17.2 | 555 | 554.7 | 19.3 |
| 316 | 315.8 | 11.0 | 376 | 375.8 | 13.1 | 436 | 435.7 | 15.2 | 496 | 495.7 | 17.3 | 556 | 555.7 | 19.4 |
| 317 | 316.8 | 11.0 | 377 | 376.8 | 13.1 | 437 | 436.7 | 15.2 | 497 | 496.7 | 17.3 | 557 | 556.7 | 19.4 |
| 318 | 317.8 | 11.1 | 378 | 377.8 | 13.2 | 438 | 437.7 | 15.3 | 498 | 497.7 | 17.3 | 558 | 557.7 | 19.4 |
| 319 | 318.8 | 11.1 | 379 | 378.8 | 13.2 | 439 | 438.7 | 15.3 | 499 | 498.7 | 17.4 | 559 | 558.7 | 19.5 |
| 320 | 319.8 | 11.2 | 380 | 379.8 | 13.2 | 440 | 439.7 | 15.3 | 500 | 499.7 | 17.4 | 560 | 559.7 | 19.5 |
| 321 | 320.8 | 11.2 | 381 | 380.8 | 13.3 | 441 | 440.7 | 15.4 | 501 | 500.7 | 17.5 | 561 | 560.7 | 19.5 |
| 322 | 321.8 | 11.2 | 382 | 381.8 | 13.3 | 442 | 441.7 | 15.4 | 502 | 501.7 | 17.5 | 562 | 561.7 | 19.6 |
| 323 | 322.8 | 11.3 | 383 | 382.8 | 13.3 | 443 | 442.7 | 15.4 | 503 | 502.7 | 17.5 | 563 | 562.7 | 19.6 |
| 324 | 323.8 | 11.3 | 384 | 383.8 | 13.4 | 444 | 443.7 | 15.5 | 504 | 503.7 | 17.6 | 564 | 563.7 | 19.6 |
| 325 | 324.8 | 11.3 | 385 | 384.8 | 13.4 | 445 | 444.7 | 15.5 | 505 | 504.7 | 17.6 | 565 | 564.7 | 19.7 |
| 326 | 325.8 | 11.4 | 386 | 385.8 | 13.5 | 446 | 445.7 | 15.6 | 506 | 505.7 | 17.6 | 566 | 565.7 | 19.7 |
| 327 | 326.8 | 11.4 | 387 | 386.8 | 13.5 | 447 | 446.7 | 15.6 | 507 | 506.7 | 17.7 | 567 | 566.7 | 19.7 |
| 328 | 327.8 | 11.4 | 388 | 387.8 | 13.5 | 448 | 447.7 | 15.6 | 508 | 507.7 | 17.7 | 568 | 567.7 | 19.8 |
| 329 | 328.8 | 11.5 | 389 | 388.8 | 13.6 | 449 | 448.7 | 15.7 | 509 | 508.7 | 17.7 | 569 | 568.7 | 19.8 |
| 330 | 329.8 | 11.5 | 390 | 389.8 | 13.6 | 450 | 449.7 | 15.7 | 510 | 509.7 | 17.8 | 570 | 569.7 | 19.9 |
| 331 | 330.8 | 11.5 | 391 | 390.8 | 13.6 | 451 | 450.7 | 15.7 | 511 | 510.7 | 17.8 | 571 | 570.7 | 19.9 |
| 332 | 331.8 | 11.6 | 392 | 391.8 | 13.7 | 452 | 451.7 | 15.8 | 512 | 511.7 | 17.8 | 572 | 571.7 | 19.9 |
| 333 | 332.8 | 11.6 | 393 | 392.8 | 13.7 | 453 | 452.7 | 15.8 | 513 | 512.7 | 17.9 | 573 | 572.7 | 20.0 |
| 334 | 333.8 | 11.6 | 394 | 393.8 | 13.7 | 454 | 453.7 | 15.8 | 514 | 513.7 | 17.9 | 574 | 573.6 | 20.0 |
| 335 | 334.8 | 11.7 | 395 | 394.8 | 13.8 | 455 | 454.7 | 15.9 | 515 | 514.7 | 17.9 | 575 | 574.6 | 20.0 |
| 336 | 335.8 | 11.7 | 396 | 395.8 | 13.8 | 456 | 455.7 | 15.9 | 516 | 515.7 | 18.0 | 576 | 575.6 | 20.1 |
| 337 | 336.8 | 11.7 | 397 | 396.8 | 13.8 | 457 | 456.7 | 15.9 | 517 | 516.7 | 18.0 | 577 | 576.6 | 20.1 |
| 338 | 337.8 | 11.8 | 398 | 397.8 | 13.9 | 458 | 457.7 | 16.0 | 518 | 517.7 | 18.1 | 578 | 577.6 | 20.1 |
| 339 | 338.8 | 11.8 | 399 | 398.8 | 13.9 | 459 | 458.7 | 16.0 | 519 | 518.7 | 18.1 | 579 | 578.6 | 20.2 |
| 340 | 339.8 | 11.9 | 400 | 399.8 | 13.9 | 460 | 459.7 | 16.0 | 520 | 519.7 | 18.1 | 580 | 579.6 | 20.2 |
| 341 | 340.8 | 11.9 | 401 | 400.8 | 14.0 | 461 | 460.7 | 16.1 | 521 | 520.7 | 18.2 | 581 | 580.6 | 20.2 |
| 342 | 341.8 | 11.9 | 402 | 401.8 | 14.0 | 462 | 461.7 | 16.1 | 522 | 521.7 | 18.2 | 582 | 581.6 | 20.3 |
| 343 | 342.8 | 12.0 | 403 | 402.8 | 14.0 | 463 | 462.7 | 16.1 | 523 | 522.7 | 18.2 | 583 | 582.6 | 20.3 |
| 344 | 343.8 | 12.0 | 404 | 403.8 | 14.1 | 464 | 463.7 | 16.2 | 524 | 523.7 | 18.3 | 584 | 583.6 | 20.3 |
| 345 | 344.8 | 12.0 | 405 | 404.8 | 14.1 | 465 | 464.7 | 16.2 | 525 | 524.7 | 18.3 | 585 | 584.6 | 20.4 |
| 346 | 345.8 | 12.1 | 406 | 405.8 | 14.2 | 466 | 465.7 | 16.2 | 526 | 525.7 | 18.4 | 586 | 585.6 | 20.4 |
| 347 | 346.8 | 12.1 | 407 | 406.8 | 14.2 | 467 | 466.7 | 16.3 | 527 | 526.7 | 18.4 | 587 | 586.6 | 20.4 |
| 348 | 347.8 | 12.1 | 408 | 407.8 | 14.2 | 468 | 467.7 | 16.3 | 528 | 527.7 | 18.4 | 588 | 587.6 | 20.5 |
| 349 | 348.8 | 12.2 | 409 | 408.8 | 14.3 | 469 | 468.7 | 16.4 | 529 | 528.7 | 18.5 | 589 | 588.6 | 20.5 |
| 350 | 349.8 | 12.2 | 410 | 409.8 | 14.3 | 470 | 469.7 | 16.4 | 530 | 529.7 | 18.5 | 590 | 589.6 | 20.5 |
| 351 | 350.8 | 12.2 | 411 | 410.8 | 14.3 | 471 | 470.7 | 16.4 | 531 | 530.7 | 18.5 | 591 | 590.6 | 20.6 |
| 352 | 351.8 | 12.3 | 412 | 411.8 | 14.4 | 472 | 471.7 | 16.5 | 532 | 531.7 | 18.6 | 592 | 591.6 | 20.6 |
| 353 | 352.8 | 12.3 | 413 | 412.8 | 14.4 | 473 | 472.7 | 16.5 | 533 | 532.7 | 18.6 | 593 | 592.6 | 20.6 |
| 354 | 353.8 | 12.3 | 414 | 413.8 | 14.4 | 474 | 473.7 | 16.5 | 534 | 533.7 | 18.6 | 594 | 593.6 | 20.7 |
| 355 | 354.8 | 12.4 | 415 | 414.8 | 14.5 | 475 | 474.7 | 16.6 | 535 | 534.7 | 18.7 | 595 | 594.6 | 20.7 |
| 356 | 355.8 | 12.4 | 416 | 415.8 | 14.5 | 476 | 475.7 | 16.6 | 536 | 535.7 | 18.7 | 596 | 595.6 | 20.7 |
| 357 | 356.8 | 12.4 | 417 | 416.8 | 14.5 | 477 | 476.7 | 16.6 | 537 | 536.7 | 18.7 | 597 | 596.6 | 20.8 |
| 358 | 357.8 | 12.5 | 418 | 417.8 | 14.6 | 478 | 477.7 | 16.7 | 538 | 537.7 | 18.8 | 598 | 597.6 | 20.8 |
| 359 | 358.8 | 12.5 | 419 | 418.8 | 14.6 | 479 | 478.7 | 16.7 | 539 | 538.7 | 18.8 | 599 | 598.6 | 20.8 |
| 360 | 359.8 | 12.5 | 420 | 419.8 | 14.6 | 480 | 479.7 | 16.7 | 540 | 539.7 | 18.8 | 600 | 599.6 | 20.9 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat | Dist. | Dep. | D. Lat | Dist. | Dep. | D. Lat. |

88° 5h 52m

## TRAVERSE TABLE TO DEGREES

3° 0h 12m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0 | 0.1 | 61 | 60.9 | 3.2 | 121 | 120.8 | 6.3 | 181 | 180.8 | 9.5 | 241 | 240.7 | 12.6 |
| 2 | 2.0 | 0.1 | 62 | 61.9 | 3.2 | 122 | 121.8 | 6.4 | 182 | 181.8 | 9.5 | 242 | 241.7 | 12.7 |
| 3 | 3.0 | 0.2 | 63 | 62.9 | 3.3 | 123 | 122.8 | 6.4 | 183 | 182.7 | 9.6 | 243 | 242.7 | 12.7 |
| 4 | 4.0 | 0.2 | 64 | 63.9 | 3.3 | 124 | 123.8 | 6.5 | 184 | 183.7 | 9.6 | 244 | 243.7 | 12.8 |
| 5 | 5.0 | 0.3 | 65 | 64.9 | 3.4 | 125 | 124.8 | 6.5 | 185 | 184.7 | 9.7 | 245 | 244.7 | 12.8 |
| 6 | 6.0 | 0.3 | 66 | 65.9 | 3.5 | 126 | 125.8 | 6.6 | 186 | 185.7 | 9.7 | 246 | 245.7 | 12.9 |
| 7 | 7.0 | 0.4 | 67 | 66.9 | 3.5 | 127 | 126.8 | 6.6 | 187 | 186.7 | 9.8 | 247 | 246.7 | 12.9 |
| 8 | 8.0 | 0.4 | 68 | 67.9 | 3.6 | 128 | 127.8 | 6.7 | 188 | 187.7 | 9.8 | 248 | 247.7 | 13.0 |
| 9 | 9.0 | 0.5 | 69 | 68.9 | 3.6 | 129 | 128.8 | 6.8 | 189 | 188.7 | 9.9 | 249 | 248.7 | 13.0 |
| 10 | 10.0 | 0.5 | 70 | 69.9 | 3.7 | 130 | 129.8 | 6.8 | 190 | 189.7 | 9.9 | 250 | 249.7 | 13.1 |
| 11 | 11.0 | 0.6 | 71 | 70.9 | 3.7 | 131 | 130.8 | 6.9 | 191 | 190.7 | 10.0 | 251 | 250.7 | 13.1 |
| 12 | 12.0 | 0.6 | 72 | 71.9 | 3.8 | 132 | 131.8 | 6.9 | 192 | 191.7 | 10.0 | 252 | 251.7 | 13.2 |
| 13 | 13.0 | 0.7 | 73 | 72.9 | 3.8 | 133 | 132.8 | 7.0 | 193 | 192.7 | 10.1 | 253 | 252.7 | 13.2 |
| 14 | 14.0 | 0.7 | 74 | 73.9 | 3.9 | 134 | 133.8 | 7.0 | 194 | 193.7 | 10.2 | 254 | 253.7 | 13.3 |
| 15 | 15.0 | 0.8 | 75 | 74.9 | 3.9 | 135 | 134.8 | 7.1 | 195 | 194.7 | 10.2 | 255 | 254.7 | 13.3 |
| 16 | 16.0 | 0.8 | 76 | 75.9 | 4.0 | 136 | 135.8 | 7.1 | 196 | 195.7 | 10.3 | 256 | 255.6 | 13.4 |
| 17 | 17.0 | 0.9 | 77 | 76.9 | 4.0 | 137 | 136.8 | 7.2 | 197 | 196.7 | 10.3 | 257 | 256.6 | 13.5 |
| 18 | 18.0 | 0.9 | 78 | 77.9 | 4.1 | 138 | 137.8 | 7.2 | 198 | 197.7 | 10.4 | 258 | 257.6 | 13.5 |
| 19 | 19.0 | 1.0 | 79 | 78.9 | 4.1 | 139 | 138.8 | 7.3 | 199 | 198.7 | 10.4 | 259 | 258.6 | 13.6 |
| 20 | 20.0 | 1.0 | 80 | 79.9 | 4.2 | 140 | 139.8 | 7.3 | 200 | 199.7 | 10.5 | 260 | 259.6 | 13.6 |
| 21 | 21.0 | 1.1 | 81 | 80.9 | 4.2 | 141 | 140.8 | 7.4 | 201 | 200.7 | 10.5 | 261 | 260.6 | 13.7 |
| 22 | 22.0 | 1.1 | 82 | 81.9 | 4.3 | 142 | 141.8 | 7.4 | 202 | 201.7 | 10.6 | 262 | 261.6 | 13.7 |
| 23 | 23.0 | 1.2 | 83 | 82.9 | 4.3 | 143 | 142.8 | 7.5 | 203 | 202.7 | 10.6 | 263 | 262.6 | 13.8 |
| 24 | 24.0 | 1.2 | 84 | 83.9 | 4.4 | 144 | 143.8 | 7.5 | 204 | 203.7 | 10.7 | 264 | 263.6 | 13.8 |
| 25 | 25.0 | 1.3 | 85 | 84.9 | 4.4 | 145 | 144.8 | 7.6 | 205 | 204.7 | 10.7 | 265 | 264.6 | 13.9 |
| 26 | 26.0 | 1.4 | 86 | 85.9 | 4.5 | 146 | 145.8 | 7.6 | 206 | 205.7 | 10.8 | 266 | 265.6 | 13.9 |
| 27 | 27.0 | 1.4 | 87 | 86.9 | 4.6 | 147 | 146.8 | 7.7 | 207 | 206.7 | 10.8 | 267 | 266.6 | 14.0 |
| 28 | 28.0 | 1.5 | 88 | 87.9 | 4.6 | 148 | 147.8 | 7.7 | 208 | 207.7 | 10.9 | 268 | 267.6 | 14.0 |
| 29 | 29.0 | 1.5 | 89 | 88.9 | 4.7 | 149 | 148.8 | 7.8 | 209 | 208.7 | 10.9 | 269 | 268.6 | 14.1 |
| 30 | 30.0 | 1.6 | 90 | 89.9 | 4.7 | 150 | 149.8 | 7.9 | 210 | 209.7 | 11.0 | 270 | 269.6 | 14.1 |
| 31 | 31.0 | 1.6 | 91 | 90.9 | 4.8 | 151 | 150.8 | 7.9 | 211 | 210.7 | 11.0 | 271 | 270.6 | 14.2 |
| 32 | 32.0 | 1.7 | 92 | 91.9 | 4.8 | 152 | 151.8 | 8.0 | 212 | 211.7 | 11.1 | 272 | 271.6 | 14.2 |
| 33 | 33.0 | 1.7 | 93 | 92.9 | 4.9 | 153 | 152.8 | 8.0 | 213 | 212.7 | 11.1 | 273 | 272.6 | 14.3 |
| 34 | 34.0 | 1.8 | 94 | 93.9 | 4.9 | 154 | 153.8 | 8.1 | 214 | 213.7 | 11.2 | 274 | 273.6 | 14.3 |
| 35 | 35.0 | 1.8 | 95 | 94.9 | 5.0 | 155 | 154.8 | 8.1 | 215 | 214.7 | 11.3 | 275 | 274.6 | 14.4 |
| 36 | 36.0 | 1.9 | 96 | 95.9 | 5.0 | 156 | 155.8 | 8.2 | 216 | 215.7 | 11.3 | 276 | 275.6 | 14.4 |
| 37 | 36.9 | 1.9 | 97 | 96.9 | 5.1 | 157 | 156.8 | 8.2 | 217 | 216.7 | 11.4 | 277 | 276.6 | 14.5 |
| 38 | 37.9 | 2.0 | 98 | 97.9 | 5.1 | 158 | 157.8 | 8.3 | 218 | 217.7 | 11.4 | 278 | 277.6 | 14.5 |
| 39 | 38.9 | 2.0 | 99 | 98.9 | 5.2 | 159 | 158.8 | 8.3 | 219 | 218.7 | 11.5 | 279 | 278.6 | 14.6 |
| 40 | 39.9 | 2.1 | 100 | 99.9 | 5.2 | 160 | 159.8 | 8.4 | 220 | 219.7 | 11.5 | 280 | 279.6 | 14.7 |
| 41 | 40.9 | 2.1 | 101 | 100.9 | 5.3 | 161 | 160.8 | 8.4 | 221 | 220.7 | 11.6 | 281 | 280.6 | 14.7 |
| 42 | 41.9 | 2.2 | 102 | 101.9 | 5.3 | 162 | 161.8 | 8.5 | 222 | 221.7 | 11.6 | 282 | 281.6 | 14.8 |
| 43 | 42.9 | 2.3 | 103 | 102.9 | 5.4 | 163 | 162.8 | 8.5 | 223 | 222.7 | 11.7 | 283 | 282.6 | 14.8 |
| 44 | 43.9 | 2.3 | 104 | 103.9 | 5.4 | 164 | 163.8 | 8.6 | 224 | 223.7 | 11.7 | 284 | 283.6 | 14.9 |
| 45 | 44.9 | 2.4 | 105 | 104.9 | 5.5 | 165 | 164.8 | 8.6 | 225 | 224.7 | 11.8 | 285 | 284.6 | 14.9 |
| 46 | 45.9 | 2.4 | 106 | 105.9 | 5.5 | 166 | 165.8 | 8.7 | 226 | 225.7 | 11.8 | 286 | 285.6 | 15.0 |
| 47 | 46.9 | 2.5 | 107 | 106.9 | 5.6 | 167 | 166.8 | 8.7 | 227 | 226.7 | 11.9 | 287 | 286.6 | 15.0 |
| 48 | 47.9 | 2.5 | 108 | 107.9 | 5.7 | 168 | 167.8 | 8.8 | 228 | 227.7 | 11.9 | 288 | 287.6 | 15.1 |
| 49 | 48.9 | 2.6 | 109 | 108.9 | 5.7 | 169 | 168.8 | 8.8 | 229 | 228.7 | 12.0 | 289 | 288.6 | 15.1 |
| 50 | 49.9 | 2.6 | 110 | 109.9 | 5.8 | 170 | 169.8 | 8.9 | 230 | 229.7 | 12.0 | 290 | 289.6 | 15.2 |
| 51 | 50.9 | 2.7 | 111 | 110.8 | 5.8 | 171 | 170.8 | 8.9 | 231 | 230.7 | 12.1 | 291 | 290.6 | 15.2 |
| 52 | 51.9 | 2.7 | 112 | 111.8 | 5.9 | 172 | 171.8 | 9.0 | 232 | 231.7 | 12.1 | 292 | 291.6 | 15.3 |
| 53 | 52.9 | 2.8 | 113 | 112.8 | 5.9 | 173 | 172.8 | 9.1 | 233 | 232.7 | 12.2 | 293 | 292.6 | 15.3 |
| 54 | 53.9 | 2.8 | 114 | 113.8 | 6.0 | 174 | 173.8 | 9.1 | 234 | 233.7 | 12.2 | 294 | 293.6 | 15.4 |
| 55 | 54.9 | 2.9 | 115 | 114.8 | 6.0 | 175 | 174.8 | 9.2 | 235 | 234.7 | 12.3 | 295 | 294.6 | 15.4 |
| 56 | 55.9 | 2.9 | 116 | 115.8 | 6.1 | 176 | 175.8 | 9.2 | 236 | 235.7 | 12.4 | 296 | 295.6 | 15.5 |
| 57 | 56.9 | 3.0 | 117 | 116.8 | 6.1 | 177 | 176.8 | 9.3 | 237 | 236.7 | 12.4 | 297 | 296.6 | 15.5 |
| 58 | 57.9 | 3.0 | 118 | 117.8 | 6.2 | 178 | 177.8 | 9.3 | 238 | 237.7 | 12.5 | 298 | 297.6 | 15.6 |
| 59 | 58.9 | 3.1 | 119 | 118.8 | 6.2 | 179 | 178.8 | 9.4 | 239 | 238.7 | 12.5 | 299 | 298.6 | 15.6 |
| 60 | 59.9 | 3.1 | 120 | 119.8 | 6.3 | 180 | 179.8 | 9.4 | 240 | 239.7 | 12.6 | 300 | 299.6 | 15.7 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

87° 5h 48m

## TRAVERSE TABLE TO DEGREES

8° 0h 12m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 300.6 | 15.7 | 361 | 360.5 | 18.9 | 421 | 420.4 | 22.0 | 481 | 480.3 | 25.2 | 541 | 540.2 | 28.3 |
| 302 | 301.6 | 15.8 | 362 | 361.5 | 19.0 | 422 | 421.4 | 22.1 | 482 | 481.3 | 25.2 | 542 | 541.2 | 28.4 |
| 303 | 302.6 | 15.9 | 363 | 362.5 | 19.0 | 423 | 422.4 | 22.2 | 483 | 482.3 | 25.3 | 543 | 542.2 | 28.4 |
| 304 | 303.5 | 15.9 | 364 | 363.5 | 19.1 | 424 | 423.4 | 22.2 | 484 | 483.3 | 25.3 | 544 | 543.2 | 28.5 |
| 305 | 304.5 | 16.0 | 365 | 364.5 | 19.1 | 425 | 424.4 | 22.3 | 485 | 484.3 | 25.4 | 545 | 544.2 | 28.5 |
| 306 | 305.5 | 16.0 | 366 | 365.5 | 19.2 | 426 | 425.4 | 22.3 | 486 | 485.3 | 25.4 | 546 | 545.2 | 28.6 |
| 307 | 306.5 | 16.1 | 367 | 366.5 | 19.2 | 427 | 426.4 | 22.4 | 487 | 486.3 | 25.5 | 547 | 546.2 | 28.6 |
| 308 | 307.5 | 16.1 | 368 | 367.5 | 19.3 | 428 | 427.4 | 22.4 | 488 | 487.3 | 25.5 | 548 | 547.2 | 28.7 |
| 309 | 308.5 | 16.2 | 369 | 368.5 | 19.3 | 429 | 428.4 | 22.5 | 489 | 488.3 | 25.6 | 549 | 548.2 | 28.7 |
| 310 | 309.5 | 16.2 | 370 | 369.5 | 19.4 | 430 | 429.4 | 22.5 | 490 | 489.3 | 25.6 | 550 | 549.2 | 28.8 |
| 311 | 310.5 | 16.3 | 371 | 370.5 | 19.4 | 431 | 430.4 | 22.6 | 491 | 490.3 | 25.7 | 551 | 550.2 | 28.8 |
| 312 | 311.5 | 16.3 | 372 | 371.5 | 19.5 | 432 | 431.4 | 22.6 | 492 | 491.3 | 25.7 | 552 | 551.2 | 28.9 |
| 313 | 312.5 | 16.4 | 373 | 372.5 | 19.5 | 433 | 432.4 | 22.7 | 493 | 492.3 | 25.8 | 553 | 552.2 | 28.9 |
| 314 | 313.5 | 16.4 | 374 | 373.5 | 19.6 | 434 | 433.4 | 22.7 | 494 | 493.3 | 25.9 | 554 | 553.2 | 29.0 |
| 315 | 314.5 | 16.5 | 375 | 374.5 | 19.6 | 435 | 434.4 | 22.8 | 495 | 494.3 | 25.9 | 555 | 554.2 | 29.1 |
| 316 | 315.5 | 16.6 | 376 | 375.5 | 19.7 | 436 | 435.4 | 22.8 | 496 | 495.3 | 26.0 | 556 | 555.2 | 29.1 |
| 317 | 316.5 | 16.6 | 377 | 376.5 | 19.8 | 437 | 436.4 | 22.9 | 497 | 496.3 | 26.0 | 557 | 556.2 | 29.2 |
| 318 | 317.5 | 16.7 | 378 | 377.4 | 19.8 | 438 | 437.4 | 22.9 | 498 | 497.3 | 26.1 | 558 | 557.2 | 29.2 |
| 319 | 318.5 | 16.7 | 379 | 378.4 | 19.9 | 439 | 438.4 | 23.0 | 499 | 498.3 | 26.1 | 559 | 558.2 | 29.3 |
| 320 | 319.5 | 16.8 | 380 | 379.4 | 19.9 | 440 | 439.4 | 23.0 | 500 | 499.3 | 26.2 | 560 | 559.2 | 29.3 |
| 321 | 320.5 | 16.8 | 381 | 380.4 | 20.0 | 441 | 440.4 | 23.1 | 501 | 500.3 | 26.2 | 561 | 560.2 | 29.4 |
| 322 | 321.5 | 16.9 | 382 | 381.4 | 20.0 | 442 | 441.4 | 23.1 | 502 | 501.3 | 26.3 | 562 | 561.2 | 29.4 |
| 323 | 322.5 | 16.9 | 383 | 382.4 | 20.1 | 443 | 442.4 | 23.2 | 503 | 502.3 | 26.3 | 563 | 562.2 | 29.5 |
| 324 | 323.5 | 17.0 | 384 | 383.4 | 20.1 | 444 | 443.4 | 23.3 | 504 | 503.3 | 26.4 | 564 | 563.2 | 29.5 |
| 325 | 324.5 | 17.0 | 385 | 384.4 | 20.2 | 445 | 444.4 | 23.3 | 505 | 504.3 | 26.4 | 565 | 564.2 | 29.6 |
| 326 | 325.5 | 17.1 | 386 | 385.4 | 20.2 | 446 | 445.4 | 23.4 | 506 | 505.3 | 26.5 | 566 | 565.2 | 29.6 |
| 327 | 326.5 | 17.1 | 387 | 386.4 | 20.3 | 447 | 446.4 | 23.4 | 507 | 506.3 | 26.5 | 567 | 566.2 | 29.7 |
| 328 | 327.5 | 17.2 | 388 | 387.4 | 20.3 | 448 | 447.4 | 23.5 | 508 | 507.3 | 26.6 | 568 | 567.2 | 29.7 |
| 329 | 328.5 | 17.2 | 389 | 388.4 | 20.4 | 449 | 448.4 | 23.5 | 509 | 508.3 | 26.6 | 569 | 568.2 | 29.8 |
| 330 | 329.5 | 17.3 | 390 | 389.4 | 20.4 | 450 | 449.3 | 23.6 | 510 | 509.3 | 26.7 | 570 | 569.2 | 29.8 |
| 331 | 330.5 | 17.3 | 391 | 390.4 | 20.5 | 451 | 450.3 | 23.6 | 511 | 510.3 | 26.7 | 571 | 570.2 | 29.9 |
| 332 | 331.5 | 17.4 | 392 | 391.4 | 20.5 | 452 | 451.3 | 23.7 | 512 | 511.3 | 26.8 | 572 | 571.2 | 29.9 |
| 333 | 332.5 | 17.5 | 393 | 392.4 | 20.6 | 453 | 452.3 | 23.7 | 513 | 512.3 | 26.8 | 573 | 572.2 | 30.0 |
| 334 | 333.5 | 17.5 | 394 | 393.4 | 20.6 | 454 | 453.3 | 23.8 | 514 | 513.3 | 26.9 | 574 | 573.2 | 30.0 |
| 335 | 334.5 | 17.6 | 395 | 394.4 | 20.7 | 455 | 454.3 | 23.8 | 515 | 514.3 | 27.0 | 575 | 574.2 | 30.1 |
| 336 | 335.5 | 17.6 | 396 | 395.4 | 20.7 | 456 | 455.3 | 23.9 | 516 | 515.3 | 27.0 | 576 | 575.2 | 30.1 |
| 337 | 336.5 | 17.7 | 397 | 396.4 | 20.8 | 457 | 456.3 | 23.9 | 517 | 516.3 | 27.1 | 577 | 576.2 | 30.2 |
| 338 | 337.5 | 17.7 | 398 | 397.4 | 20.8 | 458 | 457.3 | 24.0 | 518 | 517.3 | 27.1 | 578 | 577.2 | 30.2 |
| 339 | 338.5 | 17.8 | 399 | 398.4 | 20.9 | 459 | 458.3 | 24.0 | 519 | 518.3 | 27.2 | 579 | 578.2 | 30.3 |
| 340 | 339.5 | 17.8 | 400 | 399.4 | 20.9 | 460 | 459.3 | 24.1 | 520 | 519.3 | 27.2 | 580 | 579.2 | 30.3 |
| 341 | 340.5 | 17.9 | 401 | 400.4 | 21.0 | 461 | 460.3 | 24.1 | 521 | 520.3 | 27.3 | 581 | 580.2 | 30.4 |
| 342 | 341.5 | 17.9 | 402 | 401.4 | 21.1 | 462 | 461.3 | 24.2 | 522 | 521.3 | 27.3 | 582 | 581.2 | 30.4 |
| 343 | 342.5 | 18.0 | 403 | 402.4 | 21.1 | 463 | 462.3 | 24.2 | 523 | 522.3 | 27.4 | 583 | 582.2 | 30.5 |
| 344 | 343.5 | 18.0 | 404 | 403.4 | 21.2 | 464 | 463.3 | 24.3 | 524 | 523.3 | 27.4 | 584 | 583.2 | 30.5 |
| 345 | 344.5 | 18.1 | 405 | 404.4 | 21.2 | 465 | 464.3 | 24.4 | 525 | 524.3 | 27.5 | 585 | 584.2 | 30.6 |
| 346 | 345.5 | 18.1 | 406 | 405.4 | 21.3 | 466 | 465.3 | 24.4 | 526 | 525.3 | 27.5 | 586 | 585.2 | 30.6 |
| 347 | 346.5 | 18.2 | 407 | 406.4 | 21.3 | 467 | 466.3 | 24.5 | 527 | 526.3 | 27.6 | 587 | 586.2 | 30.7 |
| 348 | 347.5 | 18.2 | 408 | 407.4 | 21.4 | 468 | 467.3 | 24.5 | 528 | 527.3 | 27.6 | 588 | 587.2 | 30.7 |
| 349 | 348.5 | 18.3 | 409 | 408.4 | 21.4 | 469 | 468.3 | 24.6 | 529 | 528.3 | 27.7 | 589 | 588.2 | 30.8 |
| 350 | 349.5 | 18.3 | 410 | 409.4 | 21.5 | 470 | 469.3 | 24.6 | 530 | 529.3 | 27.7 | 590 | 589.2 | 30.9 |
| 351 | 350.5 | 18.4 | 411 | 410.4 | 21.5 | 471 | 470.3 | 24.7 | 531 | 530.3 | 27.8 | 591 | 590.2 | 30.9 |
| 352 | 351.5 | 18.4 | 412 | 411.4 | 21.6 | 472 | 471.3 | 24.7 | 532 | 531.3 | 27.8 | 592 | 591.2 | 31.0 |
| 353 | 352.5 | 18.5 | 413 | 412.4 | 21.6 | 473 | 472.3 | 24.8 | 533 | 532.3 | 27.9 | 593 | 592.2 | 31.0 |
| 354 | 353.5 | 18.5 | 414 | 413.4 | 21.7 | 474 | 473.3 | 24.8 | 534 | 533.3 | 27.9 | 594 | 593.2 | 31.1 |
| 355 | 354.5 | 18.6 | 415 | 414.4 | 21.7 | 475 | 474.3 | 24.9 | 535 | 534.3 | 28.0 | 595 | 594.2 | 31.1 |
| 356 | 355.5 | 18.6 | 416 | 415.4 | 21.8 | 476 | 475.3 | 24.9 | 536 | 535.3 | 28.1 | 596 | 595.2 | 31.2 |
| 357 | 356.5 | 18.7 | 417 | 416.4 | 21.8 | 477 | 476.3 | 25.0 | 537 | 536.3 | 28.1 | 597 | 596.2 | 31.2 |
| 358 | 357.5 | 18.8 | 418 | 417.4 | 21.9 | 478 | 477.3 | 25.0 | 538 | 537.3 | 28.2 | 598 | 597.2 | 31.3 |
| 359 | 358.5 | 18.8 | 419 | 418.4 | 21.9 | 479 | 478.3 | 25.1 | 539 | 538.3 | 28.2 | 599 | 598.2 | 31.3 |
| 360 | 359.5 | 18.9 | 420 | 419.4 | 22.0 | 480 | 479.3 | 25.1 | 540 | 539.3 | 28.3 | 600 | 599.2 | 31.4 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

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## TRAVERSE TABLE TO DEGREES

4° — 0h 16m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1·0 | 0·1 | 61 | 60·9 | 4·3 | 121 | 120·7 | 8·4 | 181 | 180·6 | 12·6 | 241 | 240·4 | 16·8 |
| 2 | 2·0 | 0·1 | 62 | 61·8 | 4·3 | 122 | 121·7 | 8·5 | 182 | 181·6 | 12·7 | 242 | 241·4 | 16·9 |
| 3 | 3·0 | 0·2 | 63 | 62·8 | 4·4 | 123 | 122·7 | 8·6 | 183 | 182·6 | 12·8 | 243 | 242·4 | 17·0 |
| 4 | 4·0 | 0·3 | 64 | 63·8 | 4·5 | 124 | 123·7 | 8·6 | 184 | 183·6 | 12·8 | 244 | 243·4 | 17·0 |
| 5 | 5·0 | 0·3 | 65 | 64·8 | 4·5 | 125 | 124·7 | 8·7 | 185 | 184·5 | 12·9 | 245 | 244·4 | 17·1 |
| 6 | 6·0 | 0·4 | 66 | 65·8 | 4·6 | 126 | 125·7 | 8·8 | 186 | 185·5 | 13·0 | 246 | 245·4 | 17·2 |
| 7 | 7·0 | 0·5 | 67 | 66·8 | 4·7 | 127 | 126·7 | 8·9 | 187 | 186·5 | 13·0 | 247 | 246·4 | 17·2 |
| 8 | 8·0 | 0·6 | 68 | 67·8 | 4·7 | 128 | 127·7 | 8·9 | 188 | 187·5 | 13·1 | 248 | 247·4 | 17·3 |
| 9 | 9·0 | 0·6 | 69 | 68·8 | 4·8 | 129 | 128·7 | 9·0 | 189 | 188·5 | 13·2 | 249 | 248·4 | 17·4 |
| 10 | 10·0 | 0·7 | 70 | 69·8 | 4·9 | 130 | 129·7 | 9·1 | 190 | 189·5 | 13·3 | 250 | 249·4 | 17·4 |
| 11 | 11·0 | 0·8 | 71 | 70·8 | 5·0 | 131 | 130·7 | 9·1 | 191 | 190·5 | 13·3 | 251 | 250·4 | 17·5 |
| 12 | 12·0 | 0·8 | 72 | 71·8 | 5·0 | 132 | 131·7 | 9·2 | 192 | 191·5 | 13·4 | 252 | 251·4 | 17·6 |
| 13 | 13·0 | 0·9 | 73 | 72·8 | 5·1 | 133 | 132·7 | 9·3 | 193 | 192·5 | 13·5 | 253 | 252·4 | 17·6 |
| 14 | 14·0 | 1·0 | 74 | 73·8 | 5·2 | 134 | 133·7 | 9·3 | 194 | 193·5 | 13·5 | 254 | 253·4 | 17·7 |
| 15 | 15·0 | 1·0 | 75 | 74·8 | 5·2 | 135 | 134·7 | 9·4 | 195 | 194·5 | 13·6 | 255 | 254·4 | 17·8 |
| 16 | 16·0 | 1·1 | 76 | 75·8 | 5·3 | 136 | 135·7 | 9·5 | 196 | 195·5 | 13·7 | 256 | 255·4 | 17·9 |
| 17 | 17·0 | 1·2 | 77 | 76·8 | 5·4 | 137 | 136·7 | 9·6 | 197 | 196·5 | 13·7 | 257 | 256·4 | 17·9 |
| 18 | 18·0 | 1·3 | 78 | 77·8 | 5·4 | 138 | 137·7 | 9·6 | 198 | 197·5 | 13·8 | 258 | 257·4 | 18·0 |
| 19 | 19·0 | 1·3 | 79 | 78·8 | 5·5 | 139 | 138·7 | 9·7 | 199 | 198·5 | 13·9 | 259 | 258·4 | 18·1 |
| 20 | 20·0 | 1·4 | 80 | 79·8 | 5·6 | 140 | 139·7 | 9·8 | 200 | 199·5 | 14·0 | 260 | 259·4 | 18·1 |
| 21 | 20·9 | 1·5 | 81 | 80·8 | 5·7 | 141 | 140·7 | 9·8 | 201 | 200·5 | 14·0 | 261 | 260·4 | 18·2 |
| 22 | 21·9 | 1·5 | 82 | 81·8 | 5·7 | 142 | 141·7 | 9·9 | 202 | 201·5 | 14·1 | 262 | 261·4 | 18·3 |
| 23 | 22·9 | 1·6 | 83 | 82·8 | 5·8 | 143 | 142·7 | 10·0 | 203 | 202·5 | 14·2 | 263 | 262·4 | 18·3 |
| 24 | 23·9 | 1·7 | 84 | 83·8 | 5·9 | 144 | 143·6 | 10·0 | 204 | 203·5 | 14·2 | 264 | 263·4 | 18·4 |
| 25 | 24·9 | 1·7 | 85 | 84·8 | 5·9 | 145 | 144·6 | 10·1 | 205 | 204·5 | 14·3 | 265 | 264·4 | 18·5 |
| 26 | 25·9 | 1·8 | 86 | 85·8 | 6·0 | 146 | 145·6 | 10·2 | 206 | 205·5 | 14·4 | 266 | 265·4 | 18·6 |
| 27 | 26·9 | 1·9 | 87 | 86·8 | 6·1 | 147 | 146·6 | 10·3 | 207 | 206·5 | 14·4 | 267 | 266·3 | 18·6 |
| 28 | 27·9 | 2·0 | 88 | 87·8 | 6·1 | 148 | 147·6 | 10·3 | 208 | 207·5 | 14·5 | 268 | 267·3 | 18·7 |
| 29 | 28·9 | 2·0 | 89 | 88·8 | 6·2 | 149 | 148·6 | 10·4 | 209 | 208·5 | 14·6 | 269 | 268·3 | 18·8 |
| 30 | 29·9 | 2·1 | 90 | 89·8 | 6·3 | 150 | 149·6 | 10·5 | 210 | 209·5 | 14·6 | 270 | 269·3 | 18·8 |
| 31 | 30·9 | 2·2 | 91 | 90·8 | 6·3 | 151 | 150·6 | 10·5 | 211 | 210·5 | 14·7 | 271 | 270·3 | 18·9 |
| 32 | 31·9 | 2·2 | 92 | 91·8 | 6·4 | 152 | 151·6 | 10·6 | 212 | 211·5 | 14·8 | 272 | 271·3 | 19·0 |
| 33 | 32·9 | 2·3 | 93 | 92·8 | 6·5 | 153 | 152·6 | 10·7 | 213 | 212·5 | 14·9 | 273 | 272·3 | 19·0 |
| 34 | 33·9 | 2·4 | 94 | 93·8 | 6·6 | 154 | 153·6 | 10·7 | 214 | 213·5 | 14·9 | 274 | 273·3 | 19·1 |
| 35 | 34·9 | 2·4 | 95 | 94·8 | 6·6 | 155 | 154·6 | 10·8 | 215 | 214·5 | 15·0 | 275 | 274·3 | 19·2 |
| 36 | 35·9 | 2·5 | 96 | 95·8 | 6·7 | 156 | 155·6 | 10·9 | 216 | 215·5 | 15·1 | 276 | 275·3 | 19·3 |
| 37 | 36·9 | 2·6 | 97 | 96·8 | 6·8 | 157 | 156·6 | 11·0 | 217 | 216·5 | 15·1 | 277 | 276·3 | 19·3 |
| 38 | 37·9 | 2·7 | 98 | 97·8 | 6·8 | 158 | 157·6 | 11·0 | 218 | 217·5 | 15·2 | 278 | 277·3 | 19·4 |
| 39 | 38·9 | 2·7 | 99 | 98·8 | 6·9 | 159 | 158·6 | 11·1 | 219 | 218·5 | 15·3 | 279 | 278·3 | 19·5 |
| 40 | 39·9 | 2·8 | 100 | 99·8 | 7·0 | 160 | 159·6 | 11·2 | 220 | 219·5 | 15·3 | 280 | 279·3 | 19·5 |
| 41 | 40·9 | 2·9 | 101 | 100·8 | 7·0 | 161 | 160·6 | 11·2 | 221 | 220·5 | 15·4 | 281 | 280·3 | 19·6 |
| 42 | 41·9 | 2·9 | 102 | 101·8 | 7·1 | 162 | 161·6 | 11·3 | 222 | 221·5 | 15·5 | 282 | 281·3 | 19·7 |
| 43 | 42·9 | 3·0 | 103 | 102·7 | 7·2 | 163 | 162·6 | 11·4 | 223 | 222·5 | 15·6 | 283 | 282·3 | 19·7 |
| 44 | 43·9 | 3·1 | 104 | 103·7 | 7·3 | 164 | 163·6 | 11·4 | 224 | 223·5 | 15·6 | 284 | 283·3 | 19·8 |
| 45 | 44·9 | 3·1 | 105 | 104·7 | 7·3 | 165 | 164·6 | 11·5 | 225 | 224·5 | 15·7 | 285 | 284·3 | 19·9 |
| 46 | 45·9 | 3·2 | 106 | 105·7 | 7·4 | 166 | 165·6 | 11·6 | 226 | 225·4 | 15·8 | 286 | 285·3 | 20·0 |
| 47 | 46·9 | 3·3 | 107 | 106·7 | 7·5 | 167 | 166·6 | 11·6 | 227 | 226·4 | 15·8 | 287 | 286·3 | 20·0 |
| 48 | 47·9 | 3·3 | 108 | 107·7 | 7·5 | 168 | 167·6 | 11·7 | 228 | 227·4 | 15·9 | 288 | 287·3 | 20·1 |
| 49 | 48·9 | 3·4 | 109 | 108·7 | 7·6 | 169 | 168·6 | 11·8 | 229 | 228·4 | 16·0 | 289 | 288·3 | 20·2 |
| 50 | 49·9 | 3·5 | 110 | 109·7 | 7·7 | 170 | 169·6 | 11·9 | 230 | 229·4 | 16·0 | 290 | 289·3 | 20·2 |
| 51 | 50·9 | 3·6 | 111 | 110·7 | 7·7 | 171 | 170·6 | 11·9 | 231 | 230·4 | 16·1 | 291 | 290·3 | 20·3 |
| 52 | 51·9 | 3·6 | 112 | 111·7 | 7·8 | 172 | 171·6 | 12·0 | 232 | 231·4 | 16·2 | 292 | 291·3 | 20·4 |
| 53 | 52·9 | 3·7 | 113 | 112·7 | 7·9 | 173 | 172·6 | 12·1 | 233 | 232·4 | 16·3 | 293 | 292·3 | 20·4 |
| 54 | 53·9 | 3·8 | 114 | 113·7 | 8·0 | 174 | 173·6 | 12·1 | 234 | 233·4 | 16·3 | 294 | 293·3 | 20·5 |
| 55 | 54·9 | 3·8 | 115 | 114·7 | 8·0 | 175 | 174·6 | 12·2 | 235 | 234·4 | 16·4 | 295 | 294·3 | 20·6 |
| 56 | 55·9 | 3·9 | 116 | 115·7 | 8·1 | 176 | 175·6 | 12·3 | 236 | 235·4 | 16·5 | 296 | 295·3 | 20·6 |
| 57 | 56·9 | 4·0 | 117 | 116·7 | 8·2 | 177 | 176·6 | 12·3 | 237 | 236·4 | 16·5 | 297 | 296·3 | 20·7 |
| 58 | 57·9 | 4·0 | 118 | 117·7 | 8·2 | 178 | 177·6 | 12·4 | 238 | 237·4 | 16·6 | 298 | 297·3 | 20·8 |
| 59 | 58·9 | 4·1 | 119 | 118·7 | 8·3 | 179 | 178·6 | 12·5 | 239 | 238·4 | 16·7 | 299 | 298·3 | 20·9 |
| 60 | 59·9 | 4·2 | 120 | 119·7 | 8·4 | 180 | 179·6 | 12·6 | 240 | 239·4 | 16·7 | 300 | 299·3 | 20·9 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

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## TRAVERSE TABLE TO DEGREES

4° 0h 16m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 300·3 | 21·0 | 361 | 360·1 | 25·2 | 421 | 420·0 | 29·4 | 481 | 479·8 | 33·5 | 541 | 539·7 | 37·7 |
| 302 | 301·3 | 21·1 | 362 | 361·1 | 25·2 | 422 | 421·0 | 29·4 | 482 | 480·8 | 33·6 | 542 | 540·7 | 37·8 |
| 303 | 302·2 | 21·1 | 363 | 362·1 | 25·3 | 423 | 422·0 | 29·5 | 483 | 481·8 | 33·7 | 543 | 541·7 | 37·9 |
| 304 | 303·2 | 21·2 | 364 | 363·1 | 25·4 | 424 | 423·0 | 29·6 | 484 | 482·8 | 33·7 | 544 | 542·7 | 37·9 |
| 305 | 304·2 | 21·3 | 365 | 364·1 | 25·5 | 425 | 424·0 | 29·6 | 485 | 483·8 | 33·8 | 545 | 543·7 | 38·0 |
| 306 | 305·2 | 21·3 | 366 | 365·1 | 25·5 | 426 | 424·9 | 29·7 | 486 | 484·8 | 33·9 | 546 | 544·7 | 38·1 |
| 307 | 306·2 | 21·4 | 367 | 366·1 | 25·6 | 427 | 425·9 | 29·8 | 487 | 485·8 | 33·9 | 547 | 545·7 | 38·1 |
| 308 | 307·2 | 21·5 | 368 | 367·1 | 25·7 | 428 | 426·9 | 29·9 | 488 | 486·8 | 34·0 | 548 | 546·7 | 38·2 |
| 309 | 308·2 | 21·6 | 369 | 368·1 | 25·7 | 429 | 427·9 | 29·9 | 489 | 487·8 | 34·1 | 549 | 547·7 | 38·3 |
| 310 | 309·2 | 21·6 | 370 | 369·1 | 25·8 | 430 | 428·9 | 30·0 | 490 | 488·8 | 34·2 | 550 | 548·7 | 38·3 |
| 311 | 310·2 | 21·7 | 371 | 370·1 | 25·9 | 431 | 429·9 | 30·1 | 491 | 489·8 | 34·2 | 551 | 549·7 | 38·4 |
| 312 | 311·2 | 21·8 | 372 | 371·1 | 25·9 | 432 | 430·9 | 30·1 | 492 | 490·8 | 34·3 | 552 | 550·7 | 38·5 |
| 313 | 312·2 | 21·8 | 373 | 372·1 | 26·0 | 433 | 431·9 | 30·2 | 493 | 491·8 | 34·4 | 553 | 551·7 | 38·5 |
| 314 | 313·2 | 21·9 | 374 | 373·1 | 26·1 | 434 | 432·9 | 30·3 | 494 | 492·8 | 34·4 | 554 | 552·7 | 38·6 |
| 315 | 314·2 | 22·0 | 375 | 374·1 | 26·2 | 435 | 433·9 | 30·3 | 495 | 493·8 | 34·5 | 555 | 553·6 | 38·7 |
| 316 | 315·2 | 22·1 | 376 | 375·1 | 26·2 | 436 | 434·9 | 30·4 | 496 | 494·8 | 34·6 | 556 | 554·6 | 38·7 |
| 317 | 316·2 | 22·1 | 377 | 376·1 | 26·3 | 437 | 435·9 | 30·5 | 497 | 495·8 | 34·6 | 557 | 555·6 | 38·8 |
| 318 | 317·2 | 22·2 | 378 | 377·1 | 26·4 | 438 | 436·9 | 30·6 | 498 | 496·8 | 34·7 | 558 | 556·6 | 38·9 |
| 319 | 318·2 | 22·3 | 379 | 378·1 | 26·4 | 439 | 437·9 | 30·6 | 499 | 497·8 | 34·8 | 559 | 557·6 | 38·9 |
| 320 | 319·2 | 22·3 | 380 | 379·1 | 26·5 | 440 | 438·9 | 30·7 | 500 | 498·8 | 34·8 | 560 | 558·6 | 39·0 |
| 321 | 320·2 | 22·4 | 381 | 380·1 | 26·6 | 441 | 439·9 | 30·8 | 501 | 499·8 | 34·9 | 561 | 559·6 | 39·1 |
| 322 | 321·2 | 22·5 | 382 | 381·1 | 26·6 | 442 | 440·9 | 30·8 | 502 | 500·8 | 35·0 | 562 | 560·6 | 39·2 |
| 323 | 322·2 | 22·5 | 383 | 382·1 | 26·7 | 443 | 441·9 | 30·9 | 503 | 501·8 | 35·0 | 563 | 561·6 | 39·2 |
| 324 | 323·2 | 22·6 | 384 | 383·1 | 26·8 | 444 | 442·9 | 31·0 | 504 | 502·8 | 35·1 | 564 | 562·6 | 39·3 |
| 325 | 324·2 | 22·7 | 385 | 384·0 | 26·9 | 445 | 443·9 | 31·0 | 505 | 503·8 | 35·2 | 565 | 563·6 | 39·4 |
| 326 | 325·2 | 22·7 | 386 | 385·0 | 26·9 | 446 | 444·9 | 31·1 | 506 | 504·8 | 35·2 | 566 | 564·6 | 39·4 |
| 327 | 326·2 | 22·8 | 387 | 386·0 | 27·0 | 447 | 445·9 | 31·2 | 507 | 505·8 | 35·3 | 567 | 565·6 | 39·5 |
| 328 | 327·2 | 22·9 | 388 | 387·0 | 27·1 | 448 | 446·9 | 31·2 | 508 | 506·8 | 35·4 | 568 | 566·6 | 39·6 |
| 329 | 328·2 | 23·0 | 389 | 388·0 | 27·1 | 449 | 447·9 | 31·3 | 509 | 507·8 | 35·5 | 569 | 567·6 | 39·7 |
| 330 | 329·2 | 23·0 | 390 | 389·0 | 27·2 | 450 | 448·9 | 31·4 | 510 | 508·8 | 35·6 | 570 | 568·6 | 39·8 |
| 331 | 330·2 | 23·1 | 391 | 390·0 | 27·3 | 451 | 449·9 | 31·5 | 511 | 509·8 | 35·6 | 571 | 569·6 | 39·8 |
| 332 | 331·2 | 23·2 | 392 | 391·0 | 27·3 | 452 | 450·9 | 31·5 | 512 | 510·8 | 35·7 | 572 | 570·6 | 39·9 |
| 333 | 332·2 | 23·2 | 393 | 392·0 | 27·4 | 453 | 451·9 | 31·6 | 513 | 511·8 | 35·8 | 573 | 571·6 | 40·0 |
| 334 | 333·2 | 23·3 | 394 | 393·0 | 27·5 | 454 | 452·9 | 31·7 | 514 | 512·7 | 35·8 | 574 | 572·6 | 40·0 |
| 335 | 334·2 | 23·4 | 395 | 394·0 | 27·6 | 455 | 453·9 | 31·7 | 515 | 513·7 | 35·9 | 575 | 573·6 | 40·1 |
| 336 | 335·2 | 23·4 | 396 | 395·0 | 27·6 | 456 | 454·9 | 31·8 | 516 | 514·7 | 36·0 | 576 | 574·6 | 40·2 |
| 337 | 336·2 | 23·5 | 397 | 396·0 | 27·7 | 457 | 455·9 | 31·9 | 517 | 515·7 | 36·0 | 577 | 575·6 | 40·2 |
| 338 | 337·2 | 23·6 | 398 | 397·0 | 27·8 | 458 | 456·9 | 31·9 | 518 | 516·7 | 36·1 | 578 | 576·6 | 40·3 |
| 339 | 338·2 | 23·6 | 399 | 398·0 | 27·8 | 459 | 457·9 | 32·0 | 519 | 517·7 | 36·2 | 579 | 577·6 | 40·4 |
| 340 | 339·2 | 23·7 | 400 | 399·0 | 27·9 | 460 | 458·9 | 32·1 | 520 | 518·7 | 36·2 | 580 | 578·6 | 40·5 |
| 341 | 340·2 | 23·8 | 401 | 400·0 | 28·0 | 461 | 459·9 | 32·2 | 521 | 519·7 | 36·3 | 581 | 579·6 | 40·5 |
| 342 | 341·2 | 23·9 | 402 | 401·0 | 28·0 | 462 | 460·9 | 32·2 | 522 | 520·7 | 36·4 | 582 | 580·6 | 40·6 |
| 343 | 342·2 | 23·9 | 403 | 402·0 | 28·1 | 463 | 461·9 | 32·3 | 523 | 521·7 | 36·4 | 583 | 581·6 | 40·7 |
| 344 | 343·1 | 24·0 | 404 | 403·0 | 28·2 | 464 | 462·9 | 32·4 | 524 | 522·7 | 36·5 | 584 | 582·6 | 40·7 |
| 345 | 344·1 | 24·1 | 405 | 404·0 | 28·2 | 465 | 463·9 | 32·4 | 525 | 523·7 | 36·6 | 585 | 583·6 | 40·8 |
| 346 | 345·1 | 24·1 | 406 | 405·0 | 28·3 | 466 | 464·9 | 32·5 | 526 | 524·7 | 36·7 | 586 | 584·6 | 40·9 |
| 347 | 346·1 | 24·2 | 407 | 406·0 | 28·4 | 467 | 465·8 | 32·6 | 527 | 525·7 | 36·8 | 587 | 585·6 | 40·9 |
| 348 | 347·1 | 24·3 | 408 | 407·0 | 28·5 | 468 | 466·8 | 32·6 | 528 | 526·7 | 36·8 | 588 | 586·6 | 41·0 |
| 349 | 348·1 | 24·3 | 409 | 408·0 | 28·5 | 469 | 467·8 | 32·7 | 529 | 527·7 | 36·9 | 589 | 587·6 | 41·1 |
| 350 | 349·1 | 24·4 | 410 | 409·0 | 28·6 | 470 | 468·8 | 32·8 | 530 | 528·7 | 37·0 | 590 | 588·6 | 41·2 |
| 351 | 350·1 | 24·5 | 411 | 410·0 | 28·7 | 471 | 469·8 | 32·9 | 531 | 529·7 | 37·0 | 591 | 589·6 | 41·3 |
| 352 | 351·1 | 24·6 | 412 | 411·0 | 28·7 | 472 | 470·8 | 32·9 | 532 | 530·7 | 37·1 | 592 | 590·6 | 41·3 |
| 353 | 352·1 | 24·6 | 413 | 412·0 | 28·8 | 473 | 471·8 | 33·0 | 533 | 531·7 | 37·2 | 593 | 591·6 | 41·4 |
| 354 | 353·1 | 24·7 | 414 | 413·0 | 28·9 | 474 | 472·8 | 33·1 | 534 | 532·7 | 37·2 | 594 | 592·6 | 41·5 |
| 355 | 354·1 | 24·8 | 415 | 414·0 | 28·9 | 475 | 473·8 | 33·1 | 535 | 533·7 | 37·3 | 595 | 593·6 | 41·5 |
| 356 | 355·1 | 24·8 | 416 | 415·0 | 29·0 | 476 | 474·8 | 33·2 | 536 | 534·7 | 37·4 | 596 | 594·6 | 41·6 |
| 357 | 356·1 | 24·9 | 417 | 416·0 | 29·1 | 477 | 475·8 | 33·3 | 537 | 535·7 | 37·5 | 597 | 595·6 | 41·7 |
| 358 | 357·1 | 25·0 | 418 | 417·0 | 29·2 | 478 | 476·8 | 33·3 | 538 | 536·7 | 37·5 | 598 | 596·6 | 41·7 |
| 359 | 358·1 | 25·0 | 419 | 418·0 | 29·2 | 479 | 477·8 | 33·4 | 539 | 537·7 | 37·6 | 599 | 597·6 | 41·8 |
| 360 | 359·1 | 25·1 | 420 | 419·0 | 29·3 | 480 | 478·8 | 33·5 | 540 | 538·7 | 37·7 | 600 | 598·6 | 41·9 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

86° 5h 44m

## TRAVERSE TABLE TO DEGREES

5° 0h 20m

| Dist. | D.Lat | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1·0 | 0·1 | 61 | 60·8 | 5·3 | 121 | 120·5 | 10·5 | 181 | 180·3 | 15·8 | 241 | 240·1 | 21·0 |
| 2 | 2·0 | 0·2 | 62 | 61·8 | 5·4 | 122 | 121·5 | 10·6 | 182 | 181·3 | 15·9 | 242 | 241·1 | 21·1 |
| 3 | 3·0 | 0·3 | 63 | 62·8 | 5·5 | 123 | 122·5 | 10·7 | 183 | 182·3 | 15·9 | 243 | 242·1 | 21·2 |
| 4 | 4·0 | 0·3 | 64 | 63·8 | 5·6 | 124 | 123·5 | 10·8 | 184 | 183·3 | 16·0 | 244 | 243·1 | 21·3 |
| 5 | 5·0 | 0·4 | 65 | 64·8 | 5·7 | 125 | 124·5 | 10·9 | 185 | 184·3 | 16·1 | 245 | 244·1 | 21·4 |
| 6 | 6·0 | 0·5 | 66 | 65·7 | 5·8 | 126 | 125·5 | 11·0 | 186 | 185·3 | 16·2 | 246 | 245·1 | 21·4 |
| 7 | 7·0 | 0·6 | 67 | 66·7 | 5·8 | 127 | 126·5 | 11·1 | 187 | 186·3 | 16·3 | 247 | 246·1 | 21·5 |
| 8 | 8·0 | 0·7 | 68 | 67·7 | 5·9 | 128 | 127·5 | 11·2 | 188 | 187·3 | 16·4 | 248 | 247·1 | 21·6 |
| 9 | 9·0 | 0·8 | 69 | 68·7 | 6·0 | 129 | 128·5 | 11·2 | 189 | 188·3 | 16·5 | 249 | 248·1 | 21·7 |
| 10 | 10·0 | 0·9 | 70 | 69·7 | 6·1 | 130 | 129·5 | 11·3 | 190 | 189·3 | 16·6 | 250 | 249·0 | 21·8 |
| 11 | 11·0 | 1·0 | 71 | 70·7 | 6·2 | 131 | 130·5 | 11·4 | 191 | 190·3 | 16·6 | 251 | 250·0 | 21·9 |
| 12 | 12·0 | 1·0 | 72 | 71·7 | 6·3 | 132 | 131·5 | 11·5 | 192 | 191·3 | 16·7 | 252 | 251·0 | 22·0 |
| 13 | 13·0 | 1·1 | 73 | 72·7 | 6·4 | 133 | 132·5 | 11·6 | 193 | 192·3 | 16·8 | 253 | 252·0 | 22·1 |
| 14 | 13·9 | 1·2 | 74 | 73·7 | 6·4 | 134 | 133·5 | 11·7 | 194 | 193·3 | 16·9 | 254 | 253·0 | 22·1 |
| 15 | 14·9 | 1·3 | 75 | 74·7 | 6·5 | 135 | 134·5 | 11·8 | 195 | 194·3 | 17·0 | 255 | 254·0 | 22·2 |
| 16 | 15·9 | 1·4 | 76 | 75·7 | 6·6 | 136 | 135·5 | 11·9 | 196 | 195·3 | 17·1 | 256 | 255·0 | 22·3 |
| 17 | 16·9 | 1·5 | 77 | 76·7 | 6·7 | 137 | 136·5 | 11·9 | 197 | 196·3 | 17·2 | 257 | 256·0 | 22·4 |
| 18 | 17·9 | 1·6 | 78 | 77·7 | 6·8 | 138 | 137·5 | 12·0 | 198 | 197·2 | 17·3 | 258 | 257·0 | 22·5 |
| 19 | 18·9 | 1·7 | 79 | 78·7 | 6·9 | 139 | 138·5 | 12·1 | 199 | 198·2 | 17·3 | 259 | 258·0 | 22·6 |
| 20 | 19·9 | 1·7 | 80 | 79·7 | 7·0 | 140 | 139·5 | 12·2 | 200 | 199·2 | 17·4 | 260 | 259·0 | 22·7 |
| 21 | 20·9 | 1·8 | 81 | 80·7 | 7·1 | 141 | 140·5 | 12·3 | 201 | 200·2 | 17·5 | 261 | 260·0 | 22·7 |
| 22 | 21·9 | 1·9 | 82 | 81·7 | 7·1 | 142 | 141·5 | 12·4 | 202 | 201·2 | 17·6 | 262 | 261·0 | 22·8 |
| 23 | 22·9 | 2·0 | 83 | 82·7 | 7·2 | 143 | 142·5 | 12·5 | 203 | 202·2 | 17·7 | 263 | 262·0 | 22·9 |
| 24 | 23·9 | 2·1 | 84 | 83·7 | 7·3 | 144 | 143·5 | 12·6 | 204 | 203·2 | 17·8 | 264 | 263·0 | 23·0 |
| 25 | 24·9 | 2·2 | 85 | 84·7 | 7·4 | 145 | 144·4 | 12·6 | 205 | 204·2 | 17·9 | 265 | 264·0 | 23·1 |
| 26 | 25·9 | 2·3 | 86 | 85·7 | 7·5 | 146 | 145·4 | 12·7 | 206 | 205·2 | 18·0 | 266 | 265·0 | 23·2 |
| 27 | 26·9 | 2·4 | 87 | 86·7 | 7·6 | 147 | 146·4 | 12·8 | 207 | 206·2 | 18·0 | 267 | 266·0 | 23·3 |
| 28 | 27·9 | 2·4 | 88 | 87·7 | 7·7 | 148 | 147·4 | 12·9 | 208 | 207·2 | 18·1 | 268 | 267·0 | 23·4 |
| 29 | 28·9 | 2·5 | 89 | 88·7 | 7·8 | 149 | 148·4 | 13·0 | 209 | 208·2 | 18·2 | 269 | 268·0 | 23·4 |
| 30 | 29·9 | 2·6 | 90 | 89·7 | 7·8 | 150 | 149·4 | 13·1 | 210 | 209·2 | 18·3 | 270 | 269·0 | 23·5 |
| 31 | 30·9 | 2·7 | 91 | 90·7 | 7·9 | 151 | 150·4 | 13·2 | 211 | 210·2 | 18·4 | 271 | 270·0 | 23·6 |
| 32 | 31·9 | 2·8 | 92 | 91·6 | 8·0 | 152 | 151·4 | 13·2 | 212 | 211·2 | 18·5 | 272 | 271·0 | 23·7 |
| 33 | 32·9 | 2·9 | 93 | 92·6 | 8·1 | 153 | 152·4 | 13·3 | 213 | 212·2 | 18·6 | 273 | 272·0 | 23·8 |
| 34 | 33·9 | 3·0 | 94 | 93·6 | 8·2 | 154 | 153·4 | 13·4 | 214 | 213·2 | 18·7 | 274 | 273·0 | 23·9 |
| 35 | 34·9 | 3·1 | 95 | 94·6 | 8·3 | 155 | 154·4 | 13·5 | 215 | 214·2 | 18·7 | 275 | 274·0 | 24·0 |
| 36 | 35·9 | 3·1 | 96 | 95·6 | 8·4 | 156 | 155·4 | 13·6 | 216 | 215·2 | 18·8 | 276 | 274·9 | 24·1 |
| 37 | 36·9 | 3·2 | 97 | 96·6 | 8·5 | 157 | 156·4 | 13·7 | 217 | 216·2 | 18·9 | 277 | 275·9 | 24·1 |
| 38 | 37·9 | 3·3 | 98 | 97·6 | 8·5 | 158 | 157·4 | 13·8 | 218 | 217·2 | 19·0 | 278 | 276·9 | 24·2 |
| 39 | 38·9 | 3·4 | 99 | 98·6 | 8·6 | 159 | 158·4 | 13·9 | 219 | 218·2 | 19·1 | 279 | 277·9 | 24·3 |
| 40 | 39·8 | 3·5 | 100 | 99·6 | 8·7 | 160 | 159·4 | 13·9 | 220 | 219·2 | 19·2 | 280 | 278·9 | 24·4 |
| 41 | 40·8 | 3·6 | 101 | 100·6 | 8·8 | 161 | 160·4 | 14·0 | 221 | 220·2 | 19·3 | 281 | 279·9 | 24·5 |
| 42 | 41·8 | 3·7 | 102 | 101·6 | 8·9 | 162 | 161·4 | 14·1 | 222 | 221·2 | 19·3 | 282 | 280·9 | 24·6 |
| 43 | 42·8 | 3·7 | 103 | 102·6 | 9·0 | 163 | 162·4 | 14·2 | 223 | 222·2 | 19·4 | 283 | 281·9 | 24·7 |
| 44 | 43·8 | 3·8 | 104 | 103·6 | 9·1 | 164 | 163·4 | 14·3 | 224 | 223·1 | 19·5 | 284 | 282·9 | 24·8 |
| 45 | 44·8 | 3·9 | 105 | 104·6 | 9·2 | 165 | 164·4 | 14·4 | 225 | 224·1 | 19·6 | 285 | 283·9 | 24·8 |
| 46 | 45·8 | 4·0 | 106 | 105·6 | 9·2 | 166 | 165·4 | 14·5 | 226 | 225·1 | 19·7 | 286 | 284·9 | 24·9 |
| 47 | 46·8 | 4·1 | 107 | 106·6 | 9·3 | 167 | 166·4 | 14·6 | 227 | 226·1 | 19·8 | 287 | 285·9 | 25·0 |
| 48 | 47·8 | 4·2 | 108 | 107·6 | 9·4 | 168 | 167·4 | 14·6 | 228 | 227·1 | 19·9 | 288 | 286·9 | 25·1 |
| 49 | 48·8 | 4·3 | 109 | 108·6 | 9·5 | 169 | 168·4 | 14·7 | 229 | 228·1 | 20·0 | 289 | 287·9 | 25·2 |
| 50 | 49·8 | 4·4 | 110 | 109·6 | 9·6 | 170 | 169·4 | 14·8 | 230 | 229·1 | 20·0 | 290 | 288·9 | 25·3 |
| 51 | 50·8 | 4·4 | 111 | 110·6 | 9·7 | 171 | 170·3 | 14·9 | 231 | 230·1 | 20·1 | 291 | 289·9 | 25·4 |
| 52 | 51·8 | 4·5 | 112 | 111·6 | 9·8 | 172 | 171·3 | 15·0 | 232 | 231·1 | 20·2 | 292 | 290·9 | 25·4 |
| 53 | 52·8 | 4·6 | 113 | 112·6 | 9·8 | 173 | 172·3 | 15·1 | 233 | 232·1 | 20·3 | 293 | 291·9 | 25·5 |
| 54 | 53·8 | 4·7 | 114 | 113·6 | 9·9 | 174 | 173·3 | 15·2 | 234 | 233·1 | 20·4 | 294 | 292·9 | 25·6 |
| 55 | 54·8 | 4·8 | 115 | 114·6 | 10·0 | 175 | 174·3 | 15·3 | 235 | 234·1 | 20·5 | 295 | 293·9 | 25·7 |
| 56 | 55·8 | 4·9 | 116 | 115·6 | 10·1 | 176 | 175·3 | 15·3 | 236 | 235·1 | 20·6 | 296 | 294·9 | 25·8 |
| 57 | 56·8 | 5·0 | 117 | 116·6 | 10·2 | 177 | 176·3 | 15·4 | 237 | 236·1 | 20·7 | 297 | 295·9 | 25·9 |
| 58 | 57·8 | 5·1 | 118 | 117·6 | 10·3 | 178 | 177·3 | 15·5 | 238 | 237·1 | 20·7 | 298 | 296·9 | 26·0 |
| 59 | 58·8 | 5·1 | 119 | 118·5 | 10·4 | 179 | 178·3 | 15·6 | 239 | 238·1 | 20·8 | 299 | 297·9 | 26·1 |
| 60 | 59·8 | 5·2 | 120 | 119·5 | 10·5 | 180 | 179·3 | 15·7 | 240 | 239·1 | 20·9 | 300 | 298·9 | 26·1 |
| Dist. | Dep. | D.Lat | Dist. | Dep. | D.Lat | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

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## TRAVERSE TABLE TO DEGREES

5° 0h 20m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 299.9 | 26.2 | 361 | 359.6 | 31.5 | 421 | 419.4 | 36.7 | 481 | 479.2 | 41.9 | 541 | 538.9 | 47.2 |
| 302 | 300.8 | 26.3 | 362 | 360.6 | 31.6 | 422 | 420.4 | 36.8 | 482 | 480.2 | 42.0 | 542 | 539.9 | 47.3 |
| 303 | 301.8 | 26.4 | 363 | 361.6 | 31.6 | 423 | 421.4 | 36.9 | 483 | 481.2 | 42.1 | 543 | 540.9 | 47.4 |
| 304 | 302.8 | 26.5 | 364 | 362.6 | 31.7 | 424 | 422.4 | 37.0 | 484 | 482.2 | 42.2 | 544 | 541.9 | 47.5 |
| 305 | 303.8 | 26.6 | 365 | 363.6 | 31.8 | 425 | 423.4 | 37.1 | 485 | 483.2 | 42.3 | 545 | 542.9 | 47.6 |
| 306 | 304.8 | 26.7 | 366 | 364.6 | 31.9 | 426 | 424.4 | 37.1 | 486 | 484.1 | 42.4 | 546 | 543.9 | 47.7 |
| 307 | 305.8 | 26.8 | 367 | 365.6 | 32.0 | 427 | 425.4 | 37.2 | 487 | 485.1 | 42.4 | 547 | 544.9 | 47.7 |
| 308 | 306.8 | 26.9 | 368 | 366.6 | 32.1 | 428 | 426.4 | 37.3 | 488 | 486.1 | 42.5 | 548 | 545.9 | 47.8 |
| 309 | 307.8 | 26.9 | 369 | 367.6 | 32.2 | 429 | 427.4 | 37.4 | 489 | 487.1 | 42.6 | 549 | 546.9 | 47.9 |
| 310 | 308.8 | 27.0 | 370 | 368.6 | 32.3 | 430 | 428.4 | 37.5 | 490 | 488.1 | 42.7 | 550 | 547.9 | 48.0 |
| 311 | 309.8 | 27.1 | 371 | 369.6 | 32.3 | 431 | 429.4 | 37.6 | 491 | 489.1 | 42.8 | 551 | 548.9 | 48.1 |
| 312 | 310.8 | 27.2 | 372 | 370.6 | 32.4 | 432 | 430.4 | 37.7 | 492 | 490.1 | 42.9 | 552 | 549.9 | 48.2 |
| 313 | 311.8 | 27.3 | 373 | 371.6 | 32.5 | 433 | 431.3 | 37.7 | 493 | 491.1 | 43.0 | 553 | 550.9 | 48.3 |
| 314 | 312.8 | 27.4 | 374 | 372.6 | 32.6 | 434 | 432.3 | 37.8 | 494 | 492.1 | 43.1 | 554 | 551.9 | 48.4 |
| 315 | 313.8 | 27.5 | 375 | 373.6 | 32.7 | 435 | 433.3 | 37.9 | 495 | 493.1 | 43.1 | 555 | 552.9 | 48.4 |
| 316 | 314.8 | 27.5 | 376 | 374.6 | 32.8 | 436 | 434.3 | 38.0 | 496 | 494.1 | 43.2 | 556 | 553.9 | 48.5 |
| 317 | 315.8 | 27.6 | 377 | 375.6 | 32.9 | 437 | 435.3 | 38.1 | 497 | 495.1 | 43.3 | 557 | 554.9 | 48.6 |
| 318 | 316.8 | 27.7 | 378 | 376.6 | 33.0 | 438 | 436.3 | 38.2 | 498 | 496.1 | 43.4 | 558 | 555.9 | 48.7 |
| 319 | 317.8 | 27.8 | 379 | 377.6 | 33.0 | 439 | 437.3 | 38.3 | 499 | 497.1 | 43.5 | 559 | 556.9 | 48.8 |
| 320 | 318.8 | 27.9 | 380 | 378.6 | 33.1 | 440 | 438.3 | 38.4 | 500 | 498.1 | 43.6 | 560 | 557.9 | 48.8 |
| 321 | 319.8 | 28.0 | 381 | 379.5 | 33.2 | 441 | 439.3 | 38.4 | 501 | 499.1 | 43.7 | 561 | 558.8 | 48.9 |
| 322 | 320.8 | 28.1 | 382 | 380.5 | 33.3 | 442 | 440.3 | 38.5 | 502 | 500.1 | 43.8 | 562 | 559.8 | 49.0 |
| 323 | 321.8 | 28.2 | 383 | 381.5 | 33.4 | 443 | 441.3 | 38.6 | 503 | 501.1 | 43.8 | 563 | 560.8 | 49.1 |
| 324 | 322.8 | 28.2 | 384 | 382.5 | 33.5 | 444 | 442.3 | 38.7 | 504 | 502.1 | 43.9 | 564 | 561.8 | 49.2 |
| 325 | 323.8 | 28.3 | 385 | 383.5 | 33.6 | 445 | 443.3 | 38.8 | 505 | 503.1 | 44.0 | 565 | 562.8 | 49.3 |
| 326 | 324.8 | 28.4 | 386 | 384.5 | 33.7 | 446 | 444.3 | 38.9 | 506 | 504.1 | 44.1 | 566 | 563.8 | 49.4 |
| 327 | 325.8 | 28.5 | 387 | 385.5 | 33.7 | 447 | 445.3 | 39.0 | 507 | 505.1 | 44.2 | 567 | 564.8 | 49.5 |
| 328 | 326.7 | 28.6 | 388 | 386.5 | 33.8 | 448 | 446.3 | 39.1 | 508 | 506.1 | 44.3 | 568 | 565.8 | 49.6 |
| 329 | 327.7 | 28.7 | 389 | 387.5 | 33.9 | 449 | 447.3 | 39.1 | 509 | 507.1 | 44.4 | 569 | 566.8 | 49.7 |
| 330 | 328.7 | 28.8 | 390 | 388.5 | 34.0 | 450 | 448.3 | 39.2 | 510 | 508.1 | 44.5 | 570 | 567.8 | 49.7 |
| 331 | 329.7 | 28.9 | 391 | 389.5 | 34.1 | 451 | 449.3 | 39.3 | 511 | 509.0 | 44.5 | 571 | 568.8 | 49.8 |
| 332 | 330.7 | 28.9 | 392 | 390.5 | 34.2 | 452 | 450.3 | 39.4 | 512 | 510.0 | 44.6 | 572 | 569.8 | 49.9 |
| 333 | 331.7 | 29.0 | 393 | 391.5 | 34.3 | 453 | 451.3 | 39.5 | 513 | 511.0 | 44.7 | 573 | 570.8 | 50.0 |
| 334 | 332.7 | 29.1 | 394 | 392.5 | 34.3 | 454 | 452.3 | 39.6 | 514 | 512.0 | 44.8 | 574 | 571.8 | 50.1 |
| 335 | 333.7 | 29.2 | 395 | 393.5 | 34.4 | 455 | 453.3 | 39.7 | 515 | 513.0 | 44.9 | 575 | 572.8 | 50.2 |
| 336 | 334.7 | 29.3 | 396 | 394.5 | 34.5 | 456 | 454.3 | 39.8 | 516 | 514.0 | 45.0 | 576 | 573.8 | 50.3 |
| 337 | 335.7 | 29.4 | 397 | 395.5 | 34.6 | 457 | 455.3 | 39.8 | 517 | 515.0 | 45.1 | 577 | 574.8 | 50.4 |
| 338 | 336.7 | 29.5 | 398 | 396.5 | 34.7 | 458 | 456.3 | 39.9 | 518 | 516.0 | 45.2 | 578 | 575.8 | 50.4 |
| 339 | 337.7 | 29.6 | 399 | 397.5 | 34.8 | 459 | 457.3 | 40.0 | 519 | 517.0 | 45.2 | 579 | 576.8 | 50.5 |
| 340 | 338.7 | 29.6 | 400 | 398.5 | 34.9 | 460 | 458.2 | 40.1 | 520 | 518.0 | 45.3 | 580 | 577.8 | 50.6 |
| 341 | 339.7 | 29.7 | 401 | 399.5 | 35.0 | 461 | 459.2 | 40.2 | 521 | 519.0 | 45.4 | 581 | 578.8 | 50.7 |
| 342 | 340.7 | 29.8 | 402 | 400.5 | 35.0 | 462 | 460.2 | 40.3 | 522 | 520.0 | 45.5 | 582 | 579.8 | 50.8 |
| 343 | 341.7 | 29.9 | 403 | 401.5 | 35.1 | 463 | 461.2 | 40.4 | 523 | 521.0 | 45.6 | 583 | 580.8 | 50.9 |
| 344 | 342.7 | 30.0 | 404 | 402.5 | 35.2 | 464 | 462.2 | 40.4 | 524 | 522.0 | 45.7 | 584 | 581.8 | 50.9 |
| 345 | 343.7 | 30.1 | 405 | 403.5 | 35.3 | 465 | 463.2 | 40.5 | 525 | 523.0 | 45.8 | 585 | 582.8 | 51.0 |
| 346 | 344.7 | 30.2 | 406 | 404.5 | 35.4 | 466 | 464.2 | 40.6 | 526 | 524.0 | 45.9 | 586 | 583.8 | 51.1 |
| 347 | 345.7 | 30.3 | 407 | 405.4 | 35.5 | 467 | 465.2 | 40.7 | 527 | 525.0 | 45.9 | 587 | 584.8 | 51.2 |
| 348 | 346.7 | 30.3 | 408 | 406.4 | 35.6 | 468 | 466.2 | 40.8 | 528 | 526.0 | 46.0 | 588 | 585.8 | 51.3 |
| 349 | 347.7 | 30.4 | 409 | 407.4 | 35.7 | 469 | 467.2 | 40.9 | 529 | 527.0 | 46.1 | 589 | 586.8 | 51.4 |
| 350 | 348.7 | 30.5 | 410 | 408.4 | 35.7 | 470 | 468.2 | 41.0 | 530 | 528.0 | 46.2 | 590 | 587.8 | 51.5 |
| 351 | 349.7 | 30.6 | 411 | 409.4 | 35.8 | 471 | 469.2 | 41.1 | 531 | 529.0 | 46.3 | 591 | 588.7 | 51.6 |
| 352 | 350.7 | 30.7 | 412 | 410.4 | 35.9 | 472 | 470.2 | 41.1 | 532 | 530.0 | 46.4 | 592 | 589.7 | 51.6 |
| 353 | 351.7 | 30.8 | 413 | 411.4 | 36.0 | 473 | 471.2 | 41.2 | 533 | 531.0 | 46.5 | 593 | 590.7 | 51.7 |
| 354 | 352.6 | 30.9 | 414 | 412.4 | 36.1 | 474 | 472.2 | 41.3 | 534 | 532.0 | 46.6 | 594 | 591.7 | 51.8 |
| 355 | 353.6 | 30.9 | 415 | 413.4 | 36.2 | 475 | 473.2 | 41.4 | 535 | 533.0 | 46.6 | 595 | 592.7 | 51.9 |
| 356 | 354.6 | 31.0 | 416 | 414.4 | 36.3 | 476 | 474.2 | 41.5 | 536 | 533.9 | 46.7 | 596 | 593.7 | 52.0 |
| 357 | 355.6 | 31.1 | 417 | 415.4 | 36.4 | 477 | 475.2 | 41.6 | 537 | 534.9 | 46.8 | 597 | 594.7 | 52.1 |
| 358 | 356.6 | 31.2 | 418 | 416.4 | 36.4 | 478 | 476.2 | 41.7 | 538 | 535.9 | 46.9 | 598 | 595.7 | 52.2 |
| 359 | 357.6 | 31.3 | 419 | 417.4 | 36.5 | 479 | 477.2 | 41.8 | 539 | 536.9 | 47.0 | 599 | 596.7 | 52.3 |
| 360 | 358.6 | 31.4 | 420 | 418.4 | 36.6 | 480 | 478.2 | 41.8 | 540 | 537.9 | 47.1 | 600 | 597.7 | 52.3 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

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## TRAVERSE TABLE TO DEGREES

| | | | | | | | 6° | | | | | | 0h 24m | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
| 1 | 1·0 | 0·1 | 61 | 60·7 | 6·4 | 121 | 120·3 | 12·6 | 181 | 180·0 | 18·9 | 241 | 239·7 | 25·2 |
| 2 | 2·0 | 0·2 | 62 | 61·7 | 6·5 | 122 | 121·3 | 12·8 | 182 | 181·0 | 19·0 | 242 | 240·7 | 25·3 |
| 3 | 3·0 | 0·3 | 63 | 62·7 | 6·6 | 123 | 122·3 | 12·9 | 183 | 182·0 | 19·1 | 243 | 241·7 | 25·4 |
| 4 | 4·0 | 0·4 | 64 | 63·6 | 6·7 | 124 | 123·3 | 13·0 | 184 | 183·0 | 19·2 | 244 | 242·7 | 25·5 |
| 5 | 5·0 | 0·5 | 65 | 64·6 | 6·8 | 125 | 124·3 | 13·1 | 185 | 184·0 | 19·3 | 245 | 243·7 | 25·6 |
| 6 | 6·0 | 0·6 | 66 | 65·6 | 6·9 | 126 | 125·3 | 13·2 | 186 | 185·0 | 19·4 | 246 | 244·7 | 25·7 |
| 7 | 7·0 | 0·7 | 67 | 66·6 | 7·0 | 127 | 126·3 | 13·3 | 187 | 186·0 | 19·5 | 247 | 245·6 | 25·8 |
| 8 | 8·0 | 0·8 | 68 | 67·6 | 7·1 | 128 | 127·3 | 13·4 | 188 | 187·0 | 19·7 | 248 | 246·6 | 25·9 |
| 9 | 9·0 | 0·9 | 69 | 68·6 | 7·2 | 129 | 128·3 | 13·5 | 189 | 188·0 | 19·8 | 249 | 247·6 | 26·0 |
| 10 | 9·9 | 1·0 | 70 | 69·6 | 7·3 | 130 | 129·3 | 13·6 | 190 | 189·0 | 19·9 | 250 | 248·6 | 26·1 |
| 11 | 10·9 | 1·1 | 71 | 70·6 | 7·4 | 131 | 130·3 | 13·7 | 191 | 190·0 | 20·0 | 251 | 249·6 | 26·2 |
| 12 | 11·9 | 1·3 | 72 | 71·6 | 7·5 | 132 | 131·3 | 13·8 | 192 | 190·9 | 20·1 | 252 | 250·6 | 26·3 |
| 13 | 12·9 | 1·4 | 73 | 72·6 | 7·6 | 133 | 132·3 | 13·9 | 193 | 191·9 | 20·2 | 253 | 251·6 | 26·4 |
| 14 | 13·9 | 1·5 | 74 | 73·6 | 7·7 | 134 | 133·3 | 14·0 | 194 | 192·9 | 20·3 | 254 | 252·6 | 26·6 |
| 15 | 14·9 | 1·6 | 75 | 74·6 | 7·8 | 135 | 134·3 | 14·1 | 195 | 193·9 | 20·4 | 255 | 253·6 | 26·7 |
| 16 | 15·9 | 1·7 | 76 | 75·6 | 7·9 | 136 | 135·3 | 14·2 | 196 | 194·9 | 20·5 | 256 | 254·6 | 26·8 |
| 17 | 16·9 | 1·8 | 77 | 76·6 | 8·0 | 137 | 136·2 | 14·3 | 197 | 195·9 | 20·6 | 257 | 255·6 | 26·9 |
| 18 | 17·9 | 1·9 | 78 | 77·6 | 8·2 | 138 | 137·2 | 14·4 | 198 | 196·9 | 20·7 | 258 | 256·6 | 27·0 |
| 19 | 18·9 | 2·0 | 79 | 78·6 | 8·3 | 139 | 138·2 | 14·5 | 199 | 197·9 | 20·8 | 259 | 257·6 | 27·1 |
| 20 | 19·9 | 2·1 | 80 | 79·6 | 8·4 | 140 | 139·2 | 14·6 | 200 | 198·9 | 20·9 | 260 | 258·6 | 27·2 |
| 21 | 20·9 | 2·2 | 81 | 80·6 | 8·5 | 141 | 140·2 | 14·7 | 201 | 199·9 | 21·0 | 261 | 259·6 | 27·3 |
| 22 | 21·9 | 2·3 | 82 | 81·6 | 8·6 | 142 | 141·2 | 14·8 | 202 | 200·9 | 21·1 | 262 | 260·6 | 27·4 |
| 23 | 22·9 | 2·4 | 83 | 82·5 | 8·7 | 143 | 142·2 | 14·9 | 203 | 201·9 | 21·2 | 263 | 261·6 | 27·5 |
| 24 | 23·9 | 2·5 | 84 | 83·5 | 8·8 | 144 | 143·2 | 15·0 | 204 | 202·9 | 21·3 | 264 | 262·6 | 27·6 |
| 25 | 24·9 | 2·6 | 85 | 84·5 | 8·9 | 145 | 144·2 | 15·1 | 205 | 203·9 | 21·4 | 265 | 263·5 | 27·7 |
| 26 | 25·9 | 2·7 | 86 | 85·5 | 9·0 | 146 | 145·2 | 15·3 | 206 | 204·9 | 21·5 | 266 | 264·5 | 27·8 |
| 27 | 26·9 | 2·8 | 87 | 86·5 | 9·1 | 147 | 146·2 | 15·4 | 207 | 205·9 | 21·6 | 267 | 265·5 | 27·9 |
| 28 | 27·8 | 2·9 | 88 | 87·5 | 9·2 | 148 | 147·2 | 15·5 | 208 | 206·9 | 21·7 | 268 | 266·5 | 28·0 |
| 29 | 28·8 | 3·0 | 89 | 88·5 | 9·3 | 149 | 148·2 | 15·6 | 209 | 207·9 | 21·8 | 269 | 267·5 | 28·1 |
| 30 | 29·8 | 3·1 | 90 | 89·5 | 9·4 | 150 | 149·2 | 15·7 | 210 | 208·8 | 22·0 | 270 | 268·5 | 28·2 |
| 31 | 30·8 | 3·2 | 91 | 90·5 | 9·5 | 151 | 150·2 | 15·8 | 211 | 209·8 | 22·1 | 271 | 269·5 | 28·3 |
| 32 | 31·8 | 3·3 | 92 | 91·5 | 9·6 | 152 | 151·2 | 15·9 | 212 | 210·8 | 22·2 | 272 | 270·5 | 28·4 |
| 33 | 32·8 | 3·4 | 93 | 92·5 | 9·7 | 153 | 152·2 | 16·0 | 213 | 211·8 | 22·3 | 273 | 271·5 | 28·5 |
| 34 | 33·8 | 3·6 | 94 | 93·5 | 9·8 | 154 | 153·2 | 16·1 | 214 | 212·8 | 22·4 | 274 | 272·5 | 28·6 |
| 35 | 34·8 | 3·7 | 95 | 94·5 | 9·9 | 155 | 154·2 | 16·2 | 215 | 213·8 | 22·5 | 275 | 273·5 | 28·7 |
| 36 | 35·8 | 3·8 | 96 | 95·5 | 10·0 | 156 | 155·1 | 16·3 | 216 | 214·8 | 22·6 | 276 | 274·5 | 28·8 |
| 37 | 36·8 | 3·9 | 97 | 96·5 | 10·1 | 157 | 156·1 | 16·4 | 217 | 215·8 | 22·7 | 277 | 275·5 | 29·0 |
| 38 | 37·8 | 4·0 | 98 | 97·5 | 10·2 | 158 | 157·1 | 16·5 | 218 | 216·8 | 22·8 | 278 | 276·5 | 29·1 |
| 39 | 38·8 | 4·1 | 99 | 98·5 | 10·3 | 159 | 158·1 | 16·6 | 219 | 217·8 | 22·9 | 279 | 277·5 | 29·2 |
| 40 | 39·8 | 4·2 | 100 | 99·5 | 10·5 | 160 | 159·1 | 16·7 | 220 | 218·8 | 23·0 | 280 | 278·5 | 29·3 |
| 41 | 40·8 | 4·3 | 101 | 100·4 | 10·6 | 161 | 160·1 | 16·8 | 221 | 219·8 | 23·1 | 281 | 279·5 | 29·4 |
| 42 | 41·8 | 4·4 | 102 | 101·4 | 10·7 | 162 | 161·1 | 16·9 | 222 | 220·8 | 23·2 | 282 | 280·5 | 29·5 |
| 43 | 42·8 | 4·5 | 103 | 102·4 | 10·8 | 163 | 162·1 | 17·0 | 223 | 221·8 | 23·3 | 283 | 281·4 | 29·6 |
| 44 | 43·8 | 4·6 | 104 | 103·4 | 10·9 | 164 | 163·1 | 17·1 | 224 | 222·8 | 23·4 | 284 | 282·4 | 29·7 |
| 45 | 44·8 | 4·7 | 105 | 104·4 | 11·0 | 165 | 164·1 | 17·2 | 225 | 223·8 | 23·5 | 285 | 283·4 | 29·8 |
| 46 | 45·7 | 4·8 | 106 | 105·4 | 11·1 | 166 | 165·1 | 17·4 | 226 | 224·8 | 23·6 | 286 | 284·4 | 29·9 |
| 47 | 46·7 | 4·9 | 107 | 106·4 | 11·2 | 167 | 166·1 | 17·5 | 227 | 225·8 | 23·7 | 287 | 285·4 | 30·0 |
| 48 | 47·7 | 5·0 | 108 | 107·4 | 11·3 | 168 | 167·1 | 17·6 | 228 | 226·8 | 23·8 | 288 | 286·4 | 30·1 |
| 49 | 48·7 | 5·1 | 109 | 108·4 | 11·4 | 169 | 168·1 | 17·7 | 229 | 227·7 | 23·9 | 289 | 287·4 | 30·2 |
| 50 | 49·7 | 5·2 | 110 | 109·4 | 11·5 | 170 | 169·1 | 17·8 | 230 | 228·7 | 24·0 | 290 | 288·4 | 30·3 |
| 51 | 50·7 | 5·3 | 111 | 110·4 | 11·6 | 171 | 170·1 | 17·9 | 231 | 229·7 | 24·1 | 291 | 289·4 | 30·4 |
| 52 | 51·7 | 5·4 | 112 | 111·4 | 11·7 | 172 | 171·1 | 18·0 | 232 | 230·7 | 24·3 | 292 | 290·4 | 30·5 |
| 53 | 52·7 | 5·5 | 113 | 112·4 | 11·8 | 173 | 172·1 | 18·1 | 233 | 231·7 | 24·4 | 293 | 291·4 | 30·6 |
| 54 | 53·7 | 5·6 | 114 | 113·4 | 11·9 | 174 | 173·0 | 18·2 | 234 | 232·7 | 24·5 | 294 | 292·4 | 30·7 |
| 55 | 54·7 | 5·7 | 115 | 114·4 | 12·0 | 175 | 174·0 | 18·3 | 235 | 233·7 | 24·6 | 295 | 293·4 | 30·8 |
| 56 | 55·7 | 5·9 | 116 | 115·4 | 12·1 | 176 | 175·0 | 18·4 | 236 | 234·7 | 24·7 | 296 | 294·4 | 30·9 |
| 57 | 56·7 | 6·0 | 117 | 116·4 | 12·2 | 177 | 176·0 | 18·5 | 237 | 235·7 | 24·8 | 297 | 295·4 | 31·0 |
| 58 | 57·7 | 6·1 | 118 | 117·4 | 12·3 | 178 | 177·0 | 18·6 | 238 | 236·7 | 24·9 | 298 | 296·4 | 31·1 |
| 59 | 58·7 | 6·2 | 119 | 118·3 | 12·4 | 179 | 178·0 | 18·7 | 239 | 237·7 | 25·0 | 299 | 297·4 | 31·3 |
| 60 | 59·7 | 6·3 | 120 | 119·3 | 12·5 | 180 | 179·0 | 18·8 | 240 | 238·7 | 25·1 | 300 | 298·4 | 31·4 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |
| | | | | | | | 84° | | | | | | 5h 36m | |

## TRAVERSE TABLE TO DEGREES

6° 0h 24m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 299.3 | 31.5 | 361 | 359.0 | 37.7 | 421 | 418.7 | 44.0 | 481 | 478.4 | 50.3 | 541 | 538.0 | 56.5 |
| 302 | 300.3 | 31.6 | 362 | 360.0 | 37.8 | 422 | 419.7 | 44.1 | 482 | 479.4 | 50.4 | 542 | 539.0 | 56.6 |
| 303 | 301.3 | 31.7 | 363 | 361.0 | 37.9 | 423 | 420.7 | 44.2 | 483 | 480.4 | 50.5 | 543 | 540.0 | 56.7 |
| 304 | 302.3 | 31.8 | 364 | 362.0 | 38.0 | 424 | 421.7 | 44.3 | 484 | 481.3 | 50.6 | 544 | 541.0 | 56.8 |
| 305 | 303.3 | 31.9 | 365 | 363.0 | 38.1 | 425 | 422.7 | 44.4 | 485 | 482.3 | 50.7 | 545 | 542.0 | 56.9 |
| 306 | 304.3 | 32.0 | 366 | 364.0 | 38.3 | 426 | 423.7 | 44.5 | 486 | 483.3 | 50.8 | 546 | 543.0 | 57.0 |
| 307 | 305.3 | 32.1 | 367 | 365.0 | 38.4 | 427 | 424.7 | 44.6 | 487 | 484.3 | 50.9 | 547 | 544.0 | 57.1 |
| 308 | 306.3 | 32.2 | 368 | 366.0 | 38.5 | 428 | 425.7 | 44.7 | 488 | 485.3 | 51.0 | 548 | 545.0 | 57.2 |
| 309 | 307.3 | 32.3 | 369 | 367.0 | 38.6 | 429 | 426.6 | 44.8 | 489 | 486.3 | 51.1 | 549 | 546.0 | 57.3 |
| 310 | 308.3 | 32.4 | 370 | 368.0 | 38.7 | 430 | 427.6 | 44.9 | 490 | 487.3 | 51.2 | 550 | 547.0 | 57.4 |
| 311 | 309.3 | 32.5 | 371 | 369.0 | 38.8 | 431 | 428.6 | 45.0 | 491 | 488.3 | 51.3 | 551 | 548.0 | 57.5 |
| 312 | 310.3 | 32.6 | 372 | 370.0 | 38.9 | 432 | 429.6 | 45.2 | 492 | 489.3 | 51.4 | 552 | 549.0 | 57.6 |
| 313 | 311.3 | 32.7 | 373 | 371.0 | 39.0 | 433 | 430.6 | 45.3 | 493 | 490.3 | 51.5 | 553 | 550.0 | 57.7 |
| 314 | 312.3 | 32.8 | 374 | 371.9 | 39.1 | 434 | 431.6 | 45.4 | 494 | 491.3 | 51.6 | 554 | 551.0 | 57.9 |
| 315 | 313.3 | 32.9 | 375 | 372.9 | 39.2 | 435 | 432.6 | 45.5 | 495 | 492.3 | 51.7 | 555 | 552.0 | 58.0 |
| 316 | 314.3 | 33.0 | 376 | 373.9 | 39.3 | 436 | 433.6 | 45.6 | 496 | 493.3 | 51.8 | 556 | 553.0 | 58.1 |
| 317 | 315.3 | 33.1 | 377 | 374.9 | 39.4 | 437 | 434.6 | 45.7 | 497 | 494.3 | 51.9 | 557 | 554.0 | 58.2 |
| 318 | 316.3 | 33.2 | 378 | 375.9 | 39.5 | 438 | 435.6 | 45.8 | 498 | 495.3 | 52.0 | 558 | 555.0 | 58.3 |
| 319 | 317.3 | 33.3 | 379 | 376.9 | 39.6 | 439 | 436.6 | 45.9 | 499 | 496.3 | 52.1 | 559 | 556.0 | 58.4 |
| 320 | 318.2 | 33.4 | 380 | 377.9 | 39.7 | 440 | 437.6 | 46.0 | 500 | 497.3 | 52.3 | 560 | 556.9 | 58.5 |
| 321 | 319.2 | 33.6 | 381 | 378.9 | 39.8 | 441 | 438.6 | 46.1 | 501 | 498.3 | 52.4 | 561 | 557.9 | 58.6 |
| 322 | 320.2 | 33.7 | 382 | 379.9 | 39.9 | 442 | 439.6 | 46.2 | 502 | 499.3 | 52.5 | 562 | 558.9 | 58.7 |
| 323 | 321.2 | 33.8 | 383 | 380.9 | 40.0 | 443 | 440.6 | 46.3 | 503 | 500.2 | 52.6 | 563 | 559.9 | 58.8 |
| 324 | 322.2 | 33.9 | 384 | 381.9 | 40.1 | 444 | 441.6 | 46.4 | 504 | 501.2 | 52.7 | 564 | 560.9 | 59.0 |
| 325 | 323.2 | 34.0 | 385 | 382.9 | 40.2 | 445 | 442.6 | 46.5 | 505 | 502.2 | 52.8 | 565 | 561.9 | 59.1 |
| 326 | 324.2 | 34.1 | 386 | 383.9 | 40.3 | 446 | 443.6 | 46.6 | 506 | 503.2 | 52.9 | 566 | 562.9 | 59.2 |
| 327 | 325.2 | 34.2 | 387 | 384.9 | 40.5 | 447 | 444.5 | 46.7 | 507 | 504.2 | 53.0 | 567 | 563.9 | 59.3 |
| 328 | 326.2 | 34.3 | 388 | 385.9 | 40.6 | 448 | 445.5 | 46.8 | 508 | 505.2 | 53.1 | 568 | 564.9 | 59.4 |
| 329 | 327.2 | 34.4 | 389 | 386.9 | 40.7 | 449 | 446.5 | 46.9 | 509 | 506.2 | 53.2 | 569 | 565.9 | 59.5 |
| 330 | 328.2 | 34.5 | 390 | 387.9 | 40.8 | 450 | 447.5 | 47.0 | 510 | 507.2 | 53.3 | 570 | 566.9 | 59.6 |
| 331 | 329.2 | 34.6 | 391 | 388.9 | 40.9 | 451 | 448.5 | 47.1 | 511 | 508.2 | 53.4 | 571 | 567.9 | 59.7 |
| 332 | 330.2 | 34.7 | 392 | 389.9 | 41.0 | 452 | 449.5 | 47.2 | 512 | 509.2 | 53.5 | 572 | 568.9 | 59.8 |
| 333 | 331.2 | 34.8 | 393 | 390.8 | 41.1 | 453 | 450.5 | 47.3 | 513 | 510.2 | 53.6 | 573 | 569.9 | 59.9 |
| 334 | 332.2 | 34.9 | 394 | 391.8 | 41.2 | 454 | 451.5 | 47.5 | 514 | 511.2 | 53.7 | 574 | 570.9 | 60.0 |
| 335 | 333.2 | 35.0 | 395 | 392.8 | 41.3 | 455 | 452.5 | 47.6 | 515 | 512.2 | 53.8 | 575 | 571.9 | 60.1 |
| 336 | 334.2 | 35.1 | 396 | 393.8 | 41.4 | 456 | 453.5 | 47.7 | 516 | 513.2 | 53.9 | 576 | 572.9 | 60.2 |
| 337 | 335.2 | 35.2 | 397 | 394.8 | 41.5 | 457 | 454.5 | 47.8 | 517 | 514.2 | 54.0 | 577 | 573.9 | 60.3 |
| 338 | 336.1 | 35.3 | 398 | 395.8 | 41.6 | 458 | 455.5 | 47.9 | 518 | 515.2 | 54.1 | 578 | 574.9 | 60.4 |
| 339 | 337.1 | 35.4 | 399 | 396.8 | 41.7 | 459 | 456.5 | 48.0 | 519 | 516.2 | 54.2 | 579 | 575.8 | 60.5 |
| 340 | 338.1 | 35.5 | 400 | 397.8 | 41.8 | 460 | 457.5 | 48.1 | 520 | 517.2 | 54.3 | 580 | 576.8 | 60.6 |
| 341 | 339.1 | 35.6 | 401 | 398.8 | 41.9 | 461 | 458.5 | 48.2 | 521 | 518.1 | 54.5 | 581 | 577.8 | 60.7 |
| 342 | 340.1 | 35.7 | 402 | 399.8 | 42.0 | 462 | 459.5 | 48.3 | 522 | 519.1 | 54.6 | 582 | 578.8 | 60.8 |
| 343 | 341.1 | 35.8 | 403 | 400.8 | 42.1 | 463 | 460.5 | 48.4 | 523 | 520.1 | 54.7 | 583 | 579.8 | 60.9 |
| 344 | 342.1 | 36.0 | 404 | 401.8 | 42.2 | 464 | 461.5 | 48.5 | 524 | 521.1 | 54.8 | 584 | 580.8 | 61.1 |
| 345 | 343.1 | 36.1 | 405 | 402.8 | 42.3 | 465 | 462.5 | 48.6 | 525 | 522.1 | 54.9 | 585 | 581.8 | 61.2 |
| 346 | 344.1 | 36.2 | 406 | 403.8 | 42.4 | 466 | 463.4 | 48.7 | 526 | 523.1 | 55.0 | 586 | 582.8 | 61.3 |
| 347 | 345.1 | 36.3 | 407 | 404.8 | 42.5 | 467 | 464.4 | 48.8 | 527 | 524.1 | 55.1 | 587 | 583.8 | 61.4 |
| 348 | 346.1 | 36.4 | 408 | 405.8 | 42.6 | 468 | 465.4 | 48.9 | 528 | 525.1 | 55.2 | 588 | 584.8 | 61.5 |
| 349 | 347.1 | 36.5 | 409 | 406.8 | 42.7 | 469 | 466.4 | 49.0 | 529 | 526.1 | 55.3 | 589 | 585.8 | 61.6 |
| 350 | 348.1 | 36.6 | 410 | 407.8 | 42.9 | 470 | 467.4 | 49.1 | 530 | 527.1 | 55.4 | 590 | 586.8 | 61.7 |
| 351 | 349.1 | 36.7 | 411 | 408.7 | 43.0 | 471 | 468.4 | 49.2 | 531 | 528.1 | 55.5 | 591 | 587.8 | 61.8 |
| 352 | 350.1 | 36.8 | 412 | 409.7 | 43.1 | 472 | 469.4 | 49.3 | 532 | 529.1 | 55.6 | 592 | 588.8 | 61.9 |
| 353 | 351.1 | 36.9 | 413 | 410.7 | 43.2 | 473 | 470.4 | 49.4 | 533 | 530.1 | 55.7 | 593 | 589.8 | 62.0 |
| 354 | 352.1 | 37.0 | 414 | 411.7 | 43.3 | 474 | 471.4 | 49.5 | 534 | 531.1 | 55.8 | 594 | 590.8 | 62.1 |
| 355 | 353.1 | 37.1 | 415 | 412.7 | 43.4 | 475 | 472.4 | 49.6 | 535 | 532.1 | 55.9 | 595 | 591.8 | 62.2 |
| 356 | 354.0 | 37.2 | 416 | 413.7 | 43.5 | 476 | 473.4 | 49.8 | 536 | 533.1 | 56.0 | 596 | 592.8 | 62.3 |
| 357 | 355.0 | 37.3 | 417 | 414.7 | 43.6 | 477 | 474.4 | 49.9 | 537 | 534.1 | 56.1 | 597 | 593.8 | 62.4 |
| 358 | 356.0 | 37.4 | 418 | 415.7 | 43.7 | 478 | 475.4 | 50.0 | 538 | 535.1 | 56.2 | 598 | 594.7 | 62.5 |
| 359 | 357.0 | 37.5 | 419 | 416.7 | 43.8 | 479 | 476.4 | 50.1 | 539 | 536.1 | 56.3 | 599 | 595.7 | 62.6 |
| 360 | 358.0 | 37.6 | 420 | 417.7 | 43.9 | 480 | 477.4 | 50.2 | 540 | 537.1 | 56.4 | 600 | 596.7 | 62.7 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat | Dist. | Dep. | D. Lat. |

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## TRAVERSE TABLE TO DEGREES

7° 0h 28m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1·0 | 0·1 | 61 | 60·5 | 7·4 | 121 | 120·1 | 14·7 | 181 | 179·7 | 22·1 | 241 | 239·2 | 29·4 |
| 2 | 2·0 | 0·2 | 62 | 61·5 | 7·6 | 122 | 121·1 | 14·9 | 182 | 180·6 | 22·2 | 242 | 240·2 | 29·5 |
| 3 | 3·0 | 0·4 | 63 | 62·5 | 7·7 | 123 | 122·1 | 15·0 | 183 | 181·6 | 22·3 | 243 | 241·2 | 29·6 |
| 4 | 4·0 | 0·5 | 64 | 63·5 | 7·8 | 124 | 123·1 | 15·1 | 184 | 182·6 | 22·4 | 244 | 242·2 | 29·7 |
| 5 | 5·0 | 0·6 | 65 | 64·5 | 7·9 | 125 | 124·1 | 15·2 | 185 | 183·6 | 22·5 | 245 | 243·2 | 29·9 |
| 6 | 6·0 | 0·7 | 66 | 65·5 | 8·0 | 126 | 125·1 | 15·4 | 186 | 184·6 | 22·7 | 246 | 244·2 | 30·0 |
| 7 | 6·9 | 0·9 | 67 | 66·5 | 8·2 | 127 | 126·1 | 15·5 | 187 | 185·6 | 22·8 | 247 | 245·2 | 30·1 |
| 8 | 7·9 | 1·0 | 68 | 67·5 | 8·3 | 128 | 127·0 | 15·6 | 188 | 186·6 | 22·9 | 248 | 246·2 | 30·2 |
| 9 | 8·9 | 1·1 | 69 | 68·5 | 8·4 | 129 | 128·0 | 15·7 | 189 | 187·6 | 23·0 | 249 | 247·1 | 30·3 |
| 10 | 9·9 | 1·2 | 70 | 69·5 | 8·5 | 130 | 129·0 | 15·8 | 190 | 188·6 | 23·2 | 250 | 248·1 | 30·5 |
| 11 | 10·9 | 1·3 | 71 | 70·5 | 8·7 | 131 | 130·0 | 16·0 | 191 | 189·6 | 23·3 | 251 | 249·1 | 30·6 |
| 12 | 11·9 | 1·5 | 72 | 71·5 | 8·8 | 132 | 131·0 | 16·1 | 192 | 190·6 | 23·4 | 252 | 250·1 | 30·7 |
| 13 | 12·9 | 1·6 | 73 | 72·5 | 8·9 | 133 | 132·0 | 16·2 | 193 | 191·6 | 23·5 | 253 | 251·1 | 30·8 |
| 14 | 13·9 | 1·7 | 74 | 73·4 | 9·0 | 134 | 133·0 | 16·3 | 194 | 192·6 | 23·6 | 254 | 252·1 | 31·0 |
| 15 | 14·9 | 1·8 | 75 | 74·4 | 9·1 | 135 | 134·0 | 16·5 | 195 | 193·5 | 23·8 | 255 | 253·1 | 31·1 |
| 16 | 15·9 | 1·9 | 76 | 75·4 | 9·3 | 136 | 135·0 | 16·6 | 196 | 194·5 | 23·9 | 256 | 254·1 | 31·2 |
| 17 | 16·9 | 2·1 | 77 | 76·4 | 9·4 | 137 | 136·0 | 16·7 | 197 | 195·5 | 24·0 | 257 | 255·1 | 31·3 |
| 18 | 17·9 | 2·2 | 78 | 77·4 | 9·5 | 138 | 137·0 | 16·8 | 198 | 196·5 | 24·1 | 258 | 256·1 | 31·4 |
| 19 | 18·9 | 2·3 | 79 | 78·4 | 9·6 | 139 | 138·0 | 16·9 | 199 | 197·5 | 24·3 | 259 | 257·1 | 31·6 |
| 20 | 19·9 | 2·4 | 80 | 79·4 | 9·7 | 140 | 139·0 | 17·1 | 200 | 198·5 | 24·4 | 260 | 258·1 | 31·7 |
| 21 | 20·8 | 2·6 | 81 | 80·4 | 9·9 | 141 | 139·9 | 17·2 | 201 | 199·5 | 24·5 | 261 | 259·1 | 31·8 |
| 22 | 21·8 | 2·7 | 82 | 81·4 | 10·0 | 142 | 140·9 | 17·3 | 202 | 200·5 | 24·6 | 262 | 260·0 | 31·9 |
| 23 | 22·8 | 2·8 | 83 | 82·4 | 10·1 | 143 | 141·9 | 17·4 | 203 | 201·5 | 24·7 | 263 | 261·0 | 32·1 |
| 24 | 23·8 | 2·9 | 84 | 83·4 | 10·2 | 144 | 142·9 | 17·5 | 204 | 202·5 | 24·9 | 264 | 262·0 | 32·2 |
| 25 | 24·8 | 3·0 | 85 | 84·4 | 10·4 | 145 | 143·9 | 17·7 | 205 | 203·5 | 25·0 | 265 | 263·0 | 32·3 |
| 26 | 25·8 | 3·2 | 86 | 85·4 | 10·5 | 146 | 144·9 | 17·8 | 206 | 204·5 | 25·1 | 266 | 264·0 | 32·4 |
| 27 | 26·8 | 3·3 | 87 | 86·4 | 10·6 | 147 | 145·9 | 17·9 | 207 | 205·5 | 25·2 | 267 | 265·0 | 32·5 |
| 28 | 27·8 | 3·4 | 88 | 87·3 | 10·7 | 148 | 146·9 | 18·0 | 208 | 206·4 | 25·3 | 268 | 266·0 | 32·7 |
| 29 | 28·8 | 3·5 | 89 | 88·3 | 10·8 | 149 | 147·9 | 18·2 | 209 | 207·4 | 25·5 | 269 | 267·0 | 32·8 |
| 30 | 29·8 | 3·7 | 90 | 89·3 | 11·0 | 150 | 148·9 | 18·3 | 210 | 208·4 | 25·6 | 270 | 268·0 | 32·9 |
| 31 | 30·8 | 3·8 | 91 | 90·3 | 11·1 | 151 | 149·9 | 18·4 | 211 | 209·4 | 25·7 | 271 | 269·0 | 33·0 |
| 32 | 31·8 | 3·9 | 92 | 91·3 | 11·2 | 152 | 150·9 | 18·5 | 212 | 210·4 | 25·8 | 272 | 270·0 | 33·1 |
| 33 | 32·8 | 4·0 | 93 | 92·3 | 11·3 | 153 | 151·9 | 18·6 | 213 | 211·4 | 26·0 | 273 | 271·0 | 33·3 |
| 34 | 33·7 | 4·1 | 94 | 93·3 | 11·5 | 154 | 152·9 | 18·8 | 214 | 212·4 | 26·1 | 274 | 272·0 | 33·4 |
| 35 | 34·7 | 4·3 | 95 | 94·3 | 11·6 | 155 | 153·8 | 18·9 | 215 | 213·4 | 26·2 | 275 | 273·0 | 33·5 |
| 36 | 35·7 | 4·4 | 96 | 95·3 | 11·7 | 156 | 154·8 | 19·0 | 216 | 214·4 | 26·3 | 276 | 273·9 | 33·6 |
| 37 | 36·7 | 4·5 | 97 | 96·3 | 11·8 | 157 | 155·8 | 19·1 | 217 | 215·4 | 26·4 | 277 | 274·9 | 33·8 |
| 38 | 37·7 | 4·6 | 98 | 97·3 | 11·9 | 158 | 156·8 | 19·3 | 218 | 216·4 | 26·6 | 278 | 275·9 | 33·9 |
| 39 | 38·7 | 4·8 | 99 | 98·3 | 12·1 | 159 | 157·8 | 19·4 | 219 | 217·4 | 26·7 | 279 | 276·9 | 34·0 |
| 40 | 39·7 | 4·9 | 100 | 99·3 | 12·2 | 160 | 158·8 | 19·5 | 220 | 218·4 | 26·8 | 280 | 277·9 | 34·1 |
| 41 | 40·7 | 5·0 | 101 | 100·2 | 12·3 | 161 | 159·8 | 19·6 | 221 | 219·4 | 26·9 | 281 | 278·9 | 34·2 |
| 42 | 41·7 | 5·1 | 102 | 101·2 | 12·4 | 162 | 160·8 | 19·7 | 222 | 220·3 | 27·1 | 282 | 279·9 | 34·4 |
| 43 | 42·7 | 5·2 | 103 | 102·2 | 12·6 | 163 | 161·8 | 19·9 | 223 | 221·3 | 27·2 | 283 | 280·9 | 34·5 |
| 44 | 43·7 | 5·4 | 104 | 103·2 | 12·7 | 164 | 162·8 | 20·0 | 224 | 222·3 | 27·3 | 284 | 281·9 | 34·6 |
| 45 | 44·7 | 5·5 | 105 | 104·2 | 12·8 | 165 | 163·8 | 20·1 | 225 | 223·3 | 27·4 | 285 | 282·9 | 34·7 |
| 46 | 45·7 | 5·6 | 106 | 105·2 | 12·9 | 166 | 164·8 | 20·2 | 226 | 224·3 | 27·5 | 286 | 283·9 | 34·9 |
| 47 | 46·6 | 5·7 | 107 | 106·2 | 13·0 | 167 | 165·8 | 20·4 | 227 | 225·3 | 27·7 | 287 | 284·9 | 35·0 |
| 48 | 47·6 | 5·8 | 108 | 107·2 | 13·2 | 168 | 166·7 | 20·5 | 228 | 226·3 | 27·8 | 288 | 285·9 | 35·1 |
| 49 | 48·6 | 6·0 | 109 | 108·2 | 13·3 | 169 | 167·7 | 20·6 | 229 | 227·3 | 27·9 | 289 | 286·8 | 35·2 |
| 50 | 49·6 | 6·1 | 110 | 109·2 | 13·4 | 170 | 168·7 | 20·7 | 230 | 228·3 | 28·0 | 290 | 287·8 | 35·3 |
| 51 | 50·6 | 6·2 | 111 | 110·2 | 13·5 | 171 | 169·7 | 20·8 | 231 | 229·3 | 28·2 | 291 | 288·8 | 35·5 |
| 52 | 51·6 | 6·3 | 112 | 111·2 | 13·6 | 172 | 170·7 | 21·0 | 232 | 230·3 | 28·3 | 292 | 289·8 | 35·6 |
| 53 | 52·6 | 6·5 | 113 | 112·2 | 13·8 | 173 | 171·7 | 21·1 | 233 | 231·3 | 28·4 | 293 | 290·8 | 35·7 |
| 54 | 53·6 | 6·6 | 114 | 113·2 | 13·9 | 174 | 172·7 | 21·2 | 234 | 232·3 | 28·5 | 294 | 291·8 | 35·8 |
| 55 | 54·6 | 6·7 | 115 | 114·1 | 14·0 | 175 | 173·7 | 21·3 | 235 | 233·2 | 28·6 | 295 | 292·8 | 36·0 |
| 56 | 55·6 | 6·8 | 116 | 115·1 | 14·1 | 176 | 174·7 | 21·4 | 236 | 234·2 | 28·8 | 296 | 293·8 | 36·1 |
| 57 | 56·6 | 6·9 | 117 | 116·1 | 14·3 | 177 | 175·7 | 21·6 | 237 | 235·2 | 28·9 | 297 | 294·8 | 36·2 |
| 58 | 57·6 | 7·1 | 118 | 117·1 | 14·4 | 178 | 176·7 | 21·7 | 238 | 236·2 | 29·0 | 298 | 295·8 | 36·3 |
| 59 | 58·6 | 7·2 | 119 | 118·1 | 14·5 | 179 | 177·7 | 21·8 | 239 | 237·2 | 29·1 | 299 | 296·8 | 36·4 |
| 60 | 59·6 | 7·3 | 120 | 119·1 | 14·6 | 180 | 178·7 | 21·9 | 240 | 238·2 | 29·2 | 300 | 297·8 | 36·6 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

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## TRAVERSE TABLE TO DEGREES

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| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 298·7 | 36·7 | 361 | 358·3 | 44·0 | 421 | 417·9 | 51·3 | 481 | 477·4 | 58·6 | 541 | 537·0 | 65·9 |
| 302 | 299·7 | 36·8 | 362 | 359·3 | 44·1 | 422 | 418·8 | 51·4 | 482 | 478·4 | 58·7 | 542 | 537·9 | 66·0 |
| 303 | 300·7 | 36·9 | 363 | 360·3 | 44·2 | 423 | 419·8 | 51·5 | 483 | 479·4 | 58·8 | 543 | 538·9 | 66·2 |
| 304 | 301·7 | 37·0 | 364 | 361·3 | 44·4 | 424 | 420·8 | 51·7 | 484 | 480·4 | 59·0 | 544 | 539·9 | 66·3 |
| 305 | 302·7 | 37·2 | 365 | 362·3 | 44·5 | 425 | 421·8 | 51·8 | 485 | 481·4 | 59·1 | 545 | 540·9 | 66·4 |
| 306 | 303·7 | 37·3 | 366 | 363·3 | 44·6 | 426 | 422·8 | 51·9 | 486 | 482·4 | 59·2 | 546 | 541·9 | 66·6 |
| 307 | 304·7 | 37·4 | 367 | 364·3 | 44·7 | 427 | 423·8 | 52·0 | 487 | 483·4 | 59·4 | 547 | 542·9 | 66·7 |
| 308 | 305·7 | 37·5 | 368 | 365·2 | 44·8 | 428 | 424·8 | 52·2 | 488 | 484·3 | 59·5 | 548 | 543·9 | 66·8 |
| 309 | 306·7 | 37·7 | 369 | 366·2 | 45·0 | 429 | 425·8 | 52·3 | 489 | 485·3 | 59·6 | 549 | 544·9 | 66·9 |
| 310 | 307·7 | 37·8 | 370 | 367·2 | 45·1 | 430 | 426·8 | 52·4 | 490 | 486·3 | 59·7 | 550 | 545·9 | 67·0 |
| 311 | 308·7 | 37·9 | 371 | 368·2 | 45·2 | 431 | 427·8 | 52·5 | 491 | 487·3 | 59·8 | 551 | 546·9 | 67·1 |
| 312 | 309·7 | 38·0 | 372 | 369·2 | 45·3 | 432 | 428·8 | 52·6 | 492 | 488·3 | 59·9 | 552 | 547·9 | 67·2 |
| 313 | 310·7 | 38·1 | 373 | 370·2 | 45·5 | 433 | 429·8 | 52·8 | 493 | 489·3 | 60·1 | 553 | 548·9 | 67·4 |
| 314 | 311·7 | 38·3 | 374 | 371·2 | 45·6 | 434 | 430·8 | 52·9 | 494 | 490·3 | 60·2 | 554 | 549·9 | 67·5 |
| 315 | 312·6 | 38·4 | 375 | 372·2 | 45·7 | 435 | 431·7 | 53·0 | 495 | 491·3 | 60·3 | 555 | 550·8 | 67·6 |
| 316 | 313·6 | 38·5 | 376 | 373·2 | 45·8 | 436 | 432·7 | 53·1 | 496 | 492·3 | 60·5 | 556 | 551·8 | 67·8 |
| 317 | 314·6 | 38·6 | 377 | 374·2 | 45·9 | 437 | 433·7 | 53·3 | 497 | 493·3 | 60·6 | 557 | 552·8 | 67·9 |
| 318 | 315·6 | 38·7 | 378 | 375·2 | 46·1 | 438 | 434·7 | 53·4 | 498 | 494·3 | 60·7 | 558 | 553·8 | 68·0 |
| 319 | 316·6 | 38·9 | 379 | 376·2 | 46·2 | 439 | 435·7 | 53·5 | 499 | 495·3 | 60·8 | 559 | 554·8 | 68·1 |
| 320 | 317·6 | 39·0 | 380 | 377·2 | 46·3 | 440 | 436·7 | 53·6 | 500 | 496·3 | 61·0 | 560 | 555·8 | 68·3 |
| 321 | 318·6 | 39·1 | 381 | 378·1 | 46·4 | 441 | 437·7 | 53·7 | 501 | 497·2 | 61·1 | 561 | 556·8 | 68·4 |
| 322 | 319·6 | 39·2 | 382 | 379·1 | 46·5 | 442 | 438·7 | 53·9 | 502 | 498·2 | 61·2 | 562 | 557·8 | 68·5 |
| 323 | 320·6 | 39·4 | 383 | 380·1 | 46·7 | 443 | 439·7 | 54·0 | 503 | 499·2 | 61·3 | 563 | 558·8 | 68·6 |
| 324 | 321·6 | 39·5 | 384 | 381·1 | 46·8 | 444 | 440·7 | 54·1 | 504 | 500·2 | 61·4 | 564 | 559·8 | 68·7 |
| 325 | 322·6 | 39·6 | 385 | 382·1 | 46·9 | 445 | 441·7 | 54·2 | 505 | 501·2 | 61·5 | 565 | 560·8 | 68·9 |
| 326 | 323·6 | 39·7 | 386 | 383·1 | 47·0 | 446 | 442·7 | 54·3 | 506 | 502·2 | 61·6 | 566 | 561·8 | 69·0 |
| 327 | 324·6 | 39·8 | 387 | 384·1 | 47·2 | 447 | 443·7 | 54·5 | 507 | 503·2 | 61·8 | 567 | 562·8 | 69·1 |
| 328 | 325·5 | 40·0 | 388 | 385·1 | 47·3 | 448 | 444·7 | 54·6 | 508 | 504·2 | 61·9 | 568 | 563·8 | 69·2 |
| 329 | 326·5 | 40·1 | 389 | 386·1 | 47·4 | 449 | 445·6 | 54·7 | 509 | 505·2 | 62·0 | 569 | 564·8 | 69·3 |
| 330 | 327·5 | 40·2 | 390 | 387·1 | 47·5 | 450 | 446·6 | 54·8 | 510 | 506·2 | 62·1 | 570 | 565·8 | 69·4 |
| 331 | 328·5 | 40·3 | 391 | 388·1 | 47·6 | 451 | 447·6 | 55·0 | 511 | 507·2 | 62·3 | 571 | 566·7 | 69·6 |
| 332 | 329·5 | 40·5 | 392 | 389·1 | 47·8 | 452 | 448·6 | 55·1 | 512 | 508·2 | 62·4 | 572 | 567·7 | 69·7 |
| 333 | 330·5 | 40·6 | 393 | 390·1 | 47·9 | 453 | 449·6 | 55·2 | 513 | 509·2 | 62·5 | 573 | 568·7 | 69·8 |
| 334 | 331·5 | 40·7 | 394 | 391·1 | 48·0 | 454 | 450·6 | 55·3 | 514 | 510·2 | 62·6 | 574 | 569·7 | 69·9 |
| 335 | 332·5 | 40·8 | 395 | 392·0 | 48·1 | 455 | 451·6 | 55·4 | 515 | 511·1 | 62·7 | 575 | 570·7 | 70·1 |
| 336 | 333·5 | 40·9 | 396 | 393·0 | 48·3 | 456 | 452·6 | 55·6 | 516 | 512·1 | 62·9 | 576 | 571·7 | 70·2 |
| 337 | 334·5 | 41·1 | 397 | 394·0 | 48·4 | 457 | 453·6 | 55·7 | 517 | 513·1 | 63·0 | 577 | 572·7 | 70·3 |
| 338 | 335·5 | 41·2 | 398 | 395·0 | 48·5 | 458 | 454·6 | 55·8 | 518 | 514·1 | 63·1 | 578 | 573·7 | 70·4 |
| 339 | 336·5 | 41·3 | 399 | 396·0 | 48·6 | 459 | 455·6 | 55·9 | 519 | 515·1 | 63·2 | 579 | 574·7 | 70·5 |
| 340 | 337·5 | 41·4 | 400 | 397·0 | 48·7 | 460 | 456·6 | 56·1 | 520 | 516·1 | 63·4 | 580 | 575·7 | 70·7 |
| 341 | 338·4 | 41·6 | 401 | 398·0 | 48·9 | 461 | 457·6 | 56·2 | 521 | 517·1 | 63·5 | 581 | 576·7 | 70·8 |
| 342 | 339·4 | 41·7 | 402 | 399·0 | 49·0 | 462 | 458·5 | 56·3 | 522 | 518·1 | 63·6 | 582 | 577·6 | 70·9 |
| 343 | 340·4 | 41·8 | 403 | 400·0 | 49·1 | 463 | 459·5 | 56·4 | 523 | 519·1 | 63·7 | 583 | 578·6 | 71·0 |
| 344 | 341·4 | 41·9 | 404 | 401·0 | 49·2 | 464 | 460·5 | 56·5 | 524 | 520·1 | 63·8 | 584 | 579·6 | 71·2 |
| 345 | 342·4 | 42·0 | 405 | 402·0 | 49·4 | 465 | 461·5 | 56·7 | 525 | 521·1 | 64·0 | 585 | 580·6 | 71·3 |
| 346 | 343·4 | 42·2 | 406 | 403·0 | 49·5 | 466 | 462·5 | 56·8 | 526 | 522·1 | 64·1 | 586 | 581·6 | 71·4 |
| 347 | 344·4 | 42·3 | 407 | 404·0 | 49·6 | 467 | 463·5 | 56·9 | 527 | 523·1 | 64·2 | 587 | 582·6 | 71·5 |
| 348 | 345·4 | 42·4 | 408 | 405·0 | 49·7 | 468 | 464·5 | 57·0 | 528 | 524·1 | 64·3 | 588 | 583·6 | 71·6 |
| 349 | 346·4 | 42·5 | 409 | 405·9 | 49·8 | 469 | 465·5 | 57·2 | 529 | 525·0 | 64·5 | 589 | 584·6 | 71·8 |
| 350 | 347·4 | 42·6 | 410 | 406·9 | 50·0 | 470 | 466·5 | 57·3 | 530 | 526·0 | 64·6 | 590 | 585·6 | 71·9 |
| 351 | 348·4 | 42·8 | 411 | 407·9 | 50·1 | 471 | 467·5 | 57·4 | 531 | 527·0 | 64·7 | 591 | 586·6 | 72·0 |
| 352 | 349·4 | 42·9 | 412 | 408·9 | 50·2 | 472 | 468·5 | 57·5 | 532 | 528·0 | 64·8 | 592 | 587·6 | 72·1 |
| 353 | 350·4 | 43·0 | 413 | 409·9 | 50·3 | 473 | 469·5 | 57·6 | 533 | 529·0 | 64·9 | 593 | 588·6 | 72·2 |
| 354 | 351·4 | 43·1 | 414 | 410·9 | 50·4 | 474 | 470·5 | 57·8 | 534 | 530·0 | 65·1 | 594 | 589·6 | 72·4 |
| 355 | 352·3 | 43·3 | 415 | 411·9 | 50·6 | 475 | 471·5 | 57·9 | 535 | 531·0 | 65·2 | 595 | 590·6 | 72·5 |
| 356 | 353·3 | 43·4 | 416 | 412·9 | 50·7 | 476 | 472·4 | 58·0 | 536 | 532·0 | 65·3 | 596 | 591·5 | 72·6 |
| 357 | 354·3 | 43·5 | 417 | 413·9 | 50·8 | 477 | 473·4 | 58·1 | 537 | 533·0 | 65·4 | 597 | 592·5 | 72·7 |
| 358 | 355·3 | 43·6 | 418 | 414·9 | 50·9 | 478 | 474·4 | 58·2 | 538 | 534·0 | 65·6 | 598 | 593·5 | 72·9 |
| 359 | 356·3 | 43·7 | 419 | 415·9 | 51·1 | 479 | 475·4 | 58·4 | 539 | 535·0 | 65·7 | 599 | 594·5 | 73·0 |
| 360 | 357·3 | 43·9 | 420 | 416·9 | 51·2 | 480 | 476·4 | 58·5 | 540 | 536·0 | 65·8 | 600 | 595·5 | 73·1 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist | Dep. | D. Lat. |

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| Dist. | D.Lat | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0 | 0.1 | 61 | 60.4 | 8.5 | 121 | 119.8 | 16.8 | 181 | 179.2 | 25.2 | 241 | 238.7 | 33.5 |
| 2 | 2.0 | 0.3 | 62 | 61.4 | 8.6 | 122 | 120.8 | 17.0 | 182 | 180.2 | 25.3 | 242 | 239.6 | 33.7 |
| 3 | 3.0 | 0.4 | 63 | 62.4 | 8.8 | 123 | 121.8 | 17.1 | 183 | 181.2 | 25.5 | 243 | 240.6 | 33.8 |
| 4 | 4.0 | 0.6 | 64 | 63.4 | 8.9 | 124 | 122.8 | 17.3 | 184 | 182.2 | 25.6 | 244 | 241.6 | 34.0 |
| 5 | 5.0 | 0.7 | 65 | 64.4 | 9.0 | 125 | 123.8 | 17.4 | 185 | 183.2 | 25.7 | 245 | 242.6 | 34.1 |
| 6 | 5.9 | 0.8 | 66 | 65.4 | 9.2 | 126 | 124.8 | 17.5 | 186 | 184.2 | 25.9 | 246 | 243.6 | 34.2 |
| 7 | 6.9 | 1.0 | 67 | 66.3 | 9.3 | 127 | 125.8 | 17.7 | 187 | 185.2 | 26.0 | 247 | 244.6 | 34.4 |
| 8 | 7.9 | 1.1 | 68 | 67.3 | 9.5 | 128 | 126.8 | 17.8 | 188 | 186.2 | 26.2 | 248 | 245.6 | 34.5 |
| 9 | 8.9 | 1.3 | 69 | 68.3 | 9.6 | 129 | 127.7 | 18.0 | 189 | 187.2 | 26.3 | 249 | 246.6 | 34.7 |
| 10 | 9.9 | 1.4 | 70 | 69.3 | 9.7 | 130 | 128.7 | 18.1 | 190 | 188.2 | 26.4 | 250 | 247.6 | 34.8 |
| 11 | 10.9 | 1.5 | 71 | 70.3 | 9.9 | 131 | 129.7 | 18.2 | 191 | 189.1 | 26.6 | 251 | 248.6 | 34.9 |
| 12 | 11.9 | 1.7 | 72 | 71.3 | 10.0 | 132 | 130.7 | 18.4 | 192 | 190.1 | 26.7 | 252 | 249.5 | 35.1 |
| 13 | 12.9 | 1.8 | 73 | 72.3 | 10.2 | 133 | 131.7 | 18.5 | 193 | 191.1 | 26.9 | 253 | 250.5 | 35.2 |
| 14 | 13.9 | 1.9 | 74 | 73.3 | 10.3 | 134 | 132.7 | 18.6 | 194 | 192.1 | 27.0 | 254 | 251.5 | 35.3 |
| 15 | 14.9 | 2.1 | 75 | 74.3 | 10.4 | 135 | 133.7 | 18.8 | 195 | 193.1 | 27.1 | 255 | 252.5 | 35.5 |
| 16 | 15.8 | 2.2 | 76 | 75.3 | 10.6 | 136 | 134.7 | 18.9 | 196 | 194.1 | 27.3 | 256 | 253.5 | 35.6 |
| 17 | 16.8 | 2.4 | 77 | 76.3 | 10.7 | 137 | 135.7 | 19.1 | 197 | 195.1 | 27.4 | 257 | 254.5 | 35.8 |
| 18 | 17.8 | 2.5 | 78 | 77.2 | 10.9 | 138 | 136.7 | 19.2 | 198 | 196.1 | 27.6 | 258 | 255.5 | 35.9 |
| 19 | 18.8 | 2.6 | 79 | 78.2 | 11.0 | 139 | 137.7 | 19.3 | 199 | 197.1 | 27.7 | 259 | 256.5 | 36.0 |
| 20 | 19.8 | 2.8 | 80 | 79.2 | 11.1 | 140 | 138.6 | 19.5 | 200 | 198.1 | 27.8 | 260 | 257.5 | 36.2 |
| 21 | 20.8 | 2.9 | 81 | 80.2 | 11.3 | 141 | 139.6 | 19.6 | 201 | 199.0 | 28.0 | 261 | 258.5 | 36.3 |
| 22 | 21.8 | 3.1 | 82 | 81.2 | 11.4 | 142 | 140.6 | 19.8 | 202 | 200.0 | 28.1 | 262 | 259.5 | 36.5 |
| 23 | 22.8 | 3.2 | 83 | 82.2 | 11.6 | 143 | 141.6 | 19.9 | 203 | 201.0 | 28.3 | 263 | 260.4 | 36.6 |
| 24 | 23.8 | 3.3 | 84 | 83.2 | 11.7 | 144 | 142.6 | 20.0 | 204 | 202.0 | 28.4 | 264 | 261.4 | 36.7 |
| 25 | 24.8 | 3.5 | 85 | 84.2 | 11.8 | 145 | 143.6 | 20.2 | 205 | 203.0 | 28.5 | 265 | 262.4 | 36.9 |
| 26 | 25.7 | 3.6 | 86 | 85.2 | 12.0 | 146 | 144.6 | 20.3 | 206 | 204.0 | 28.7 | 266 | 263.4 | 37.0 |
| 27 | 26.7 | 3.8 | 87 | 86.2 | 12.1 | 147 | 145.6 | 20.5 | 207 | 205.0 | 28.8 | 267 | 264.4 | 37.2 |
| 28 | 27.7 | 3.9 | 88 | 87.1 | 12.2 | 148 | 146.6 | 20.6 | 208 | 206.0 | 28.9 | 268 | 265.4 | 37.3 |
| 29 | 28.7 | 4.0 | 89 | 88.1 | 12.4 | 149 | 147.5 | 20.7 | 209 | 207.0 | 29.1 | 269 | 266.4 | 37.4 |
| 30 | 29.7 | 4.2 | 90 | 89.1 | 12.5 | 150 | 148.5 | 20.9 | 210 | 208.0 | 29.2 | 270 | 267.4 | 37.6 |
| 31 | 30.7 | 4.3 | 91 | 90.1 | 12.7 | 151 | 149.5 | 21.0 | 211 | 208.9 | 29.4 | 271 | 268.4 | 37.7 |
| 32 | 31.7 | 4.5 | 92 | 91.1 | 12.8 | 152 | 150.5 | 21.2 | 212 | 209.9 | 29.5 | 272 | 269.4 | 37.9 |
| 33 | 32.7 | 4.6 | 93 | 92.1 | 12.9 | 153 | 151.5 | 21.3 | 213 | 210.9 | 29.6 | 273 | 270.3 | 38.0 |
| 34 | 33.7 | 4.7 | 94 | 93.1 | 13.1 | 154 | 152.5 | 21.4 | 214 | 211.9 | 29.8 | 274 | 271.3 | 38.1 |
| 35 | 34.7 | 4.9 | 95 | 94.1 | 13.2 | 155 | 153.5 | 21.6 | 215 | 212.9 | 29.9 | 275 | 272.3 | 38.3 |
| 36 | 35.6 | 5.0 | 96 | 95.1 | 13.4 | 156 | 154.5 | 21.7 | 216 | 213.9 | 30.1 | 276 | 273.3 | 38.4 |
| 37 | 36.6 | 5.2 | 97 | 96.1 | 13.5 | 157 | 155.5 | 21.9 | 217 | 214.9 | 30.2 | 277 | 274.3 | 38.6 |
| 38 | 37.6 | 5.3 | 98 | 97.0 | 13.6 | 158 | 156.5 | 22.0 | 218 | 215.9 | 30.3 | 278 | 275.3 | 38.7 |
| 39 | 38.6 | 5.4 | 99 | 98.0 | 13.8 | 159 | 157.5 | 22.1 | 219 | 216.9 | 30.5 | 279 | 276.3 | 38.8 |
| 40 | 39.6 | 5.6 | 100 | 99.0 | 13.9 | 160 | 158.4 | 22.3 | 220 | 217.9 | 30.6 | 280 | 277.3 | 39.0 |
| 41 | 40.6 | 5.7 | 101 | 100.0 | 14.1 | 161 | 159.4 | 22.4 | 221 | 218.8 | 30.8 | 281 | 278.3 | 39.1 |
| 42 | 41.6 | 5.8 | 102 | 101.0 | 14.2 | 162 | 160.4 | 22.5 | 222 | 219.8 | 30.9 | 282 | 279.3 | 39.2 |
| 43 | 42.6 | 6.0 | 103 | 102.0 | 14.3 | 163 | 161.4 | 22.7 | 223 | 220.8 | 31.0 | 283 | 280.2 | 39.4 |
| 44 | 43.6 | 6.1 | 104 | 103.0 | 14.5 | 164 | 162.4 | 22.8 | 224 | 221.8 | 31.2 | 284 | 281.2 | 39.5 |
| 45 | 44.6 | 6.3 | 105 | 104.0 | 14.6 | 165 | 163.4 | 23.0 | 225 | 222.8 | 31.3 | 285 | 282.2 | 39.7 |
| 46 | 45.6 | 6.4 | 106 | 105.0 | 14.8 | 166 | 164.4 | 23.1 | 226 | 223.8 | 31.5 | 286 | 283.2 | 39.8 |
| 47 | 46.5 | 6.5 | 107 | 106.0 | 14.9 | 167 | 165.4 | 23.2 | 227 | 224.8 | 31.6 | 287 | 284.2 | 39.9 |
| 48 | 47.5 | 6.7 | 108 | 107.0 | 15.0 | 168 | 166.4 | 23.4 | 228 | 225.8 | 31.7 | 288 | 285.2 | 40.1 |
| 49 | 48.5 | 6.8 | 109 | 107.9 | 15.2 | 169 | 167.4 | 23.5 | 229 | 226.8 | 31.9 | 289 | 286.2 | 40.2 |
| 50 | 49.5 | 7.0 | 110 | 108.9 | 15.3 | 170 | 168.3 | 23.7 | 230 | 227.8 | 32.0 | 290 | 287.2 | 40.4 |
| 51 | 50.5 | 7.1 | 111 | 109.9 | 15.4 | 171 | 169.3 | 23.8 | 231 | 228.8 | 32.1 | 291 | 288.2 | 40.5 |
| 52 | 51.5 | 7.2 | 112 | 110.9 | 15.6 | 172 | 170.3 | 23.9 | 232 | 229.7 | 32.3 | 292 | 289.2 | 40.6 |
| 53 | 52.5 | 7.4 | 113 | 111.9 | 15.7 | 173 | 171.3 | 24.1 | 233 | 230.7 | 32.4 | 293 | 290.1 | 40.8 |
| 54 | 53.5 | 7.5 | 114 | 112.9 | 15.9 | 174 | 172.3 | 24.2 | 234 | 231.7 | 32.6 | 294 | 291.1 | 40.9 |
| 55 | 54.5 | 7.7 | 115 | 113.9 | 16.0 | 175 | 173.3 | 24.4 | 235 | 232.7 | 32.7 | 295 | 292.1 | 41.1 |
| 56 | 55.5 | 7.8 | 116 | 114.9 | 16.1 | 176 | 174.3 | 24.5 | 236 | 233.7 | 32.8 | 296 | 293.1 | 41.2 |
| 57 | 56.4 | 7.9 | 117 | 115.9 | 16.3 | 177 | 175.3 | 24.6 | 237 | 234.7 | 33.0 | 297 | 294.1 | 41.3 |
| 58 | 57.4 | 8.1 | 118 | 116.9 | 16.4 | 178 | 176.3 | 24.8 | 238 | 235.7 | 33.1 | 298 | 295.1 | 41.5 |
| 59 | 58.4 | 8.2 | 119 | 117.8 | 16.6 | 179 | 177.3 | 24.9 | 239 | 236.7 | 33.3 | 299 | 296.1 | 41.6 |
| 60 | 59.4 | 8.4 | 120 | 118.8 | 16.7 | 180 | 178.2 | 25.1 | 240 | 237.7 | 33.4 | 300 | 297.1 | 41.8 |
| Dist. | Dep. | D.Lat | Dist. | Dep. | D.Lat | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

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8° 0h 32m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 298·0 | 41·9 | 361 | 357·5 | 50·2 | 421 | 416·9 | 58·6 | 481 | 476·3 | 66·9 | 541 | 535·7 | 75·2 |
| 302 | 299·0 | 42·0 | 362 | 358·5 | 50·4 | 422 | 417·9 | 58·7 | 482 | 477·3 | 67·1 | 542 | 536·7 | 75·4 |
| 303 | 300·0 | 42·2 | 363 | 359·4 | 50·5 | 423 | 418·9 | 58·9 | 483 | 478·3 | 67·2 | 543 | 537·7 | 75·5 |
| 304 | 301·0 | 42·3 | 364 | 360·4 | 50·7 | 424 | 419·8 | 59·0 | 484 | 479·3 | 67·4 | 544 | 538·7 | 75·7 |
| 305 | 302·0 | 42·5 | 365 | 361·4 | 50·8 | 425 | 420·8 | 59·2 | 485 | 480·3 | 67·5 | 545 | 539·7 | 75·8 |
| 306 | 303·0 | 42·6 | 366 | 362·4 | 50·9 | 426 | 421·8 | 59·3 | 486 | 481·2 | 67·6 | 546 | 540·6 | 75·9 |
| 307 | 304·0 | 42·7 | 367 | 363·4 | 51·1 | 427 | 422·8 | 59·4 | 487 | 482·2 | 67·8 | 547 | 541·6 | 76·1 |
| 308 | 305·0 | 42·9 | 368 | 364·4 | 51·2 | 428 | 423·8 | 59·6 | 488 | 483·2 | 67·9 | 548 | 542·6 | 76·2 |
| 309 | 306·0 | 43·0 | 369 | 365·4 | 51·4 | 429 | 424·8 | 59·7 | 489 | 484·2 | 68·1 | 549 | 543·6 | 76·4 |
| 310 | 307·0 | 43·1 | 370 | 366·4 | 51·5 | 430 | 425·8 | 59·8 | 490 | 485·2 | 68·2 | 550 | 544·6 | 76·5 |
| 311 | 307·9 | 43·3 | 371 | 367·4 | 51·6 | 431 | 426·8 | 60·0 | 491 | 486·2 | 68·3 | 551 | 545·6 | 76·6 |
| 312 | 308·9 | 43·4 | 372 | 368·4 | 51·8 | 432 | 427·8 | 60·1 | 492 | 487·2 | 68·5 | 552 | 546·6 | 76·8 |
| 313 | 309·9 | 43·6 | 373 | 369·3 | 51·9 | 433 | 428·8 | 60·3 | 493 | 488·2 | 68·6 | 553 | 547·6 | 76·9 |
| 314 | 310·9 | 43·7 | 374 | 370·3 | 52·1 | 434 | 429·8 | 60·4 | 494 | 489·2 | 68·8 | 554 | 548·6 | 77·1 |
| 315 | 311·9 | 43·8 | 375 | 371·3 | 52·2 | 435 | 430·7 | 60·5 | 495 | 490·2 | 68·9 | 555 | 549·6 | 77·2 |
| 316 | 312·9 | 44·0 | 376 | 372·3 | 52·3 | 436 | 431·7 | 60·7 | 496 | 491·2 | 69·0 | 556 | 550·6 | 77·4 |
| 317 | 313·9 | 44·1 | 377 | 373·3 | 52·5 | 437 | 432·7 | 60·8 | 497 | 492·1 | 69·2 | 557 | 551·5 | 77·5 |
| 318 | 314·9 | 44·3 | 378 | 374·3 | 52·6 | 438 | 433·7 | 61·0 | 498 | 493·1 | 69·3 | 558 | 552·5 | 77·6 |
| 319 | 315·9 | 44·4 | 379 | 375·3 | 52·7 | 439 | 434·7 | 61·1 | 499 | 494·1 | 69·5 | 559 | 553·5 | 77·8 |
| 320 | 316·9 | 44·5 | 380 | 376·3 | 52·9 | 440 | 435·7 | 61·2 | 500 | 495·1 | 69·6 | 560 | 554·5 | 77·9 |
| 321 | 317·9 | 44·7 | 381 | 377·3 | 53·0 | 441 | 436·7 | 61·4 | 501 | 496·1 | 69·7 | 561 | 555·5 | 78·1 |
| 322 | 318·8 | 44·8 | 382 | 378·3 | 53·2 | 442 | 437·7 | 61·5 | 502 | 497·1 | 69·9 | 562 | 556·5 | 78·2 |
| 323 | 319·8 | 45·0 | 383 | 379·2 | 53·3 | 443 | 438·7 | 61·7 | 503 | 498·1 | 70·0 | 563 | 557·5 | 78·3 |
| 324 | 320·8 | 45·1 | 384 | 380·2 | 53·4 | 444 | 439·7 | 61·8 | 504 | 499·1 | 70·2 | 564 | 558·5 | 78·5 |
| 325 | 321·8 | 45·2 | 385 | 381·2 | 53·6 | 445 | 440·6 | 61·9 | 505 | 500·1 | 70·3 | 565 | 559·5 | 78·6 |
| 326 | 322·8 | 45·4 | 386 | 382·2 | 53·7 | 446 | 441·6 | 62·1 | 506 | 501·0 | 70·4 | 566 | 560·5 | 78·8 |
| 327 | 323·8 | 45·5 | 387 | 383·2 | 53·9 | 447 | 442·6 | 62·2 | 507 | 502·0 | 70·6 | 567 | 561·5 | 78·9 |
| 328 | 324·8 | 45·7 | 388 | 384·2 | 54·0 | 448 | 443·6 | 62·4 | 508 | 503·0 | 70·7 | 568 | 562·5 | 79·0 |
| 329 | 325·8 | 45·8 | 389 | 385·2 | 54·1 | 449 | 444·6 | 62·5 | 509 | 504·0 | 70·8 | 569 | 563·5 | 79·1 |
| 330 | 326·8 | 45·9 | 390 | 386·2 | 54·3 | 450 | 445·6 | 62·6 | 510 | 505·0 | 70·9 | 570 | 564·5 | 79·3 |
| 331 | 327·8 | 46·1 | 391 | 387·2 | 54·4 | 451 | 446·6 | 62·8 | 511 | 506·0 | 71·1 | 571 | 565·4 | 79·4 |
| 332 | 328·7 | 46·2 | 392 | 388·2 | 54·6 | 452 | 447·6 | 62·9 | 512 | 507·0 | 71·2 | 572 | 566·4 | 79·6 |
| 333 | 329·7 | 46·3 | 393 | 389·1 | 54·7 | 453 | 448·6 | 63·0 | 513 | 508·0 | 71·4 | 573 | 567·4 | 79·7 |
| 334 | 330·7 | 46·5 | 394 | 390·1 | 54·8 | 454 | 449·6 | 63·2 | 514 | 509·0 | 71·5 | 574 | 568·4 | 79·8 |
| 335 | 331·7 | 46·6 | 395 | 391·1 | 55·0 | 455 | 450·5 | 63·3 | 515 | 510·0 | 71·6 | 575 | 569·4 | 80·0 |
| 336 | 332·7 | 46·8 | 396 | 392·1 | 55·1 | 456 | 451·5 | 63·5 | 516 | 510·9 | 71·8 | 576 | 570·4 | 80·1 |
| 337 | 333·7 | 46·9 | 397 | 393·1 | 55·3 | 457 | 452·5 | 63·6 | 517 | 511·9 | 71·9 | 577 | 571·4 | 80·2 |
| 338 | 334·7 | 47·0 | 398 | 394·1 | 55·4 | 458 | 453·5 | 63·7 | 518 | 512·9 | 72·0 | 578 | 572·4 | 80·4 |
| 339 | 335·7 | 47·2 | 399 | 395·1 | 55·5 | 459 | 454·5 | 63·9 | 519 | 513·9 | 72·2 | 579 | 573·4 | 80·5 |
| 340 | 336·7 | 47·3 | 400 | 396·1 | 55·7 | 460 | 455·5 | 64·0 | 520 | 514·9 | 72·3 | 580 | 574·4 | 80·6 |
| 341 | 337·7 | 47·5 | 401 | 397·1 | 55·8 | 461 | 456·5 | 64·2 | 521 | 515·9 | 72·4 | 581 | 575·4 | 80·8 |
| 342 | 338·6 | 47·6 | 402 | 398·1 | 56·0 | 462 | 457·5 | 64·3 | 522 | 516·9 | 72·6 | 582 | 576·4 | 80·9 |
| 343 | 339·6 | 47·7 | 403 | 399·1 | 56·1 | 463 | 458·5 | 64·4 | 523 | 517·9 | 72·8 | 583 | 577·4 | 81·1 |
| 344 | 340·6 | 47·9 | 404 | 400·0 | 56·2 | 464 | 459·5 | 64·6 | 524 | 518·9 | 73·0 | 584 | 578·4 | 81·3 |
| 345 | 341·6 | 48·0 | 405 | 401·0 | 56·4 | 465 | 460·4 | 64·7 | 525 | 519·9 | 73·1 | 585 | 579·4 | 81·4 |
| 346 | 342·6 | 48·2 | 406 | 402·0 | 56·5 | 466 | 461·4 | 64·9 | 526 | 520·9 | 73·2 | 586 | 580·3 | 81·6 |
| 347 | 343·6 | 48·3 | 407 | 403·0 | 56·6 | 467 | 462·4 | 65·0 | 527 | 521·8 | 73·4 | 587 | 581·3 | 81·7 |
| 348 | 344·6 | 48·4 | 408 | 404·0 | 56·8 | 468 | 463·4 | 65·1 | 528 | 522·8 | 73·5 | 588 | 582·3 | 81·8 |
| 349 | 345·6 | 48·6 | 409 | 405·0 | 56·9 | 469 | 464·4 | 65·3 | 529 | 523·8 | 73·7 | 589 | 583·3 | 82·0 |
| 350 | 346·6 | 48·7 | 410 | 406·0 | 57·1 | 470 | 465·4 | 65·4 | 530 | 524·8 | 73·8 | 590 | 584·3 | 82·1 |
| 351 | 347·6 | 48·9 | 411 | 407·0 | 57·2 | 471 | 466·4 | 65·6 | 531 | 525·8 | 73·9 | 591 | 585·3 | 82·2 |
| 352 | 348·5 | 49·0 | 412 | 408·0 | 57·3 | 472 | 467·4 | 65·7 | 532 | 526·8 | 74·1 | 592 | 586·3 | 82·4 |
| 353 | 349·5 | 49·1 | 413 | 409·0 | 57·5 | 473 | 468·4 | 65·8 | 533 | 527·8 | 74·2 | 593 | 587·3 | 82·5 |
| 354 | 350·5 | 49·3 | 414 | 409·9 | 57·6 | 474 | 469·4 | 66·0 | 534 | 528·8 | 74·3 | 594 | 588·3 | 82·6 |
| 355 | 351·5 | 49·4 | 415 | 410·9 | 57·8 | 475 | 470·4 | 66·1 | 535 | 529·8 | 74·5 | 595 | 589·3 | 82·8 |
| 356 | 352·5 | 49·5 | 416 | 411·9 | 57·9 | 476 | 471·3 | 66·2 | 536 | 530·8 | 74·6 | 596 | 590·3 | 83·0 |
| 357 | 353·5 | 49·7 | 417 | 412·9 | 58·0 | 477 | 472·3 | 66·4 | 537 | 531·7 | 74·7 | 597 | 591·2 | 83·1 |
| 358 | 354·5 | 49·8 | 418 | 413·9 | 58·2 | 478 | 473·3 | 66·5 | 538 | 532·7 | 74·9 | 598 | 592·2 | 83·2 |
| 359 | 355·5 | 50·0 | 419 | 414·9 | 58·3 | 479 | 474·3 | 66·7 | 539 | 533·7 | 75·0 | 599 | 593·2 | 83·3 |
| 360 | 356·5 | 50·1 | 420 | 415·9 | 58·5 | 480 | 475·3 | 66·8 | 540 | 534·7 | 75·1 | 600 | 594·2 | 83·5 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

82° 5h 28m

## TRAVERSE TABLE TO DEGREES

9° — 0h 36m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0 | 0.2 | 61 | 60.2 | 9.5 | 121 | 119.5 | 18.9 | 181 | 178.8 | 28.3 | 241 | 238.0 | 37.7 |
| 2 | 2.0 | 0.3 | 62 | 61.2 | 9.7 | 122 | 120.5 | 19.1 | 182 | 179.8 | 28.5 | 242 | 239.0 | 37.9 |
| 3 | 3.0 | 0.5 | 63 | 62.2 | 9.9 | 123 | 121.5 | 19.2 | 183 | 180.7 | 28.6 | 243 | 240.0 | 38.0 |
| 4 | 4.0 | 0.6 | 64 | 63.2 | 10.0 | 124 | 122.5 | 19.4 | 184 | 181.7 | 28.8 | 244 | 241.0 | 38.2 |
| 5 | 4.9 | 0.8 | 65 | 64.2 | 10.2 | 125 | 123.5 | 19.6 | 185 | 182.7 | 28.9 | 245 | 242.0 | 38.3 |
| 6 | 5.9 | 0.9 | 66 | 65.2 | 10.3 | 126 | 124.4 | 19.7 | 186 | 183.7 | 29.1 | 246 | 243.0 | 38.5 |
| 7 | 6.9 | 1.1 | 67 | 66.2 | 10.5 | 127 | 125.4 | 19.9 | 187 | 184.7 | 29.3 | 247 | 244.0 | 38.6 |
| 8 | 7.9 | 1.3 | 68 | 67.2 | 10.6 | 128 | 126.4 | 20.0 | 188 | 185.7 | 29.4 | 248 | 244.9 | 38.8 |
| 9 | 8.9 | 1.4 | 69 | 68.2 | 10.8 | 129 | 127.4 | 20.2 | 189 | 186.7 | 29.6 | 249 | 245.9 | 39.0 |
| 10 | 9.9 | 1.6 | 70 | 69.1 | 11.0 | 130 | 128.4 | 20.3 | 190 | 187.7 | 29.7 | 250 | 246.9 | 39.1 |
| 11 | 10.9 | 1.7 | 71 | 70.1 | 11.1 | 131 | 129.4 | 20.5 | 191 | 188.6 | 29.9 | 251 | 247.9 | 39.3 |
| 12 | 11.9 | 1.9 | 72 | 71.1 | 11.3 | 132 | 130.4 | 20.6 | 192 | 189.6 | 30.0 | 252 | 248.9 | 39.4 |
| 13 | 12.8 | 2.0 | 73 | 72.1 | 11.4 | 133 | 131.4 | 20.8 | 193 | 190.6 | 30.2 | 253 | 249.9 | 39.6 |
| 14 | 13.8 | 2.2 | 74 | 73.1 | 11.6 | 134 | 132.4 | 21.0 | 194 | 191.6 | 30.3 | 254 | 250.9 | 39.7 |
| 15 | 14.8 | 2.3 | 75 | 74.1 | 11.7 | 135 | 133.3 | 21.1 | 195 | 192.6 | 30.5 | 255 | 251.9 | 39.9 |
| 16 | 15.8 | 2.5 | 76 | 75.1 | 11.9 | 136 | 134.3 | 21.3 | 196 | 193.6 | 30.7 | 256 | 252.8 | 40.0 |
| 17 | 16.8 | 2.7 | 77 | 76.1 | 12.0 | 137 | 135.3 | 21.4 | 197 | 194.6 | 30.8 | 257 | 253.8 | 40.2 |
| 18 | 17.8 | 2.8 | 78 | 77.0 | 12.2 | 138 | 136.3 | 21.6 | 198 | 195.6 | 31.0 | 258 | 254.8 | 40.4 |
| 19 | 18.8 | 3.0 | 79 | 78.0 | 12.4 | 139 | 137.3 | 21.7 | 199 | 196.5 | 31.1 | 259 | 255.8 | 40.5 |
| 20 | 19.8 | 3.1 | 80 | 79.0 | 12.5 | 140 | 138.3 | 21.9 | 200 | 197.5 | 31.3 | 260 | 256.8 | 40.7 |
| 21 | 20.7 | 3.3 | 81 | 80.0 | 12.7 | 141 | 139.3 | 22.1 | 201 | 198.5 | 31.4 | 261 | 257.8 | 40.8 |
| 22 | 21.7 | 3.4 | 82 | 81.0 | 12.8 | 142 | 140.3 | 22.2 | 202 | 199.5 | 31.6 | 262 | 258.8 | 41.0 |
| 23 | 22.7 | 3.6 | 83 | 82.0 | 13.0 | 143 | 141.2 | 22.4 | 203 | 200.5 | 31.8 | 263 | 259.8 | 41.1 |
| 24 | 23.7 | 3.8 | 84 | 83.0 | 13.1 | 144 | 142.2 | 22.5 | 204 | 201.5 | 31.9 | 264 | 260.7 | 41.3 |
| 25 | 24.7 | 3.9 | 85 | 84.0 | 13.3 | 145 | 143.2 | 22.7 | 205 | 202.5 | 32.1 | 265 | 261.7 | 41.5 |
| 26 | 25.7 | 4.1 | 86 | 84.9 | 13.5 | 146 | 144.2 | 22.8 | 206 | 203.5 | 32.2 | 266 | 262.7 | 41.6 |
| 27 | 26.7 | 4.2 | 87 | 85.9 | 13.6 | 147 | 145.2 | 23.0 | 207 | 204.5 | 32.4 | 267 | 263.7 | 41.8 |
| 28 | 27.7 | 4.4 | 88 | 86.9 | 13.8 | 148 | 146.2 | 23.2 | 208 | 205.4 | 32.5 | 268 | 264.7 | 41.9 |
| 29 | 28.6 | 4.5 | 89 | 87.9 | 13.9 | 149 | 147.2 | 23.3 | 209 | 206.4 | 32.7 | 269 | 265.7 | 42.1 |
| 30 | 29.6 | 4.7 | 90 | 88.9 | 14.1 | 150 | 148.2 | 23.5 | 210 | 207.4 | 32.9 | 270 | 266.7 | 42.2 |
| 31 | 30.6 | 4.8 | 91 | 89.9 | 14.2 | 151 | 149.1 | 23.6 | 211 | 208.4 | 33.0 | 271 | 267.7 | 42.4 |
| 32 | 31.6 | 5.0 | 92 | 90.9 | 14.4 | 152 | 150.1 | 23.8 | 212 | 209.4 | 33.2 | 272 | 268.7 | 42.6 |
| 33 | 32.6 | 5.2 | 93 | 91.9 | 14.5 | 153 | 151.1 | 23.9 | 213 | 210.4 | 33.3 | 273 | 269.6 | 42.7 |
| 34 | 33.6 | 5.3 | 94 | 92.8 | 14.7 | 154 | 152.1 | 24.1 | 214 | 211.4 | 33.5 | 274 | 270.6 | 42.9 |
| 35 | 34.6 | 5.5 | 95 | 93.8 | 14.9 | 155 | 153.1 | 24.2 | 215 | 212.4 | 33.6 | 275 | 271.6 | 43.0 |
| 36 | 35.6 | 5.6 | 96 | 94.8 | 15.0 | 156 | 154.1 | 24.4 | 216 | 213.3 | 33.8 | 276 | 272.6 | 43.2 |
| 37 | 36.5 | 5.8 | 97 | 95.8 | 15.2 | 157 | 155.1 | 24.6 | 217 | 214.3 | 33.9 | 277 | 273.6 | 43.3 |
| 38 | 37.5 | 5.9 | 98 | 96.8 | 15.3 | 158 | 156.1 | 24.7 | 218 | 215.3 | 34.1 | 278 | 274.6 | 43.5 |
| 39 | 38.5 | 6.1 | 99 | 97.8 | 15.5 | 159 | 157.0 | 24.9 | 219 | 216.3 | 34.3 | 279 | 275.6 | 43.6 |
| 40 | 39.5 | 6.3 | 100 | 98.8 | 15.6 | 160 | 158.0 | 25.0 | 220 | 217.3 | 34.4 | 280 | 276.6 | 43.8 |
| 41 | 40.5 | 6.4 | 101 | 99.8 | 15.8 | 161 | 159.0 | 25.2 | 221 | 218.3 | 34.6 | 281 | 277.5 | 44.0 |
| 42 | 41.5 | 6.6 | 102 | 100.7 | 16.0 | 162 | 160.0 | 25.3 | 222 | 219.3 | 34.7 | 282 | 278.5 | 44.1 |
| 43 | 42.5 | 6.7 | 103 | 101.7 | 16.1 | 163 | 161.0 | 25.5 | 223 | 220.3 | 34.9 | 283 | 279.5 | 44.3 |
| 44 | 43.5 | 6.9 | 104 | 102.7 | 16.3 | 164 | 162.0 | 25.7 | 224 | 221.2 | 35.0 | 284 | 280.5 | 44.4 |
| 45 | 44.4 | 7.0 | 105 | 103.7 | 16.4 | 165 | 163.0 | 25.8 | 225 | 222.2 | 35.2 | 285 | 281.5 | 44.6 |
| 46 | 45.4 | 7.2 | 106 | 104.7 | 16.6 | 166 | 164.0 | 26.0 | 226 | 223.2 | 35.4 | 286 | 282.5 | 44.7 |
| 47 | 46.4 | 7.4 | 107 | 105.7 | 16.7 | 167 | 164.9 | 26.1 | 227 | 224.2 | 35.5 | 287 | 283.5 | 44.9 |
| 48 | 47.4 | 7.5 | 108 | 106.7 | 16.9 | 168 | 165.9 | 26.3 | 228 | 225.2 | 35.7 | 288 | 284.5 | 45.1 |
| 49 | 48.4 | 7.7 | 109 | 107.7 | 17.1 | 169 | 166.9 | 26.4 | 229 | 226.2 | 35.8 | 289 | 285.4 | 45.2 |
| 50 | 49.4 | 7.8 | 110 | 108.6 | 17.2 | 170 | 167.9 | 26.6 | 230 | 227.2 | 36.0 | 290 | 286.4 | 45.4 |
| 51 | 50.4 | 8.0 | 111 | 109.6 | 17.4 | 171 | 168.9 | 26.8 | 231 | 228.2 | 36.1 | 291 | 287.4 | 45.5 |
| 52 | 51.4 | 8.1 | 112 | 110.6 | 17.5 | 172 | 169.9 | 26.9 | 232 | 229.1 | 36.3 | 292 | 288.4 | 45.7 |
| 53 | 52.3 | 8.3 | 113 | 111.6 | 17.7 | 173 | 170.9 | 27.1 | 233 | 230.1 | 36.4 | 293 | 289.4 | 45.8 |
| 54 | 53.3 | 8.4 | 114 | 112.6 | 17.8 | 174 | 171.9 | 27.2 | 234 | 231.1 | 36.6 | 294 | 290.4 | 46.0 |
| 55 | 54.3 | 8.6 | 115 | 113.6 | 18.0 | 175 | 172.8 | 27.4 | 235 | 232.1 | 36.8 | 295 | 291.4 | 46.1 |
| 56 | 55.3 | 8.8 | 116 | 114.6 | 18.1 | 176 | 173.8 | 27.5 | 236 | 233.1 | 36.9 | 296 | 292.4 | 46.3 |
| 57 | 56.3 | 8.9 | 117 | 115.6 | 18.3 | 177 | 174.8 | 27.7 | 237 | 234.1 | 37.1 | 297 | 293.3 | 46.5 |
| 58 | 57.3 | 9.1 | 118 | 116.5 | 18.5 | 178 | 175.8 | 27.8 | 238 | 235.1 | 37.2 | 298 | 294.3 | 46.6 |
| 59 | 58.3 | 9.2 | 119 | 117.5 | 18.6 | 179 | 176.8 | 28.0 | 239 | 236.1 | 37.4 | 299 | 295.3 | 46.8 |
| 60 | 59.3 | 9.4 | 120 | 118.5 | 18.8 | 180 | 177.8 | 28.2 | 240 | 237.0 | 37.5 | 300 | 296.3 | 46.9 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

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## TRAVERSE TABLE TO DEGREES

9° 0h 36m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 297.3 | 47.1 | 361 | 356.6 | 56.5 | 421 | 415.8 | 65.9 | 481 | 475.1 | 75.2 | 541 | 534.4 | 84.6 |
| 302 | 298.3 | 47.2 | 362 | 357.5 | 56.7 | 422 | 416.8 | 66.0 | 482 | 476.1 | 75.3 | 542 | 535.4 | 84.7 |
| 303 | 299.3 | 47.4 | 363 | 358.5 | 56.8 | 423 | 417.8 | 66.2 | 483 | 477.1 | 75.5 | 543 | 536.3 | 84.9 |
| 304 | 300.3 | 47.6 | 364 | 359.5 | 56.9 | 424 | 418.8 | 66.3 | 484 | 478.0 | 75.6 | 544 | 537.3 | 85.1 |
| 305 | 301.2 | 47.7 | 365 | 360.5 | 57.1 | 425 | 419.8 | 66.5 | 485 | 479.0 | 75.8 | 545 | 538.3 | 85.3 |
| 306 | 302.2 | 47.9 | 366 | 361.5 | 57.3 | 426 | 420.8 | 66.6 | 486 | 480.0 | 75.9 | 546 | 539.3 | 85.4 |
| 307 | 303.2 | 48.0 | 367 | 362.5 | 57.4 | 427 | 421.7 | 66.8 | 487 | 481.0 | 76.1 | 547 | 540.3 | 85.6 |
| 308 | 304.2 | 48.2 | 368 | 363.5 | 57.6 | 428 | 422.7 | 67.0 | 488 | 482.0 | 76.2 | 548 | 541.3 | 85.7 |
| 309 | 305.2 | 48.3 | 369 | 364.5 | 57.7 | 429 | 423.7 | 67.1 | 489 | 483.0 | 76.4 | 549 | 542.3 | 85.9 |
| 310 | 306.2 | 48.5 | 370 | 365.4 | 57.9 | 430 | 424.7 | 67.3 | 490 | 484.0 | 76.5 | 550 | 543.3 | 86.0 |
| 311 | 307.2 | 48.7 | 371 | 366.4 | 58.1 | 431 | 425.7 | 67.4 | 491 | 485.0 | 76.7 | 551 | 544.3 | 86.2 |
| 312 | 308.2 | 48.8 | 372 | 367.4 | 58.2 | 432 | 426.7 | 67.6 | 492 | 485.9 | 76.8 | 552 | 545.2 | 86.3 |
| 313 | 309.1 | 49.0 | 373 | 368.4 | 58.4 | 433 | 427.7 | 67.7 | 493 | 486.9 | 77.0 | 553 | 546.2 | 86.5 |
| 314 | 310.1 | 49.1 | 374 | 369.4 | 58.5 | 434 | 428.7 | 67.9 | 494 | 487.9 | 77.1 | 554 | 547.2 | 86.6 |
| 315 | 311.1 | 49.3 | 375 | 370.4 | 58.7 | 435 | 429.6 | 68.1 | 495 | 488.9 | 77.3 | 555 | 548.2 | 86.8 |
| 316 | 312.1 | 49.4 | 376 | 371.4 | 58.8 | 436 | 430.6 | 68.2 | 496 | 489.9 | 77.5 | 556 | 549.2 | 87.0 |
| 317 | 313.1 | 49.6 | 377 | 372.4 | 59.0 | 437 | 431.6 | 68.4 | 497 | 490.9 | 77.7 | 557 | 550.2 | 87.1 |
| 318 | 314.1 | 49.8 | 378 | 373.3 | 59.1 | 438 | 432.6 | 68.5 | 498 | 491.9 | 77.9 | 558 | 551.2 | 87.3 |
| 319 | 315.1 | 49.9 | 379 | 374.3 | 59.3 | 439 | 433.6 | 68.7 | 499 | 492.9 | 78.0 | 559 | 552.2 | 87.4 |
| 320 | 316.1 | 50.1 | 380 | 375.3 | 59.5 | 440 | 434.6 | 68.8 | 500 | 493.8 | 78.2 | 560 | 553.1 | 87.6 |
| 321 | 317.0 | 50.2 | 381 | 376.3 | 59.6 | 441 | 435.6 | 69.0 | 501 | 494.8 | 78.4 | 561 | 554.1 | 87.7 |
| 322 | 318.0 | 50.4 | 382 | 377.3 | 59.8 | 442 | 436.6 | 69.1 | 502 | 495.8 | 78.5 | 562 | 555.1 | 87.9 |
| 323 | 319.0 | 50.5 | 383 | 378.3 | 59.9 | 443 | 437.5 | 69.3 | 503 | 496.8 | 78.7 | 563 | 556.1 | 88.0 |
| 324 | 320.0 | 50.7 | 384 | 379.3 | 60.1 | 444 | 438.5 | 69.5 | 504 | 497.8 | 78.8 | 564 | 557.1 | 88.2 |
| 325 | 321.0 | 50.8 | 385 | 380.3 | 60.2 | 445 | 439.5 | 69.6 | 505 | 498.8 | 79.0 | 565 | 558.1 | 88.3 |
| 326 | 322.0 | 51.0 | 386 | 381.2 | 60.4 | 446 | 440.5 | 69.8 | 506 | 499.8 | 79.1 | 566 | 559.1 | 88.5 |
| 327 | 323.0 | 51.2 | 387 | 382.2 | 60.5 | 447 | 441.5 | 69.9 | 507 | 500.8 | 79.2 | 567 | 560.1 | 88.6 |
| 328 | 324.0 | 51.3 | 388 | 383.2 | 60.7 | 448 | 442.5 | 70.1 | 508 | 501.7 | 79.4 | 568 | 561.0 | 88.8 |
| 329 | 324.9 | 51.5 | 389 | 384.2 | 60.9 | 449 | 443.5 | 70.2 | 509 | 502.7 | 79.5 | 569 | 562.0 | 88.9 |
| 330 | 325.9 | 51.7 | 390 | 385.2 | 61.0 | 450 | 444.5 | 70.4 | 510 | 503.7 | 79.7 | 570 | 563.0 | 89.1 |
| 331 | 326.9 | 51.8 | 391 | 386.2 | 61.2 | 451 | 445.4 | 70.6 | 511 | 504.7 | 79.8 | 571 | 564.0 | 89.2 |
| 332 | 327.9 | 51.9 | 392 | 387.2 | 61.3 | 452 | 446.4 | 70.7 | 512 | 505.7 | 80.1 | 572 | 565.0 | 89.4 |
| 333 | 328.9 | 52.1 | 393 | 388.2 | 61.5 | 453 | 447.4 | 70.9 | 513 | 506.7 | 80.2 | 573 | 566.0 | 89.5 |
| 334 | 329.9 | 52.3 | 394 | 389.1 | 61.6 | 454 | 448.4 | 71.0 | 514 | 507.7 | 80.3 | 574 | 567.0 | 89.7 |
| 335 | 330.9 | 52.4 | 395 | 390.1 | 61.8 | 455 | 449.4 | 71.2 | 515 | 508.7 | 80.5 | 575 | 568.0 | 89.9 |
| 336 | 331.9 | 52.6 | 396 | 391.1 | 62.0 | 456 | 450.4 | 71.3 | 516 | 509.6 | 80.6 | 576 | 568.9 | 90.1 |
| 337 | 332.8 | 52.7 | 397 | 392.1 | 62.1 | 457 | 451.4 | 71.5 | 517 | 510.6 | 80.8 | 577 | 569.9 | 90.2 |
| 338 | 333.8 | 52.9 | 398 | 393.1 | 62.3 | 458 | 452.4 | 71.7 | 518 | 511.6 | 80.9 | 578 | 570.9 | 90.3 |
| 339 | 334.8 | 53.0 | 399 | 394.1 | 62.4 | 459 | 453.3 | 71.8 | 519 | 512.6 | 81.1 | 579 | 571.9 | 90.5 |
| 340 | 335.8 | 53.2 | 400 | 395.1 | 62.6 | 460 | 454.3 | 72.0 | 520 | 513.6 | 81.3 | 580 | 572.9 | 90.7 |
| 341 | 336.8 | 53.3 | 401 | 396.1 | 62.7 | 461 | 455.3 | 72.1 | 521 | 514.6 | 81.4 | 581 | 573.9 | 90.9 |
| 342 | 337.8 | 53.5 | 402 | 397.0 | 62.9 | 462 | 456.3 | 72.3 | 522 | 515.6 | 81.6 | 582 | 574.9 | 91.0 |
| 343 | 338.8 | 53.7 | 403 | 398.0 | 63.0 | 463 | 457.3 | 72.4 | 523 | 516.6 | 81.8 | 583 | 575.9 | 91.2 |
| 344 | 339.8 | 53.8 | 404 | 399.0 | 63.2 | 464 | 458.3 | 72.6 | 524 | 517.6 | 81.9 | 584 | 576.9 | 91.3 |
| 345 | 340.8 | 54.0 | 405 | 400.0 | 63.4 | 465 | 459.3 | 72.7 | 525 | 518.6 | 82.1 | 585 | 577.9 | 91.5 |
| 346 | 341.7 | 54.1 | 406 | 401.0 | 63.5 | 466 | 460.3 | 72.9 | 526 | 519.5 | 82.3 | 586 | 578.8 | 91.7 |
| 347 | 342.7 | 54.3 | 407 | 402.0 | 63.7 | 467 | 461.2 | 73.1 | 527 | 520.5 | 82.4 | 587 | 579.8 | 91.8 |
| 348 | 343.7 | 54.4 | 408 | 403.0 | 63.8 | 468 | 462.2 | 73.2 | 528 | 521.5 | 82.6 | 588 | 580.8 | 92.0 |
| 349 | 344.7 | 54.6 | 409 | 404.0 | 64.0 | 469 | 463.2 | 73.4 | 529 | 522.5 | 82.7 | 589 | 581.8 | 92.1 |
| 350 | 345.7 | 54.8 | 410 | 405.0 | 64.1 | 470 | 464.2 | 73.5 | 530 | 523.5 | 82.9 | 590 | 582.8 | 92.2 |
| 351 | 346.7 | 54.9 | 411 | 405.9 | 64.3 | 471 | 465.2 | 73.7 | 531 | 524.5 | 83.1 | 591 | 583.8 | 92.4 |
| 352 | 347.7 | 55.1 | 412 | 406.9 | 64.5 | 472 | 466.2 | 73.8 | 532 | 525.5 | 83.2 | 592 | 584.8 | 92.5 |
| 353 | 348.7 | 55.2 | 413 | 407.9 | 64.6 | 473 | 467.2 | 74.0 | 533 | 526.5 | 83.4 | 593 | 585.7 | 92.7 |
| 354 | 349.6 | 55.4 | 414 | 408.9 | 64.8 | 474 | 468.2 | 74.2 | 534 | 527.5 | 83.5 | 594 | 586.7 | 92.9 |
| 355 | 350.6 | 55.5 | 415 | 409.9 | 64.9 | 475 | 469.2 | 74.3 | 535 | 528.4 | 83.7 | 595 | 587.7 | 93.1 |
| 356 | 351.6 | 55.7 | 416 | 410.9 | 65.1 | 476 | 470.1 | 74.5 | 536 | 529.4 | 83.8 | 596 | 588.7 | 93.2 |
| 357 | 352.6 | 55.9 | 417 | 411.9 | 65.2 | 477 | 471.1 | 74.6 | 537 | 530.4 | 84.0 | 597 | 589.7 | 93.4 |
| 358 | 353.6 | 56.0 | 418 | 412.9 | 65.4 | 478 | 472.1 | 74.8 | 538 | 531.4 | 84.1 | 598 | 590.7 | 93.5 |
| 359 | 354.6 | 56.2 | 419 | 413.8 | 65.6 | 479 | 473.1 | 74.9 | 539 | 532.4 | 84.3 | 599 | 591.7 | 93.7 |
| 360 | 355.6 | 56.3 | 420 | 414.8 | 65.7 | 480 | 474.1 | 75.0 | 540 | 533.4 | 84.4 | 600 | 592.6 | 93.8 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

81° 5h 24m

## TRAVERSE TABLE TO DEGREES

10° 0h 40m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1·0 | 0·2 | 61 | 60·1 | 10·6 | 121 | 119·2 | 21·0 | 181 | 178·3 | 31·4 | 241 | 237·3 | 41·8 |
| 2 | 2·0 | 0·3 | 62 | 61·1 | 10·8 | 122 | 120·1 | 21·2 | 182 | 179·2 | 31·6 | 242 | 238·3 | 42·0 |
| 3 | 3·0 | 0·5 | 63 | 62·0 | 10·9 | 123 | 121·1 | 21·4 | 183 | 180·2 | 31·8 | 243 | 239·3 | 42·2 |
| 4 | 3·9 | 0·7 | 64 | 63·0 | 11·1 | 124 | 122·1 | 21·5 | 184 | 181·2 | 32·0 | 244 | 240·3 | 42·4 |
| 5 | 4·9 | 0·9 | 65 | 64·0 | 11·3 | 125 | 123·1 | 21·7 | 185 | 182·2 | 32·1 | 245 | 241·3 | 42·5 |
| 6 | 5·9 | 1·0 | 66 | 65·0 | 11·5 | 126 | 124·1 | 21·9 | 186 | 183·2 | 32·3 | 246 | 242·3 | 42·7 |
| 7 | 6·9 | 1·2 | 67 | 66·0 | 11·6 | 127 | 125·1 | 22·1 | 187 | 184·2 | 32·5 | 247 | 243·2 | 42·9 |
| 8 | 7·9 | 1·4 | 68 | 67·0 | 11·8 | 128 | 126·1 | 22·2 | 188 | 185·1 | 32·6 | 248 | 244·2 | 43·1 |
| 9 | 8·9 | 1·6 | 69 | 68·0 | 12·0 | 129 | 127·0 | 22·4 | 189 | 186·1 | 32·8 | 249 | 245·2 | 43·2 |
| 10 | 9·8 | 1·7 | 70 | 68·9 | 12·2 | 130 | 128·0 | 22·6 | 190 | 187·1 | 33·0 | 250 | 246·2 | 43·4 |
| 11 | 10·8 | 1·9 | 71 | 69·9 | 12·3 | 131 | 129·0 | 22·7 | 191 | 188·1 | 33·2 | 251 | 247·2 | 43·6 |
| 12 | 11·8 | 2·1 | 72 | 70·9 | 12·5 | 132 | 130·0 | 22·9 | 192 | 189·1 | 33·3 | 252 | 248·2 | 43·8 |
| 13 | 12·8 | 2·3 | 73 | 71·9 | 12·7 | 133 | 131·0 | 23·1 | 193 | 190·1 | 33·5 | 253 | 249·2 | 43·9 |
| 14 | 13·8 | 2·4 | 74 | 72·9 | 12·8 | 134 | 132·0 | 23·3 | 194 | 191·1 | 33·7 | 254 | 250·1 | 44·1 |
| 15 | 14·8 | 2·6 | 75 | 73·9 | 13·0 | 135 | 132·9 | 23·4 | 195 | 192·0 | 33·9 | 255 | 251·1 | 44·3 |
| 16 | 15·8 | 2·8 | 76 | 74·8 | 13·2 | 136 | 133·9 | 23·6 | 196 | 193·0 | 34·0 | 256 | 252·1 | 44·5 |
| 17 | 16·7 | 3·0 | 77 | 75·8 | 13·4 | 137 | 134·9 | 23·8 | 197 | 194·0 | 34·2 | 257 | 253·1 | 44·6 |
| 18 | 17·7 | 3·1 | 78 | 76·8 | 13·5 | 138 | 135·9 | 24·0 | 198 | 195·0 | 34·4 | 258 | 254·1 | 44·8 |
| 19 | 18·7 | 3·3 | 79 | 77·8 | 13·7 | 139 | 136·9 | 24·1 | 199 | 196·0 | 34·6 | 259 | 255·1 | 45·0 |
| 20 | 19·7 | 3·5 | 80 | 78·8 | 13·9 | 140 | 137·9 | 24·3 | 200 | 197·0 | 34·7 | 260 | 256·1 | 45·1 |
| 21 | 20·7 | 3·6 | 81 | 79·8 | 14·1 | 141 | 138·9 | 24·5 | 201 | 197·9 | 34·9 | 261 | 257·0 | 45·3 |
| 22 | 21·7 | 3·8 | 82 | 80·8 | 14·2 | 142 | 139·8 | 24·7 | 202 | 198·9 | 35·1 | 262 | 258·0 | 45·5 |
| 23 | 22·7 | 4·0 | 83 | 81·7 | 14·4 | 143 | 140·8 | 24·8 | 203 | 199·9 | 35·3 | 263 | 259·0 | 45·7 |
| 24 | 23·6 | 4·2 | 84 | 82·7 | 14·6 | 144 | 141·8 | 25·0 | 204 | 200·9 | 35·4 | 264 | 260·0 | 45·8 |
| 25 | 24·6 | 4·3 | 85 | 83·7 | 14·8 | 145 | 142·8 | 25·2 | 205 | 201·9 | 35·6 | 265 | 261·0 | 46·0 |
| 26 | 25·6 | 4·5 | 86 | 84·7 | 14·9 | 146 | 143·8 | 25·4 | 206 | 202·9 | 35·8 | 266 | 262·0 | 46·2 |
| 27 | 26·6 | 4·7 | 87 | 85·7 | 15·1 | 147 | 144·8 | 25·5 | 207 | 203·9 | 35·9 | 267 | 262·9 | 46·4 |
| 28 | 27·6 | 4·9 | 88 | 86·7 | 15·3 | 148 | 145·8 | 25·7 | 208 | 204·8 | 36·1 | 268 | 263·9 | 46·5 |
| 29 | 28·6 | 5·0 | 89 | 87·6 | 15·5 | 149 | 146·7 | 25·9 | 209 | 205·8 | 36·3 | 269 | 264·9 | 46·7 |
| 30 | 29·5 | 5·2 | 90 | 88·6 | 15·6 | 150 | 147·7 | 26·0 | 210 | 206·8 | 36·5 | 270 | 265·9 | 46·9 |
| 31 | 30·5 | 5·4 | 91 | 89·6 | 15·8 | 151 | 148·7 | 26·2 | 211 | 207·8 | 36·6 | 271 | 266·9 | 47·1 |
| 32 | 31·5 | 5·6 | 92 | 90·6 | 16·0 | 152 | 149·7 | 26·4 | 212 | 208·8 | 36·8 | 272 | 267·9 | 47·2 |
| 33 | 32·5 | 5·7 | 93 | 91·6 | 16·1 | 153 | 150·7 | 26·6 | 213 | 209·8 | 37·0 | 273 | 268·9 | 47·4 |
| 34 | 33·5 | 5·9 | 94 | 92·6 | 16·3 | 154 | 151·7 | 26·7 | 214 | 210·7 | 37·2 | 274 | 269·8 | 47·6 |
| 35 | 34·5 | 6·1 | 95 | 93·6 | 16·5 | 155 | 152·6 | 26·9 | 215 | 211·7 | 37·3 | 275 | 270·8 | 47·8 |
| 36 | 35·5 | 6·3 | 96 | 94·5 | 16·7 | 156 | 153·6 | 27·1 | 216 | 212·7 | 37·5 | 276 | 271·8 | 47·9 |
| 37 | 36·4 | 6·4 | 97 | 95·5 | 16·8 | 157 | 154·6 | 27·3 | 217 | 213·7 | 37·7 | 277 | 272·8 | 48·1 |
| 38 | 37·4 | 6·6 | 98 | 96·5 | 17·0 | 158 | 155·6 | 27·4 | 218 | 214·7 | 37·9 | 278 | 273·8 | 48·3 |
| 39 | 38·4 | 6·8 | 99 | 97·5 | 17·2 | 159 | 156·6 | 27·6 | 219 | 215·7 | 38·0 | 279 | 274·8 | 48·4 |
| 40 | 39·4 | 6·9 | 100 | 98·5 | 17·4 | 160 | 157·6 | 27·8 | 220 | 216·7 | 38·2 | 280 | 275·7 | 48·6 |
| 41 | 40·4 | 7·1 | 101 | 99·5 | 17·5 | 161 | 158·6 | 28·0 | 221 | 217·6 | 38·4 | 281 | 276·7 | 48·8 |
| 42 | 41·4 | 7·3 | 102 | 100·5 | 17·7 | 162 | 159·5 | 28·1 | 222 | 218·6 | 38·5 | 282 | 277·7 | 49·0 |
| 43 | 42·3 | 7·5 | 103 | 101·4 | 17·9 | 163 | 160·5 | 28·3 | 223 | 219·6 | 38·7 | 283 | 278·7 | 49·1 |
| 44 | 43·3 | 7·6 | 104 | 102·4 | 18·1 | 164 | 161·5 | 28·5 | 224 | 220·6 | 38·9 | 284 | 279·7 | 49·3 |
| 45 | 44·3 | 7·8 | 105 | 103·4 | 18·2 | 165 | 162·5 | 28·7 | 225 | 221·6 | 39·1 | 285 | 280·7 | 49·5 |
| 46 | 45·3 | 8·0 | 106 | 104·4 | 18·4 | 166 | 163·5 | 28·8 | 226 | 222·6 | 39·2 | 286 | 281·7 | 49·7 |
| 47 | 46·3 | 8·2 | 107 | 105·4 | 18·6 | 167 | 164·5 | 29·0 | 227 | 223·6 | 39·4 | 287 | 282·6 | 49·8 |
| 48 | 47·3 | 8·3 | 108 | 106·4 | 18·8 | 168 | 165·4 | 29·2 | 228 | 224·5 | 39·6 | 288 | 283·6 | 50·0 |
| 49 | 48·3 | 8·5 | 109 | 107·3 | 18·9 | 169 | 166·4 | 29·3 | 229 | 225·5 | 39·8 | 289 | 284·6 | 50·2 |
| 50 | 49·2 | 8·7 | 110 | 108·3 | 19·1 | 170 | 167·4 | 29·5 | 230 | 226·5 | 39·9 | 290 | 285·6 | 50·4 |
| 51 | 50·2 | 8·9 | 111 | 109·3 | 19·3 | 171 | 168·4 | 29·7 | 231 | 227·5 | 40·1 | 291 | 286·6 | 50·5 |
| 52 | 51·2 | 9·0 | 112 | 110·3 | 19·4 | 172 | 169·4 | 29·9 | 232 | 228·5 | 40·3 | 292 | 287·6 | 50·7 |
| 53 | 52·2 | 9·2 | 113 | 111·3 | 19·6 | 173 | 170·4 | 30·0 | 233 | 229·5 | 40·5 | 293 | 288·5 | 50·9 |
| 54 | 53·2 | 9·4 | 114 | 112·3 | 19·8 | 174 | 171·4 | 30·2 | 234 | 230·4 | 40·6 | 294 | 289·5 | 51·1 |
| 55 | 54·2 | 9·6 | 115 | 113·3 | 20·0 | 175 | 172·3 | 30·4 | 235 | 231·4 | 40·8 | 295 | 290·5 | 51·2 |
| 56 | 55·1 | 9·7 | 116 | 114·2 | 20·1 | 176 | 173·3 | 30·6 | 236 | 232·4 | 41·0 | 296 | 291·5 | 51·4 |
| 57 | 56·1 | 9·9 | 117 | 115·2 | 20·3 | 177 | 174·3 | 30·7 | 237 | 233·4 | 41·2 | 297 | 292·5 | 51·6 |
| 58 | 57·1 | 10·1 | 118 | 116·2 | 20·5 | 178 | 175·3 | 30·9 | 238 | 234·4 | 41·3 | 298 | 293·5 | 51·7 |
| 59 | 58·1 | 10·2 | 119 | 117·2 | 20·7 | 179 | 176·3 | 31·1 | 239 | 235·4 | 41·5 | 299 | 294·5 | 51·9 |
| 60 | 59·1 | 10·4 | 120 | 118·2 | 20·8 | 180 | 177·3 | 31·3 | 240 | 236·4 | 41·7 | 300 | 295·4 | 52·1 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

80° 5h 20m

## TRAVERSE TABLE TO DEGREES

10° — 0h 40m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 296·4 | 52·3 | 361 | 355·5 | 62·7 | 421 | 414·6 | 73·1 | 481 | 473·7 | 83·5 | 541 | 532·8 | 93·9 |
| 302 | 297·4 | 52·5 | 362 | 356·5 | 62·9 | 422 | 415·6 | 73·3 | 482 | 474·7 | 83·7 | 542 | 533·8 | 94·1 |
| 303 | 298·4 | 52·6 | 363 | 357·5 | 63·0 | 423 | 416·6 | 73·5 | 483 | 475·7 | 83·9 | 543 | 534·8 | 94·3 |
| 304 | 299·4 | 52·8 | 364 | 358·5 | 63·2 | 424 | 417·6 | 73·6 | 484 | 476·6 | 84·1 | 544 | 535·7 | 94·5 |
| 305 | 300·4 | 53·0 | 365 | 359·5 | 63·4 | 425 | 418·5 | 73·8 | 485 | 477·6 | 84·2 | 545 | 536·7 | 94·6 |
| 306 | 301·4 | 53·1 | 366 | 360·4 | 63·6 | 426 | 419·5 | 74·0 | 486 | 478·6 | 84·4 | 546 | 537·7 | 94·8 |
| 307 | 302·3 | 53·3 | 367 | 361·4 | 63·7 | 427 | 420·5 | 74·2 | 487 | 479·6 | 84·6 | 547 | 538·7 | 95·0 |
| 308 | 303·3 | 53·5 | 368 | 362·4 | 63·9 | 428 | 421·5 | 74·3 | 488 | 480·6 | 84·7 | 548 | 539·7 | 95·1 |
| 309 | 304·3 | 53·7 | 369 | 363·4 | 64·1 | 429 | 422·5 | 74·5 | 489 | 481·6 | 84·9 | 549 | 540·7 | 95·3 |
| 310 | 305·3 | 53·8 | 370 | 364·4 | 64·3 | 430 | 423·5 | 74·7 | 490 | 482·6 | 85·1 | 550 | 541·6 | 95·5 |
| 311 | 306·3 | 54·0 | 371 | 365·4 | 64·4 | 431 | 424·5 | 74·9 | 491 | 483·5 | 85·2 | 551 | 542·6 | 95·6 |
| 312 | 307·3 | 54·2 | 372 | 366·4 | 64·6 | 432 | 425·4 | 75·0 | 492 | 484·5 | 85·4 | 552 | 543·6 | 95·8 |
| 313 | 308·2 | 54·3 | 373 | 367·3 | 64·8 | 433 | 426·4 | 75·2 | 493 | 485·5 | 85·6 | 553 | 544·6 | 96·0 |
| 314 | 309·2 | 54·5 | 374 | 368·3 | 65·0 | 434 | 427·4 | 75·4 | 494 | 486·5 | 85·8 | 554 | 545·6 | 96·2 |
| 315 | 310·2 | 54·7 | 375 | 369·3 | 65·1 | 435 | 428·4 | 75·5 | 495 | 487·5 | 85·9 | 555 | 546·6 | 96·3 |
| 316 | 311·2 | 54·9 | 376 | 370·3 | 65·3 | 436 | 429·4 | 75·7 | 496 | 488·5 | 86·1 | 556 | 547·5 | 96·5 |
| 317 | 312·2 | 55·1 | 377 | 371·3 | 65·5 | 437 | 430·4 | 75·9 | 497 | 489·4 | 86·3 | 557 | 548·5 | 96·7 |
| 318 | 313·2 | 55·2 | 378 | 372·3 | 65·6 | 438 | 431·3 | 76·1 | 498 | 490·4 | 86·5 | 558 | 549·5 | 96·9 |
| 319 | 314·2 | 55·4 | 379 | 373·2 | 65·8 | 439 | 432·3 | 76·2 | 499 | 491·4 | 86·6 | 559 | 550·5 | 97·0 |
| 320 | 315·1 | 55·6 | 380 | 374·2 | 66·0 | 440 | 433·3 | 76·4 | 500 | 492·4 | 86·8 | 560 | 551·5 | 97·2 |
| 321 | 316·1 | 55·8 | 381 | 375·2 | 66·2 | 441 | 434·3 | 76·6 | 501 | 493·4 | 87·0 | 561 | 552·5 | 97·4 |
| 322 | 317·1 | 55·9 | 382 | 376·2 | 66·3 | 442 | 435·3 | 76·8 | 502 | 494·4 | 87·2 | 562 | 553·5 | 97·6 |
| 323 | 318·1 | 56·1 | 383 | 377·2 | 66·5 | 443 | 436·3 | 76·9 | 503 | 495·3 | 87·3 | 563 | 554·4 | 97·7 |
| 324 | 319·1 | 56·3 | 384 | 378·2 | 66·7 | 444 | 437·3 | 77·1 | 504 | 496·3 | 87·5 | 564 | 555·4 | 97·9 |
| 325 | 320·1 | 56·4 | 385 | 379·2 | 66·9 | 445 | 438·2 | 77·3 | 505 | 497·3 | 87·7 | 565 | 556·4 | 98·1 |
| 326 | 321·0 | 56·6 | 386 | 380·1 | 67·0 | 446 | 439·2 | 77·5 | 506 | 498·3 | 87·9 | 566 | 557·4 | 98·3 |
| 327 | 322·0 | 56·8 | 387 | 381·1 | 67·2 | 447 | 440·2 | 77·6 | 507 | 499·3 | 88·0 | 567 | 558·4 | 98·4 |
| 328 | 323·0 | 57·0 | 388 | 382·1 | 67·4 | 448 | 441·2 | 77·8 | 508 | 500·3 | 88·2 | 568 | 559·4 | 98·6 |
| 329 | 324·0 | 57·1 | 389 | 383·1 | 67·6 | 449 | 442·2 | 78·0 | 509 | 501·3 | 88·4 | 569 | 560·3 | 98·8 |
| 330 | 325·0 | 57·3 | 390 | 384·1 | 67·7 | 450 | 443·2 | 78·2 | 510 | 502·2 | 88·6 | 570 | 561·3 | 99·0 |
| 331 | 326·0 | 57·5 | 391 | 385·1 | 67·9 | 451 | 444·2 | 78·3 | 511 | 503·2 | 88·7 | 571 | 562·3 | 99·1 |
| 332 | 327·0 | 57·7 | 392 | 386·0 | 68·1 | 452 | 445·1 | 78·5 | 512 | 504·2 | 88·9 | 572 | 563·3 | 99·3 |
| 333 | 327·9 | 57·8 | 393 | 387·0 | 68·2 | 453 | 446·1 | 78·7 | 513 | 505·2 | 89·1 | 573 | 564·3 | 99·5 |
| 334 | 328·9 | 58·0 | 394 | 388·0 | 68·4 | 454 | 447·1 | 78·8 | 514 | 506·2 | 89·2 | 574 | 565·3 | 99·6 |
| 335 | 329·9 | 58·2 | 395 | 389·0 | 68·6 | 455 | 448·1 | 79·0 | 515 | 507·2 | 89·4 | 575 | 566·3 | 99·8 |
| 336 | 330·9 | 58·4 | 396 | 390·0 | 68·8 | 456 | 449·1 | 79·2 | 516 | 508·2 | 89·6 | 576 | 567·2 | 100·0 |
| 337 | 331·9 | 58·5 | 397 | 391·0 | 68·9 | 457 | 450·1 | 79·4 | 517 | 509·1 | 89·8 | 577 | 568·2 | 100·2 |
| 338 | 332·9 | 58·7 | 398 | 392·0 | 69·1 | 458 | 451·0 | 79·5 | 518 | 510·1 | 89·9 | 578 | 569·2 | 100·3 |
| 339 | 333·9 | 58·9 | 399 | 392·9 | 69·3 | 459 | 452·0 | 79·7 | 519 | 511·1 | 90·1 | 579 | 570·2 | 100·5 |
| 340 | 334·8 | 59·1 | 400 | 393·9 | 69·5 | 460 | 453·0 | 79·9 | 520 | 512·1 | 90·3 | 580 | 571·2 | 100·7 |
| 341 | 335·8 | 59·2 | 401 | 394·9 | 69·6 | 461 | 454·0 | 80·1 | 521 | 513·1 | 90·5 | 581 | 572·2 | 100·9 |
| 342 | 336·8 | 59·4 | 402 | 395·9 | 69·8 | 462 | 455·0 | 80·2 | 522 | 514·1 | 90·6 | 582 | 573·2 | 101·0 |
| 343 | 337·8 | 59·6 | 403 | 396·9 | 70·0 | 463 | 456·0 | 80·4 | 523 | 515·1 | 90·8 | 583 | 574·1 | 101·2 |
| 344 | 338·8 | 59·8 | 404 | 397·9 | 70·2 | 464 | 457·0 | 80·6 | 524 | 516·0 | 91·0 | 584 | 575·1 | 101·4 |
| 345 | 339·8 | 59·9 | 405 | 398·9 | 70·3 | 465 | 457·9 | 80·8 | 525 | 517·0 | 91·2 | 585 | 576·1 | 101·6 |
| 346 | 340·7 | 60·1 | 406 | 399·8 | 70·5 | 466 | 458·9 | 80·9 | 526 | 518·0 | 91·3 | 586 | 577·1 | 101·7 |
| 347 | 341·7 | 60·3 | 407 | 400·8 | 70·7 | 467 | 459·9 | 81·1 | 527 | 519·0 | 91·5 | 587 | 578·1 | 101·9 |
| 348 | 342·7 | 60·4 | 408 | 401·8 | 70·9 | 468 | 460·9 | 81·3 | 528 | 520·0 | 91·7 | 588 | 579·1 | 102·1 |
| 349 | 343·7 | 60·6 | 409 | 402·8 | 71·0 | 469 | 461·9 | 81·5 | 529 | 521·0 | 91·9 | 589 | 580·0 | 102·3 |
| 350 | 344·7 | 60·8 | 410 | 403·8 | 71·2 | 470 | 462·9 | 81·6 | 530 | 521·9 | 92·0 | 590 | 581·0 | 102·4 |
| 351 | 345·7 | 61·0 | 411 | 404·8 | 71·4 | 471 | 463·8 | 81·8 | 531 | 522·9 | 92·2 | 591 | 582·0 | 102·6 |
| 352 | 346·7 | 61·1 | 412 | 405·7 | 71·6 | 472 | 464·8 | 82·0 | 532 | 523·9 | 92·4 | 592 | 583·0 | 102·8 |
| 353 | 347·6 | 61·3 | 413 | 406·7 | 71·7 | 473 | 465·8 | 82·1 | 533 | 524·9 | 92·5 | 593 | 584·0 | 102·9 |
| 354 | 348·6 | 61·5 | 414 | 407·7 | 71·9 | 474 | 466·8 | 82·3 | 534 | 525·9 | 92·7 | 594 | 585·0 | 103·1 |
| 355 | 349·6 | 61·7 | 415 | 408·7 | 72·1 | 475 | 467·8 | 82·5 | 535 | 526·9 | 92·9 | 595 | 586·0 | 103·3 |
| 356 | 350·6 | 61·8 | 416 | 409·7 | 72·2 | 476 | 468·8 | 82·7 | 536 | 527·9 | 93·1 | 596 | 586·9 | 103·5 |
| 357 | 351·6 | 62·0 | 417 | 410·7 | 72·4 | 477 | 469·8 | 82·8 | 537 | 528·8 | 93·2 | 597 | 587·9 | 103·6 |
| 358 | 352·6 | 62·2 | 418 | 411·7 | 72·6 | 478 | 470·7 | 83·0 | 538 | 529·8 | 93·4 | 598 | 588·9 | 103·8 |
| 359 | 353·5 | 62·4 | 419 | 412·6 | 72·8 | 479 | 471·7 | 83·2 | 539 | 530·8 | 93·6 | 599 | 589·9 | 104·0 |
| 360 | 354·5 | 62·5 | 420 | 413·6 | 72·9 | 480 | 472·7 | 83·4 | 540 | 531·8 | 93·8 | 600 | 590·9 | 104·2 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

80° — 5h 20m

## TRAVERSE TABLE TO DEGREES

11° — $0^h\ 44^m$

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0 | 0.2 | 61 | 59.9 | 11.6 | 121 | 118.8 | 23.1 | 181 | 177.7 | 34.5 | 241 | 236.6 | 46.0 |
| 2 | 2.0 | 0.4 | 62 | 60.9 | 11.8 | 122 | 119.8 | 23.3 | 182 | 178.7 | 34.7 | 242 | 237.6 | 46.2 |
| 3 | 2.9 | 0.6 | 63 | 61.8 | 12.0 | 123 | 120.7 | 23.5 | 183 | 179.6 | 34.9 | 243 | 238.5 | 46.4 |
| 4 | 3.9 | 0.8 | 64 | 62.8 | 12.2 | 124 | 121.7 | 23.7 | 184 | 180.6 | 35.1 | 244 | 239.5 | 46.6 |
| 5 | 4.9 | 1.0 | 65 | 63.8 | 12.4 | 125 | 122.7 | 23.9 | 185 | 181.6 | 35.3 | 245 | 240.5 | 46.7 |
| 6 | 5.9 | 1.1 | 66 | 64.8 | 12.6 | 126 | 123.7 | 24.0 | 186 | 182.6 | 35.5 | 246 | 241.5 | 46.9 |
| 7 | 6.9 | 1.3 | 67 | 65.8 | 12.8 | 127 | 124.7 | 24.2 | 187 | 183.6 | 35.7 | 247 | 242.5 | 47.1 |
| 8 | 7.9 | 1.5 | 68 | 66.8 | 13.0 | 128 | 125.6 | 24.4 | 188 | 184.5 | 35.9 | 248 | 243.4 | 47.3 |
| 9 | 8.8 | 1.7 | 69 | 67.7 | 13.2 | 129 | 126.6 | 24.6 | 189 | 185.5 | 36.1 | 249 | 244.4 | 47.5 |
| 10 | 9.8 | 1.9 | 70 | 68.7 | 13.4 | 130 | 127.6 | 24.8 | 190 | 186.5 | 36.3 | 250 | 245.4 | 47.7 |
| 11 | 10.8 | 2.1 | 71 | 69.7 | 13.5 | 131 | 128.6 | 25.0 | 191 | 187.5 | 36.4 | 251 | 246.4 | 47.9 |
| 12 | 11.8 | 2.3 | 72 | 70.7 | 13.7 | 132 | 129.6 | 25.2 | 192 | 188.5 | 36.6 | 252 | 247.4 | 48.1 |
| 13 | 12.8 | 2.5 | 73 | 71.7 | 13.9 | 133 | 130.6 | 25.4 | 193 | 189.5 | 36.8 | 253 | 248.4 | 48.3 |
| 14 | 13.7 | 2.7 | 74 | 72.6 | 14.1 | 134 | 131.5 | 25.6 | 194 | 190.4 | 37.0 | 254 | 249.3 | 48.5 |
| 15 | 14.7 | 2.9 | 75 | 73.6 | 14.3 | 135 | 132.5 | 25.8 | 195 | 191.4 | 37.2 | 255 | 250.3 | 48.7 |
| 16 | 15.7 | 3.1 | 76 | 74.6 | 14.5 | 136 | 133.5 | 26.0 | 196 | 192.4 | 37.4 | 256 | 251.3 | 48.8 |
| 17 | 16.7 | 3.2 | 77 | 75.6 | 14.7 | 137 | 134.5 | 26.1 | 197 | 193.4 | 37.6 | 257 | 252.3 | 49.0 |
| 18 | 17.7 | 3.4 | 78 | 76.6 | 14.9 | 138 | 135.5 | 26.3 | 198 | 194.4 | 37.8 | 258 | 253.3 | 49.2 |
| 19 | 18.7 | 3.6 | 79 | 77.5 | 15.1 | 139 | 136.4 | 26.5 | 199 | 195.3 | 38.0 | 259 | 254.2 | 49.4 |
| 20 | 19.6 | 3.8 | 80 | 78.5 | 15.3 | 140 | 137.4 | 26.7 | 200 | 196.3 | 38.2 | 260 | 255.2 | 49.6 |
| 21 | 20.6 | 4.0 | 81 | 79.5 | 15.5 | 141 | 138.4 | 26.9 | 201 | 197.3 | 38.4 | 261 | 256.2 | 49.8 |
| 22 | 21.6 | 4.2 | 82 | 80.5 | 15.6 | 142 | 139.4 | 27.1 | 202 | 198.3 | 38.5 | 262 | 257.2 | 50.0 |
| 23 | 22.6 | 4.4 | 83 | 81.5 | 15.8 | 143 | 140.4 | 27.3 | 203 | 199.3 | 38.7 | 263 | 258.2 | 50.2 |
| 24 | 23.6 | 4.6 | 84 | 82.5 | 16.0 | 144 | 141.4 | 27.5 | 204 | 200.3 | 38.9 | 264 | 259.1 | 50.4 |
| 25 | 24.5 | 4.8 | 85 | 83.4 | 16.2 | 145 | 142.3 | 27.7 | 205 | 201.2 | 39.1 | 265 | 260.1 | 50.6 |
| 26 | 25.5 | 5.0 | 86 | 84.4 | 16.4 | 146 | 143.3 | 27.9 | 206 | 202.2 | 39.3 | 266 | 261.1 | 50.8 |
| 27 | 26.5 | 5.2 | 87 | 85.4 | 16.6 | 147 | 144.3 | 28.0 | 207 | 203.2 | 39.5 | 267 | 262.1 | 50.9 |
| 28 | 27.5 | 5.3 | 88 | 86.4 | 16.8 | 148 | 145.3 | 28.2 | 208 | 204.2 | 39.7 | 268 | 263.1 | 51.1 |
| 29 | 28.5 | 5.5 | 89 | 87.4 | 17.0 | 149 | 146.3 | 28.4 | 209 | 205.2 | 39.9 | 269 | 264.1 | 51.3 |
| 30 | 29.4 | 5.7 | 90 | 88.3 | 17.2 | 150 | 147.2 | 28.6 | 210 | 206.1 | 40.1 | 270 | 265.0 | 51.5 |
| 31 | 30.4 | 5.9 | 91 | 89.3 | 17.4 | 151 | 148.2 | 28.8 | 211 | 207.1 | 40.3 | 271 | 266.0 | 51.7 |
| 32 | 31.4 | 6.1 | 92 | 90.3 | 17.6 | 152 | 149.2 | 29.0 | 212 | 208.1 | 40.5 | 272 | 267.0 | 51.9 |
| 33 | 32.4 | 6.3 | 93 | 91.3 | 17.7 | 153 | 150.2 | 29.2 | 213 | 209.1 | 40.6 | 273 | 268.0 | 52.1 |
| 34 | 33.4 | 6.5 | 94 | 92.3 | 17.9 | 154 | 151.2 | 29.4 | 214 | 210.1 | 40.8 | 274 | 269.0 | 52.3 |
| 35 | 34.4 | 6.7 | 95 | 93.3 | 18.1 | 155 | 152.2 | 29.6 | 215 | 211.0 | 41.0 | 275 | 269.9 | 52.5 |
| 36 | 35.3 | 6.9 | 96 | 94.2 | 18.3 | 156 | 153.1 | 29.8 | 216 | 212.0 | 41.2 | 276 | 270.9 | 52.7 |
| 37 | 36.3 | 7.1 | 97 | 95.2 | 18.5 | 157 | 154.1 | 30.0 | 217 | 213.0 | 41.4 | 277 | 271.9 | 52.9 |
| 38 | 37.3 | 7.3 | 98 | 96.2 | 18.7 | 158 | 155.1 | 30.1 | 218 | 214.0 | 41.6 | 278 | 272.9 | 53.0 |
| 39 | 38.3 | 7.4 | 99 | 97.2 | 18.9 | 159 | 156.1 | 30.3 | 219 | 215.0 | 41.8 | 279 | 273.9 | 53.2 |
| 40 | 39.3 | 7.6 | 100 | 98.2 | 19.1 | 160 | 157.1 | 30.5 | 220 | 216.0 | 42.0 | 280 | 274.9 | 53.4 |
| 41 | 40.2 | 7.8 | 101 | 99.1 | 19.3 | 161 | 158.0 | 30.7 | 221 | 216.9 | 42.2 | 281 | 275.8 | 53.6 |
| 42 | 41.2 | 8.0 | 102 | 100.1 | 19.5 | 162 | 159.0 | 30.9 | 222 | 217.9 | 42.4 | 282 | 276.8 | 53.8 |
| 43 | 42.2 | 8.2 | 103 | 101.1 | 19.7 | 163 | 160.0 | 31.1 | 223 | 218.9 | 42.6 | 283 | 277.8 | 54.0 |
| 44 | 43.2 | 8.4 | 104 | 102.1 | 19.8 | 164 | 161.0 | 31.3 | 224 | 219.9 | 42.7 | 284 | 278.8 | 54.2 |
| 45 | 44.2 | 8.6 | 105 | 103.1 | 20.0 | 165 | 162.0 | 31.5 | 225 | 220.9 | 42.9 | 285 | 279.8 | 54.4 |
| 46 | 45.2 | 8.8 | 106 | 104.1 | 20.2 | 166 | 163.0 | 31.7 | 226 | 221.8 | 43.1 | 286 | 280.7 | 54.6 |
| 47 | 46.1 | 9.0 | 107 | 105.0 | 20.4 | 167 | 163.9 | 31.9 | 227 | 222.8 | 43.3 | 287 | 281.7 | 54.8 |
| 48 | 47.1 | 9.2 | 108 | 106.0 | 20.6 | 168 | 164.9 | 32.1 | 228 | 223.8 | 43.5 | 288 | 282.7 | 55.0 |
| 49 | 48.1 | 9.3 | 109 | 107.0 | 20.8 | 169 | 165.9 | 32.2 | 229 | 224.8 | 43.7 | 289 | 283.7 | 55.1 |
| 50 | 49.1 | 9.5 | 110 | 108.0 | 21.0 | 170 | 166.9 | 32.4 | 230 | 225.8 | 43.9 | 290 | 284.7 | 55.3 |
| 51 | 50.1 | 9.7 | 111 | 109.0 | 21.2 | 171 | 167.9 | 32.6 | 231 | 226.8 | 44.1 | 291 | 285.7 | 55.5 |
| 52 | 51.0 | 9.9 | 112 | 109.9 | 21.4 | 172 | 168.8 | 32.8 | 232 | 227.7 | 44.3 | 292 | 286.6 | 55.7 |
| 53 | 52.0 | 10.1 | 113 | 110.9 | 21.6 | 173 | 169.8 | 33.0 | 233 | 228.7 | 44.5 | 293 | 287.6 | 55.9 |
| 54 | 53.0 | 10.3 | 114 | 111.9 | 21.8 | 174 | 170.8 | 33.2 | 234 | 229.7 | 44.6 | 294 | 288.6 | 56.1 |
| 55 | 54.0 | 10.5 | 115 | 112.9 | 21.9 | 175 | 171.8 | 33.4 | 235 | 230.7 | 44.8 | 295 | 289.6 | 56.3 |
| 56 | 55.0 | 10.7 | 116 | 113.9 | 22.1 | 176 | 172.8 | 33.6 | 236 | 231.7 | 45.0 | 296 | 290.6 | 56.5 |
| 57 | 56.0 | 10.9 | 117 | 114.9 | 22.3 | 177 | 173.7 | 33.8 | 237 | 232.6 | 45.2 | 297 | 291.5 | 56.7 |
| 58 | 56.9 | 11.1 | 118 | 115.8 | 22.5 | 178 | 174.7 | 34.0 | 238 | 233.6 | 45.4 | 298 | 292.5 | 56.9 |
| 59 | 57.9 | 11.3 | 119 | 116.8 | 22.7 | 179 | 175.7 | 34.2 | 239 | 234.6 | 45.6 | 299 | 293.5 | 57.1 |
| 60 | 58.9 | 11.4 | 120 | 117.8 | 22.9 | 180 | 176.7 | 34.3 | 240 | 235.6 | 45.8 | 300 | 294.5 | 57.2 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

79° — $5^h\ 16^m$

TRAVERSE TABLE TO DEGREES

11° 0h 44m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 295·4 | 57·4 | 361 | 354·3 | 68·9 | 421 | 413·2 | 80·3 | 481 | 472·1 | 91·8 | 541 | 531·0 | 103·2 |
| 302 | 296·4 | 57·6 | 362 | 355·3 | 69·1 | 422 | 414·2 | 80·5 | 482 | 473·1 | 92·0 | 542 | 532·0 | 103·4 |
| 303 | 297·4 | 57·8 | 363 | 356·3 | 69·3 | 423 | 415·2 | 80·7 | 483 | 474·1 | 92·2 | 543 | 533·0 | 103·6 |
| 304 | 298·4 | 58·0 | 364 | 357·3 | 69·5 | 424 | 416·2 | 80·9 | 484 | 475·1 | 92·4 | 544 | 534·0 | 103·8 |
| 305 | 299·4 | 58·2 | 365 | 358·3 | 69·6 | 425 | 417·2 | 81·1 | 485 | 476·1 | 92·6 | 545 | 535·0 | 104·0 |
| 306 | 300·3 | 58·4 | 366 | 359·2 | 69·8 | 426 | 418·1 | 81·3 | 486 | 477·0 | 92·8 | 546 | 535·9 | 104·2 |
| 307 | 301·3 | 58·6 | 367 | 360·2 | 70·0 | 427 | 419·1 | 81·5 | 487 | 478·0 | 93·0 | 547 | 536·9 | 104·4 |
| 308 | 302·3 | 58·8 | 368 | 361·2 | 70·2 | 428 | 420·1 | 81·7 | 488 | 479·0 | 93·2 | 548 | 537·9 | 104·6 |
| 309 | 303·3 | 59·0 | 369 | 362·2 | 70·4 | 429 | 421·1 | 81·9 | 489 | 480·0 | 93·3 | 549 | 538·9 | 104·8 |
| 310 | 304·3 | 59·2 | 370 | 363·2 | 70·6 | 430 | 422·1 | 82·1 | 490 | 481·0 | 93·5 | 550 | 539·9 | 105·0 |
| 311 | 305·3 | 59·3 | 371 | 364·1 | 70·8 | 431 | 423·0 | 82·2 | 491 | 481·9 | 93·6 | 551 | 540·8 | 105·1 |
| 312 | 306·2 | 59·5 | 372 | 365·1 | 71·0 | 432 | 424·0 | 82·4 | 492 | 482·9 | 93·8 | 552 | 541·8 | 105·3 |
| 313 | 307·2 | 59·7 | 373 | 366·1 | 71·2 | 433 | 425·0 | 82·6 | 493 | 483·9 | 94·0 | 553 | 542·8 | 105·5 |
| 314 | 308·2 | 59·9 | 374 | 367·1 | 71·4 | 434 | 426·0 | 82·8 | 494 | 484·9 | 94·2 | 554 | 543·8 | 105·7 |
| 315 | 309·2 | 60·1 | 375 | 368·1 | 71·6 | 435 | 427·0 | 83·0 | 495 | 485·9 | 94·4 | 555 | 544·8 | 105·9 |
| 316 | 310·2 | 60·3 | 376 | 369·1 | 71·7 | 436 | 428·0 | 83·2 | 496 | 486·9 | 94·6 | 556 | 545·8 | 106·1 |
| 317 | 311·1 | 60·5 | 377 | 370·0 | 71·9 | 437 | 428·9 | 83·4 | 497 | 487·8 | 94·8 | 557 | 546·7 | 106·3 |
| 318 | 312·1 | 60·7 | 378 | 371·0 | 72·1 | 438 | 429·9 | 83·6 | 498 | 488·8 | 95·0 | 558 | 547·7 | 106·5 |
| 319 | 313·1 | 60·9 | 379 | 372·0 | 72·3 | 439 | 430·9 | 83·8 | 499 | 489·8 | 95·2 | 559 | 548·7 | 106·7 |
| 320 | 314·1 | 61·1 | 380 | 373·0 | 72·5 | 440 | 431·9 | 84·0 | 500 | 490·8 | 95·4 | 560 | 549·7 | 106·9 |
| 321 | 315·1 | 61·3 | 381 | 374·0 | 72·7 | 441 | 432·9 | 84·1 | 501 | 491·8 | 95·6 | 561 | 550·7 | 107·1 |
| 322 | 316·1 | 61·4 | 382 | 374·9 | 72·9 | 442 | 433·8 | 84·3 | 502 | 492·7 | 95·8 | 562 | 551·6 | 107·2 |
| 323 | 317·0 | 61·6 | 383 | 375·9 | 73·1 | 443 | 434·8 | 84·5 | 503 | 493·7 | 96·0 | 563 | 552·6 | 107·4 |
| 324 | 318·0 | 61·8 | 384 | 376·9 | 73·3 | 444 | 435·8 | 84·7 | 504 | 494·7 | 96·2 | 564 | 553·6 | 107·6 |
| 325 | 319·0 | 62·0 | 385 | 377·9 | 73·5 | 445 | 436·8 | 84·9 | 505 | 495·7 | 96·4 | 565 | 554·6 | 107·8 |
| 326 | 320·0 | 62·2 | 386 | 378·9 | 73·7 | 446 | 437·8 | 85·1 | 506 | 496·7 | 96·6 | 566 | 555·6 | 108·0 |
| 327 | 321·0 | 62·4 | 387 | 379·9 | 73·8 | 447 | 438·8 | 85·3 | 507 | 497·7 | 96·8 | 567 | 556·6 | 108·2 |
| 328 | 321·9 | 62·6 | 388 | 380·8 | 74·0 | 448 | 439·7 | 85·5 | 508 | 498·6 | 97·0 | 568 | 557·6 | 108·4 |
| 329 | 322·9 | 62·8 | 389 | 381·8 | 74·2 | 449 | 440·7 | 85·7 | 509 | 499·6 | 97·2 | 569 | 558·6 | 108·6 |
| 330 | 323·9 | 63·0 | 390 | 382·8 | 74·4 | 450 | 441·7 | 85·9 | 510 | 500·6 | 97·3 | 570 | 559·5 | 108·8 |
| 331 | 324·9 | 63·2 | 391 | 383·8 | 74·6 | 451 | 442·7 | 86·1 | 511 | 501·6 | 97·5 | 571 | 560·5 | 109·0 |
| 332 | 325·9 | 63·4 | 392 | 384·8 | 74·8 | 452 | 443·7 | 86·2 | 512 | 502·6 | 97·6 | 572 | 561·5 | 109·1 |
| 333 | 326·8 | 63·5 | 393 | 385·7 | 75·0 | 453 | 444·6 | 86·4 | 513 | 503·5 | 97·8 | 573 | 562·5 | 109·3 |
| 334 | 327·8 | 63·7 | 394 | 386·7 | 75·2 | 454 | 445·6 | 86·6 | 514 | 504·5 | 98·0 | 574 | 563·5 | 109·5 |
| 335 | 328·8 | 63·9 | 395 | 387·7 | 75·4 | 455 | 446·6 | 86·8 | 515 | 505·5 | 98·2 | 575 | 564·5 | 109·7 |
| 336 | 329·8 | 64·1 | 396 | 388·7 | 75·6 | 456 | 447·6 | 87·0 | 516 | 506·5 | 98·4 | 576 | 565·4 | 109·9 |
| 337 | 330·8 | 64·3 | 397 | 389·7 | 75·8 | 457 | 448·6 | 87·2 | 517 | 507·5 | 98·6 | 577 | 566·4 | 110·1 |
| 338 | 331·8 | 64·5 | 398 | 390·7 | 75·9 | 458 | 449·6 | 87·4 | 518 | 508·5 | 98·8 | 578 | 567·4 | 110·3 |
| 339 | 332·7 | 64·7 | 399 | 391·6 | 76·1 | 459 | 450·5 | 87·6 | 519 | 509·4 | 99·0 | 579 | 568·3 | 110·5 |
| 340 | 333·7 | 64·9 | 400 | 392·6 | 76·3 | 460 | 451·5 | 87·8 | 520 | 510·4 | 99·2 | 580 | 569·3 | 110·7 |
| 341 | 334·7 | 65·1 | 401 | 393·6 | 76·5 | 461 | 452·5 | 88·0 | 521 | 511·4 | 99·4 | 581 | 570·3 | 110·9 |
| 342 | 335·7 | 65·3 | 402 | 394·6 | 76·7 | 462 | 453·5 | 88·2 | 522 | 512·4 | 99·6 | 582 | 571·3 | 111·1 |
| 343 | 336·7 | 65·5 | 403 | 395·6 | 76·9 | 463 | 454·5 | 88·3 | 523 | 513·4 | 99·8 | 583 | 572·3 | 111·3 |
| 344 | 337·6 | 65·6 | 404 | 396·5 | 77·1 | 464 | 455·4 | 88·5 | 524 | 514·3 | 100·0 | 584 | 573·2 | 111·5 |
| 345 | 338·6 | 65·8 | 405 | 397·5 | 77·3 | 465 | 456·4 | 88·7 | 525 | 515·3 | 100·2 | 585 | 574·2 | 111·7 |
| 346 | 339·6 | 66·0 | 406 | 398·5 | 77·5 | 466 | 457·4 | 88·9 | 526 | 516·3 | 100·4 | 586 | 575·2 | 111·8 |
| 347 | 340·6 | 66·2 | 407 | 399·5 | 77·7 | 467 | 458·4 | 89·1 | 527 | 517·3 | 100·6 | 587 | 576·2 | 112·1 |
| 348 | 341·6 | 66·4 | 408 | 400·5 | 77·9 | 468 | 459·4 | 89·3 | 528 | 518·3 | 100·8 | 588 | 577·2 | 112·3 |
| 349 | 342·6 | 66·6 | 409 | 401·5 | 78·1 | 469 | 460·4 | 89·5 | 529 | 519·3 | 101·0 | 589 | 578·2 | 112·4 |
| 350 | 343·5 | 66·8 | 410 | 402·4 | 78·2 | 470 | 461·3 | 89·7 | 530 | 520·2 | 101·2 | 590 | 579·1 | 112·6 |
| 351 | 344·5 | 67·0 | 411 | 403·4 | 78·4 | 471 | 462·3 | 89·9 | 531 | 521·2 | 101·4 | 591 | 580·1 | 112·8 |
| 352 | 345·5 | 67·2 | 412 | 404·4 | 78·6 | 472 | 463·3 | 90·1 | 532 | 522·2 | 101·6 | 592 | 581·1 | 113·0 |
| 353 | 346·5 | 67·4 | 413 | 405·4 | 78·8 | 473 | 464·3 | 90·3 | 533 | 523·2 | 101·7 | 593 | 582·1 | 113·2 |
| 354 | 347·5 | 67·5 | 414 | 406·4 | 79·0 | 474 | 465·3 | 90·4 | 534 | 524·2 | 101·8 | 594 | 583·1 | 113·3 |
| 355 | 348·4 | 67·7 | 415 | 407·3 | 79·2 | 475 | 466·2 | 90·6 | 535 | 525·1 | 102·0 | 595 | 584·0 | 113·5 |
| 356 | 349·4 | 67·9 | 416 | 408·3 | 79·4 | 476 | 467·2 | 90·8 | 536 | 526·1 | 102·2 | 596 | 585·0 | 113·7 |
| 357 | 350·4 | 68·1 | 417 | 409·3 | 79·6 | 477 | 468·2 | 91·0 | 537 | 527·1 | 102·4 | 597 | 586·0 | 113·9 |
| 358 | 351·4 | 68·3 | 418 | 410·3 | 79·8 | 478 | 469·2 | 91·2 | 538 | 528·1 | 102·6 | 598 | 587·0 | 114·1 |
| 359 | 352·4 | 68·5 | 419 | 411·3 | 80·0 | 479 | 470·2 | 91·4 | 539 | 529·1 | 102·8 | 599 | 588·0 | 114·3 |
| 360 | 353·4 | 68·7 | 420 | 412·3 | 80·1 | 480 | 471·1 | 91·6 | 540 | 530·1 | 103·0 | 600 | 589·0 | 114·5 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

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## TRAVERSE TABLE TO DEGREES

12° 0ʰ 48ᵐ

| Dist. | D.Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1·0 | 0·2 | 61 | 59·7 | 12·7 | 121 | 118·4 | 25·2 | 181 | 177·0 | 37·6 | 241 | 235·7 | 50·1 |
| 2 | 2·0 | 0·4 | 62 | 60·6 | 12·9 | 122 | 119·3 | 25·4 | 182 | 178·0 | 37·8 | 242 | 236·7 | 50·3 |
| 3 | 2·9 | 0·6 | 63 | 61·6 | 13·1 | 123 | 120·3 | 25·6 | 183 | 179·0 | 38·0 | 243 | 237·7 | 50·5 |
| 4 | 3·9 | 0·8 | 64 | 62·6 | 13·3 | 124 | 121·3 | 25·8 | 184 | 180·0 | 38·3 | 244 | 238·7 | 50·7 |
| 5 | 4·9 | 1·0 | 65 | 63·6 | 13·5 | 125 | 122·3 | 26·0 | 185 | 181·0 | 38·5 | 245 | 239·6 | 50·9 |
| 6 | 5·9 | 1·2 | 66 | 64·6 | 13·7 | 126 | 123·2 | 26·2 | 186 | 181·9 | 38·7 | 246 | 240·6 | 51·1 |
| 7 | 6·8 | 1·5 | 67 | 65·5 | 13·9 | 127 | 124·2 | 26·4 | 187 | 182·9 | 38·9 | 247 | 241·6 | 51·4 |
| 8 | 7·8 | 1·7 | 68 | 66·5 | 14·1 | 128 | 125·2 | 26·6 | 188 | 183·9 | 39·1 | 248 | 242·6 | 51·6 |
| 9 | 8·8 | 1·9 | 69 | 67·5 | 14·3 | 129 | 126·2 | 26·8 | 189 | 184·9 | 39·3 | 249 | 243·6 | 51·8 |
| 10 | 9·8 | 2·1 | 70 | 68·5 | 14·6 | 130 | 127·2 | 27·0 | 190 | 185·8 | 39·5 | 250 | 244·5 | 52·0 |
| 11 | 10·8 | 2·3 | 71 | 69·4 | 14·8 | 131 | 128·1 | 27·2 | 191 | 186·8 | 39·7 | 251 | 245·5 | 52·2 |
| 12 | 11·7 | 2·5 | 72 | 70·4 | 15·0 | 132 | 129·1 | 27·4 | 192 | 187·8 | 39·9 | 252 | 246·5 | 52·4 |
| 13 | 12·7 | 2·7 | 73 | 71·4 | 15·2 | 133 | 130·1 | 27·7 | 193 | 188·8 | 40·1 | 253 | 247·5 | 52·6 |
| 14 | 13·7 | 2·9 | 74 | 72·4 | 15·4 | 134 | 131·1 | 27·9 | 194 | 189·8 | 40·3 | 254 | 248·4 | 52·8 |
| 15 | 14·7 | 3·1 | 75 | 73·4 | 15·6 | 135 | 132·0 | 28·1 | 195 | 190·7 | 40·5 | 255 | 249·4 | 53·0 |
| 16 | 15·7 | 3·3 | 76 | 74·3 | 15·8 | 136 | 133·0 | 28·3 | 196 | 191·7 | 40·8 | 256 | 250·4 | 53·2 |
| 17 | 16·6 | 3·5 | 77 | 75·3 | 16·0 | 137 | 134·0 | 28·5 | 197 | 192·7 | 41·0 | 257 | 251·4 | 53·4 |
| 18 | 17·6 | 3·7 | 78 | 76·3 | 16·2 | 138 | 135·0 | 28·7 | 198 | 193·7 | 41·2 | 258 | 252·4 | 53·6 |
| 19 | 18·6 | 4·0 | 79 | 77·3 | 16·4 | 139 | 136·0 | 28·9 | 199 | 194·7 | 41·4 | 259 | 253·3 | 53·8 |
| 20 | 19·6 | 4·2 | 80 | 78·3 | 16·6 | 140 | 136·9 | 29·1 | 200 | 195·6 | 41·6 | 260 | 254·3 | 54·1 |
| 21 | 20·5 | 4·4 | 81 | 79·2 | 16·8 | 141 | 137·9 | 29·3 | 201 | 196·6 | 41·8 | 261 | 255·3 | 54·3 |
| 22 | 21·5 | 4·6 | 82 | 80·2 | 17·0 | 142 | 138·9 | 29·5 | 202 | 197·6 | 42·0 | 262 | 256·3 | 54·5 |
| 23 | 22·5 | 4·8 | 83 | 81·2 | 17·3 | 143 | 139·9 | 29·7 | 203 | 198·6 | 42·2 | 263 | 257·3 | 54·7 |
| 24 | 23·5 | 5·0 | 84 | 82·2 | 17·5 | 144 | 140·9 | 29·9 | 204 | 199·5 | 42·4 | 264 | 258·2 | 54·9 |
| 25 | 24·5 | 5·2 | 85 | 83·1 | 17·7 | 145 | 141·8 | 30·1 | 205 | 200·5 | 42·6 | 265 | 259·2 | 55·1 |
| 26 | 25·4 | 5·5 | 86 | 84·1 | 17·9 | 146 | 142·8 | 30·4 | 206 | 201·5 | 42·8 | 266 | 260·2 | 55·3 |
| 27 | 26·4 | 5·6 | 87 | 85·1 | 18·1 | 147 | 143·8 | 30·6 | 207 | 202·5 | 43·0 | 267 | 261·2 | 55·5 |
| 28 | 27·4 | 5·8 | 88 | 86·1 | 18·3 | 148 | 144·8 | 30·8 | 208 | 203·5 | 43·2 | 268 | 262·1 | 55·7 |
| 29 | 28·4 | 6·0 | 89 | 87·1 | 18·5 | 149 | 145·7 | 31·0 | 209 | 204·4 | 43·5 | 269 | 263·1 | 55·9 |
| 30 | 29·3 | 6·2 | 90 | 88·0 | 18·7 | 150 | 146·7 | 31·2 | 210 | 205·4 | 43·7 | 270 | 264·1 | 56·1 |
| 31 | 30·3 | 6·4 | 91 | 89·0 | 18·9 | 151 | 147·7 | 31·4 | 211 | 206·4 | 43·9 | 271 | 265·1 | 56·3 |
| 32 | 31·3 | 6·7 | 92 | 90·0 | 19·1 | 152 | 148·7 | 31·6 | 212 | 207·4 | 44·1 | 272 | 266·1 | 56·6 |
| 33 | 32·3 | 6·9 | 93 | 91·0 | 19·3 | 153 | 149·7 | 31·8 | 213 | 208·3 | 44·3 | 273 | 267·0 | 56·8 |
| 34 | 33·3 | 7·1 | 94 | 91·9 | 19·5 | 154 | 150·6 | 32·0 | 214 | 209·3 | 44·5 | 274 | 268·0 | 57·0 |
| 35 | 34·2 | 7·3 | 95 | 92·9 | 19·8 | 155 | 151·6 | 32·2 | 215 | 210·3 | 44·7 | 275 | 269·0 | 57·2 |
| 36 | 35·2 | 7·5 | 96 | 93·9 | 20·0 | 156 | 152·6 | 32·4 | 216 | 211·3 | 44·9 | 276 | 270·0 | 57·4 |
| 37 | 36·2 | 7·7 | 97 | 94·9 | 20·2 | 157 | 153·6 | 32·6 | 217 | 212·3 | 45·1 | 277 | 270·9 | 57·6 |
| 38 | 37·2 | 7·9 | 98 | 95·9 | 20·4 | 158 | 154·5 | 32·9 | 218 | 213·2 | 45·3 | 278 | 271·9 | 57·8 |
| 39 | 38·1 | 8·1 | 99 | 96·8 | 20·6 | 159 | 155·5 | 33·1 | 219 | 214·2 | 45·5 | 279 | 272·9 | 58·0 |
| 40 | 39·1 | 8·3 | 100 | 97·8 | 20·8 | 160 | 156·5 | 33·3 | 220 | 215·2 | 45·7 | 280 | 273·9 | 58·2 |
| 41 | 40·1 | 8·5 | 101 | 98·8 | 21·0 | 161 | 157·5 | 33·5 | 221 | 216·2 | 45·9 | 281 | 274·9 | 58·4 |
| 42 | 41·1 | 8·7 | 102 | 99·8 | 21·2 | 162 | 158·5 | 33·7 | 222 | 217·1 | 46·2 | 282 | 275·8 | 58·6 |
| 43 | 42·1 | 8·9 | 103 | 100·7 | 21·4 | 163 | 159·4 | 33·9 | 223 | 218·1 | 46·4 | 283 | 276·8 | 58·8 |
| 44 | 43·0 | 9·1 | 104 | 101·7 | 21·6 | 164 | 160·4 | 34·1 | 224 | 219·1 | 46·6 | 284 | 277·8 | 59·0 |
| 45 | 44·0 | 9·4 | 105 | 102·7 | 21·8 | 165 | 161·4 | 34·3 | 225 | 220·1 | 46·8 | 285 | 278·8 | 59·3 |
| 46 | 45·0 | 9·6 | 106 | 103·7 | 22·0 | 166 | 162·4 | 34·5 | 226 | 221·1 | 47·0 | 286 | 279·8 | 59·5 |
| 47 | 46·0 | 9·8 | 107 | 104·7 | 22·2 | 167 | 163·4 | 34·7 | 227 | 222·0 | 47·2 | 287 | 280·7 | 59·7 |
| 48 | 47·0 | 10·0 | 108 | 105·6 | 22·5 | 168 | 164·3 | 34·9 | 228 | 223·0 | 47·4 | 288 | 281·7 | 59·9 |
| 49 | 47·9 | 10·2 | 109 | 106·6 | 22·7 | 169 | 165·3 | 35·1 | 229 | 224·0 | 47·6 | 289 | 282·7 | 60·1 |
| 50 | 48·9 | 10·4 | 110 | 107·6 | 22·9 | 170 | 166·3 | 35·3 | 230 | 225·0 | 47·8 | 290 | 283·7 | 60·3 |
| 51 | 49·9 | 10·6 | 111 | 108·6 | 23·1 | 171 | 167·3 | 35·6 | 231 | 226·0 | 48·0 | 291 | 284·6 | 60·5 |
| 52 | 50·9 | 10·8 | 112 | 109·6 | 23·3 | 172 | 168·2 | 35·8 | 232 | 226·9 | 48·2 | 292 | 285·6 | 60·7 |
| 53 | 51·8 | 11·0 | 113 | 110·5 | 23·5 | 173 | 169·2 | 36·0 | 233 | 227·9 | 48·4 | 293 | 286·6 | 60·9 |
| 54 | 52·8 | 11·2 | 114 | 111·5 | 23·7 | 174 | 170·2 | 36·2 | 234 | 228·9 | 48·7 | 294 | 287·6 | 61·1 |
| 55 | 53·8 | 11·4 | 115 | 112·5 | 23·9 | 175 | 171·2 | 36·4 | 235 | 229·9 | 48·9 | 295 | 288·6 | 61·3 |
| 56 | 54·8 | 11·6 | 116 | 113·5 | 24·1 | 176 | 172·2 | 36·6 | 236 | 230·8 | 49·1 | 296 | 289·5 | 61·5 |
| 57 | 55·8 | 11·9 | 117 | 114·4 | 24·3 | 177 | 173·1 | 36·8 | 237 | 231·8 | 49·3 | 297 | 290·5 | 61·7 |
| 58 | 56·7 | 12·1 | 118 | 115·4 | 24·5 | 178 | 174·1 | 37·0 | 238 | 232·8 | 49·5 | 298 | 291·5 | 62·0 |
| 59 | 57·7 | 12·3 | 119 | 116·4 | 24·7 | 179 | 175·1 | 37·2 | 239 | 233·8 | 49·7 | 299 | 292·5 | 62·2 |
| 60 | 58·7 | 12·5 | 120 | 117·4 | 24·9 | 180 | 176·1 | 37·4 | 240 | 234·8 | 49·9 | 300 | 293·4 | 62·4 |
| Dist. | Dep. | D.Lat. | Dist. | Dep. | D.Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

78° 5ʰ 12ᵐ

## TRAVERSE TABLE TO DEGREES

12° $0^h\ 48^m$

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 294·4 | 62·6 | 361 | 353·1 | 75·0 | 421 | 411·8 | 87·5 | 481 | 470·5 | 100·0 | 541 | 529·2 | 112·5 |
| 302 | 295·4 | 62·8 | 362 | 354·1 | 75·2 | 422 | 412·8 | 87·7 | 482 | 471·5 | 100·2 | 542 | 530·2 | 112·7 |
| 303 | 296·4 | 63·0 | 363 | 355·1 | 75·4 | 423 | 413·8 | 87·9 | 483 | 472·5 | 100·4 | 543 | 531·1 | 112·9 |
| 304 | 297·4 | 63·2 | 364 | 356·0 | 75·7 | 424 | 414·7 | 88·1 | 484 | 473·4 | 100·6 | 544 | 532·1 | 113·1 |
| 305 | 298·3 | 63·4 | 365 | 357·0 | 75·9 | 425 | 415·7 | 88·3 | 485 | 474·4 | 100·8 | 545 | 533·1 | 113·3 |
| 306 | 299·3 | 63·6 | 366 | 358·0 | 76·1 | 426 | 416·7 | 88·6 | 486 | 475·4 | 101·0 | 546 | 534·1 | 113·5 |
| 307 | 300·3 | 63·8 | 367 | 359·0 | 76·3 | 427 | 417·7 | 88·8 | 487 | 476·4 | 101·2 | 547 | 535·1 | 113·7 |
| 308 | 301·3 | 64·0 | 368 | 360·0 | 76·5 | 428 | 418·6 | 89·0 | 488 | 477·3 | 101·4 | 548 | 536·0 | 113·9 |
| 309 | 302·2 | 64·2 | 369 | 360·9 | 76·7 | 429 | 419·6 | 89·2 | 489 | 478·3 | 101·6 | 549 | 537·0 | 114·1 |
| 310 | 303·2 | 64·4 | 370 | 361·9 | 76·9 | 430 | 420·6 | 89·4 | 490 | 479·3 | 101·9 | 550 | 538·0 | 114·4 |
| 311 | 304·2 | 64·6 | 371 | 362·9 | 77·1 | 431 | 421·6 | 89·6 | 491 | 480·3 | 102·1 | 551 | 538·9 | 114·6 |
| 312 | 305·2 | 64·8 | 372 | 363·9 | 77·3 | 432 | 422·6 | 89·8 | 492 | 481·2 | 102·3 | 552 | 539·9 | 114·8 |
| 313 | 306·2 | 65·1 | 373 | 364·8 | 77·5 | 433 | 423·5 | 90·0 | 493 | 482·2 | 102·5 | 553 | 540·9 | 115·0 |
| 314 | 307·1 | 65·3 | 374 | 365·8 | 77·7 | 434 | 424·5 | 90·2 | 494 | 483·2 | 102·7 | 554 | 541·9 | 115·2 |
| 315 | 308·1 | 65·5 | 375 | 366·8 | 77·9 | 435 | 425·5 | 90·4 | 495 | 484·2 | 102·9 | 555 | 542·9 | 115·4 |
| 316 | 309·1 | 65·7 | 376 | 367·8 | 78·2 | 436 | 426·5 | 90·6 | 496 | 485·2 | 103·1 | 556 | 543·8 | 115·6 |
| 317 | 310·1 | 65·9 | 377 | 368·8 | 78·4 | 437 | 427·5 | 90·8 | 497 | 486·1 | 103·3 | 557 | 544·8 | 115·8 |
| 318 | 311·1 | 66·1 | 378 | 369·7 | 78·6 | 438 | 428·4 | 91·0 | 498 | 487·1 | 103·5 | 558 | 545·8 | 116·0 |
| 319 | 312·0 | 66·3 | 379 | 370·7 | 78·8 | 439 | 429·4 | 91·3 | 499 | 488·1 | 103·8 | 559 | 546·8 | 116·2 |
| 320 | 313·0 | 66·5 | 380 | 371·7 | 79·0 | 440 | 430·4 | 91·5 | 500 | 489·1 | 104·0 | 560 | 547·8 | 116·4 |
| 321 | 314·0 | 66·7 | 381 | 372·7 | 79·2 | 441 | 431·4 | 91·7 | 501 | 490·0 | 104·2 | 561 | 548·7 | 116·6 |
| 322 | 315·0 | 66·9 | 382 | 373·7 | 79·4 | 442 | 432·3 | 91·9 | 502 | 491·0 | 104·4 | 562 | 549·7 | 116·8 |
| 323 | 315·9 | 67·1 | 383 | 374·6 | 79·6 | 443 | 433·3 | 92·1 | 503 | 492·0 | 104·6 | 563 | 550·7 | 117·0 |
| 324 | 316·9 | 67·3 | 384 | 375·6 | 79·8 | 444 | 434·3 | 92·3 | 504 | 493·0 | 104·8 | 564 | 551·7 | 117·2 |
| 325 | 317·9 | 67·6 | 385 | 376·6 | 80·0 | 445 | 435·3 | 92·5 | 505 | 494·0 | 105·0 | 565 | 552·7 | 117·4 |
| 326 | 318·9 | 67·8 | 386 | 377·6 | 80·2 | 446 | 436·3 | 92·7 | 506 | 495·0 | 105·2 | 566 | 553·7 | 117·6 |
| 327 | 319·9 | 68·0 | 387 | 378·5 | 80·4 | 447 | 437·2 | 92·9 | 507 | 495·9 | 105·4 | 567 | 554·6 | 117·8 |
| 328 | 320·8 | 68·2 | 388 | 379·5 | 80·7 | 448 | 438·2 | 93·1 | 508 | 496·9 | 105·6 | 568 | 555·6 | 118·0 |
| 329 | 321·8 | 68·4 | 389 | 380·5 | 80·9 | 449 | 439·2 | 93·3 | 509 | 497·9 | 105·8 | 569 | 556·6 | 118·2 |
| 330 | 322·8 | 68·6 | 390 | 381·5 | 81·1 | 450 | 440·2 | 93·5 | 510 | 498·9 | 106·0 | 570 | 557·5 | 118·5 |
| 331 | 323·8 | 68·8 | 391 | 382·5 | 81·3 | 451 | 441·1 | 93·7 | 511 | 499·8 | 106·2 | 571 | 558·5 | 118·7 |
| 332 | 324·7 | 69·0 | 392 | 383·4 | 81·5 | 452 | 442·1 | 93·9 | 512 | 500·8 | 106·4 | 572 | 559·5 | 118·9 |
| 333 | 325·7 | 69·2 | 393 | 384·4 | 81·7 | 453 | 443·1 | 94·1 | 513 | 501·8 | 106·6 | 573 | 560·5 | 119·1 |
| 334 | 326·7 | 69·4 | 394 | 385·4 | 81·9 | 454 | 444·1 | 94·4 | 514 | 502·8 | 106·8 | 574 | 561·5 | 119·3 |
| 335 | 327·7 | 69·6 | 395 | 386·4 | 82·1 | 455 | 445·1 | 94·6 | 515 | 503·7 | 107·0 | 575 | 562·4 | 119·5 |
| 336 | 328·7 | 69·8 | 396 | 387·3 | 82·3 | 456 | 446·0 | 94·8 | 516 | 504·7 | 107·2 | 576 | 563·4 | 119·7 |
| 337 | 329·6 | 70·0 | 397 | 388·3 | 82·5 | 457 | 447·0 | 95·0 | 517 | 505·7 | 107·4 | 577 | 564·4 | 119·9 |
| 338 | 330·6 | 70·3 | 398 | 389·3 | 82·7 | 458 | 448·0 | 95·2 | 518 | 506·7 | 107·6 | 578 | 565·4 | 120·1 |
| 339 | 331·6 | 70·5 | 399 | 390·3 | 82·9 | 459 | 449·0 | 95·4 | 519 | 507·7 | 107·8 | 579 | 566·4 | 120·3 |
| 340 | 332·6 | 70·7 | 400 | 391·3 | 83·1 | 460 | 450·0 | 95·6 | 520 | 508·7 | 108·1 | 580 | 567·4 | 120·6 |
| 341 | 333·5 | 70·9 | 401 | 392·2 | 83·4 | 461 | 450·9 | 95·8 | 521 | 509·6 | 108·3 | 581 | 568·3 | 120·8 |
| 342 | 334·5 | 71·1 | 402 | 393·2 | 83·6 | 462 | 451·9 | 96·0 | 522 | 510·6 | 108·5 | 582 | 569·3 | 121·0 |
| 343 | 335·5 | 71·3 | 403 | 394·2 | 83·8 | 463 | 452·9 | 96·2 | 523 | 511·6 | 108·7 | 583 | 570·3 | 121·2 |
| 344 | 336·5 | 71·5 | 404 | 395·2 | 84·0 | 464 | 453·9 | 96·5 | 524 | 512·5 | 108·9 | 584 | 571·2 | 121·4 |
| 345 | 337·5 | 71·7 | 405 | 396·2 | 84·2 | 465 | 454·8 | 96·7 | 525 | 513·5 | 109·2 | 585 | 572·2 | 121·6 |
| 346 | 338·4 | 71·9 | 406 | 397·1 | 84·4 | 466 | 455·8 | 96·9 | 526 | 514·5 | 109·4 | 586 | 573·2 | 121·8 |
| 347 | 339·4 | 72·1 | 407 | 398·1 | 84·6 | 467 | 456·8 | 97·1 | 527 | 515·5 | 109·6 | 587 | 574·2 | 122·0 |
| 348 | 340·4 | 72·3 | 408 | 399·1 | 84·8 | 468 | 457·8 | 97·3 | 528 | 516·5 | 109·8 | 588 | 575·2 | 122·2 |
| 349 | 341·4 | 72·5 | 409 | 400·1 | 85·0 | 469 | 458·8 | 97·5 | 529 | 517·5 | 110·0 | 589 | 576·2 | 122·4 |
| 350 | 342·4 | 72·7 | 410 | 401·0 | 85·2 | 470 | 459·7 | 97·7 | 530 | 518·4 | 110·2 | 590 | 577·1 | 122·6 |
| 351 | 343·3 | 73·0 | 411 | 402·0 | 85·4 | 471 | 460·7 | 97·9 | 531 | 519·4 | 110·4 | 591 | 578·1 | 122·8 |
| 352 | 344·3 | 73·2 | 412 | 403·0 | 85·6 | 472 | 461·7 | 98·1 | 532 | 520·4 | 110·6 | 592 | 579·1 | 123·0 |
| 353 | 345·3 | 73·4 | 413 | 404·0 | 85·8 | 473 | 462·7 | 98·3 | 533 | 521·3 | 110·8 | 593 | 580·0 | 123·2 |
| 354 | 346·3 | 73·6 | 414 | 405·0 | 86·1 | 474 | 463·6 | 98·5 | 534 | 522·3 | 111·0 | 594 | 581·0 | 123·4 |
| 355 | 347·2 | 73·8 | 415 | 405·9 | 86·3 | 475 | 464·6 | 98·7 | 535 | 523·3 | 111·2 | 595 | 582·0 | 123·6 |
| 356 | 348·2 | 74·0 | 416 | 406·9 | 86·5 | 476 | 465·6 | 98·9 | 536 | 524·3 | 111·4 | 596 | 583·0 | 123·9 |
| 357 | 349·2 | 74·2 | 417 | 407·9 | 86·7 | 477 | 466·6 | 99·1 | 537 | 525·3 | 111·6 | 597 | 584·0 | 124·1 |
| 358 | 350·2 | 74·4 | 418 | 408·9 | 86·9 | 478 | 467·6 | 99·4 | 538 | 526·2 | 111·8 | 598 | 584·9 | 124·3 |
| 359 | 351·2 | 74·6 | 419 | 409·8 | 87·1 | 479 | 468·5 | 99·6 | 539 | 527·2 | 112·0 | 599 | 585·9 | 124·5 |
| 360 | 352·1 | 74·8 | 420 | 410·8 | 87·3 | 480 | 469·5 | 99·8 | 540 | 528·2 | 112·3 | 600 | 586·9 | 124·7 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

78° $5^h\ 12^m$

## TRAVERSE TABLE TO DEGREES

13° 0h 52m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0 | 0.2 | 61 | 59.4 | 13.7 | 121 | 117.9 | 27.2 | 181 | 176.4 | 40.7 | 241 | 234.8 | 54.2 |
| 2 | 1.9 | 0.4 | 62 | 60.4 | 13.9 | 122 | 118.9 | 27.4 | 182 | 177.3 | 40.9 | 242 | 235.8 | 54.4 |
| 3 | 2.9 | 0.7 | 63 | 61.4 | 14.2 | 123 | 119.8 | 27.7 | 183 | 178.3 | 41.2 | 243 | 236.8 | 54.7 |
| 4 | 3.9 | 0.9 | 64 | 62.4 | 14.4 | 124 | 120.8 | 27.9 | 184 | 179.3 | 41.4 | 244 | 237.7 | 54.9 |
| 5 | 4.9 | 1.1 | 65 | 63.3 | 14.6 | 125 | 121.8 | 28.1 | 185 | 180.3 | 41.6 | 245 | 238.7 | 55.1 |
| 6 | 5.8 | 1.3 | 66 | 64.3 | 14.8 | 126 | 122.8 | 28.3 | 186 | 181.2 | 41.8 | 246 | 239.7 | 55.3 |
| 7 | 6.8 | 1.6 | 67 | 65.3 | 15.1 | 127 | 123.7 | 28.6 | 187 | 182.2 | 42.1 | 247 | 240.7 | 55.6 |
| 8 | 7.8 | 1.8 | 68 | 66.3 | 15.3 | 128 | 124.7 | 28.8 | 188 | 183.2 | 42.3 | 248 | 241.6 | 55.8 |
| 9 | 8.8 | 2.0 | 69 | 67.2 | 15.5 | 129 | 125.7 | 29.0 | 189 | 184.2 | 42.5 | 249 | 242.6 | 56.0 |
| 10 | 9.7 | 2.2 | 70 | 68.2 | 15.7 | 130 | 126.7 | 29.2 | 190 | 185.1 | 42.7 | 250 | 243.6 | 56.2 |
| 11 | 10.7 | 2.5 | 71 | 69.2 | 16.0 | 131 | 127.6 | 29.5 | 191 | 186.1 | 43.0 | 251 | 244.6 | 56.5 |
| 12 | 11.7 | 2.7 | 72 | 70.2 | 16.2 | 132 | 128.6 | 29.7 | 192 | 187.1 | 43.2 | 252 | 245.5 | 56.7 |
| 13 | 12.7 | 2.9 | 73 | 71.1 | 16.4 | 133 | 129.6 | 29.9 | 193 | 188.1 | 43.4 | 253 | 246.5 | 56.9 |
| 14 | 13.6 | 3.1 | 74 | 72.1 | 16.6 | 134 | 130.6 | 30.1 | 194 | 189.0 | 43.6 | 254 | 247.5 | 57.1 |
| 15 | 14.6 | 3.4 | 75 | 73.1 | 16.9 | 135 | 131.5 | 30.4 | 195 | 190.0 | 43.9 | 255 | 248.5 | 57.4 |
| 16 | 15.6 | 3.6 | 76 | 74.1 | 17.1 | 136 | 132.5 | 30.6 | 196 | 191.0 | 44.1 | 256 | 249.4 | 57.6 |
| 17 | 16.6 | 3.8 | 77 | 75.0 | 17.3 | 137 | 133.5 | 30.8 | 197 | 192.0 | 44.3 | 257 | 250.4 | 57.8 |
| 18 | 17.5 | 4.0 | 78 | 76.0 | 17.5 | 138 | 134.5 | 31.0 | 198 | 192.9 | 44.5 | 258 | 251.4 | 58.0 |
| 19 | 18.5 | 4.3 | 79 | 77.0 | 17.8 | 139 | 135.4 | 31.3 | 199 | 193.9 | 44.8 | 259 | 252.4 | 58.3 |
| 20 | 19.5 | 4.5 | 80 | 78.0 | 18.0 | 140 | 136.4 | 31.5 | 200 | 194.9 | 45.0 | 260 | 253.3 | 58.5 |
| 21 | 20.5 | 4.7 | 81 | 78.9 | 18.2 | 141 | 137.4 | 31.7 | 201 | 195.8 | 45.2 | 261 | 254.3 | 58.7 |
| 22 | 21.4 | 4.9 | 82 | 79.9 | 18.4 | 142 | 138.4 | 31.9 | 202 | 196.8 | 45.4 | 262 | 255.3 | 58.9 |
| 23 | 22.4 | 5.2 | 83 | 80.9 | 18.7 | 143 | 139.3 | 32.2 | 203 | 197.8 | 45.7 | 263 | 256.3 | 59.2 |
| 24 | 23.4 | 5.4 | 84 | 81.8 | 18.9 | 144 | 140.3 | 32.4 | 204 | 198.8 | 45.9 | 264 | 257.2 | 59.4 |
| 25 | 24.4 | 5.6 | 85 | 82.8 | 19.1 | 145 | 141.3 | 32.6 | 205 | 199.7 | 46.1 | 265 | 258.2 | 59.6 |
| 26 | 25.3 | 5.8 | 86 | 83.8 | 19.3 | 146 | 142.3 | 32.8 | 206 | 200.7 | 46.3 | 266 | 259.2 | 59.8 |
| 27 | 26.3 | 6.1 | 87 | 84.8 | 19.6 | 147 | 143.2 | 33.1 | 207 | 201.7 | 46.6 | 267 | 260.2 | 60.1 |
| 28 | 27.3 | 6.3 | 88 | 85.7 | 19.8 | 148 | 144.2 | 33.3 | 208 | 202.7 | 46.8 | 268 | 261.1 | 60.3 |
| 29 | 28.3 | 6.5 | 89 | 86.7 | 20.0 | 149 | 145.2 | 33.5 | 209 | 203.6 | 47.0 | 269 | 262.1 | 60.5 |
| 30 | 29.2 | 6.7 | 90 | 87.7 | 20.2 | 150 | 146.2 | 33.7 | 210 | 204.6 | 47.2 | 270 | 263.1 | 60.7 |
| 31 | 30.2 | 7.0 | 91 | 88.7 | 20.5 | 151 | 147.1 | 34.0 | 211 | 205.6 | 47.5 | 271 | 264.1 | 61.0 |
| 32 | 31.2 | 7.2 | 92 | 89.6 | 20.7 | 152 | 148.1 | 34.2 | 212 | 206.6 | 47.7 | 272 | 265.0 | 61.2 |
| 33 | 32.2 | 7.4 | 93 | 90.6 | 20.9 | 153 | 149.1 | 34.4 | 213 | 207.5 | 47.9 | 273 | 266.0 | 61.4 |
| 34 | 33.1 | 7.6 | 94 | 91.6 | 21.1 | 154 | 150.1 | 34.6 | 214 | 208.5 | 48.1 | 274 | 267.0 | 61.6 |
| 35 | 34.1 | 7.9 | 95 | 92.6 | 21.4 | 155 | 151.0 | 34.9 | 215 | 209.5 | 48.4 | 275 | 268.0 | 61.9 |
| 36 | 35.1 | 8.1 | 96 | 93.5 | 21.6 | 156 | 152.0 | 35.1 | 216 | 210.5 | 48.6 | 276 | 268.9 | 62.1 |
| 37 | 36.1 | 8.3 | 97 | 94.5 | 21.8 | 157 | 153.0 | 35.3 | 217 | 211.4 | 48.8 | 277 | 269.9 | 62.3 |
| 38 | 37.0 | 8.5 | 98 | 95.5 | 22.0 | 158 | 154.0 | 35.5 | 218 | 212.4 | 49.0 | 278 | 270.9 | 62.5 |
| 39 | 38.0 | 8.8 | 99 | 96.5 | 22.3 | 159 | 154.9 | 35.8 | 219 | 213.4 | 49.3 | 279 | 271.8 | 62.8 |
| 40 | 39.0 | 9.0 | 100 | 97.4 | 22.5 | 160 | 155.9 | 36.0 | 220 | 214.4 | 49.5 | 280 | 272.8 | 63.0 |
| 41 | 39.9 | 9.2 | 101 | 98.4 | 22.7 | 161 | 156.9 | 36.2 | 221 | 215.3 | 49.7 | 281 | 273.8 | 63.2 |
| 42 | 40.9 | 9.4 | 102 | 99.4 | 22.9 | 162 | 157.8 | 36.4 | 222 | 216.3 | 49.9 | 282 | 274.8 | 63.4 |
| 43 | 41.9 | 9.7 | 103 | 100.4 | 23.2 | 163 | 158.8 | 36.7 | 223 | 217.3 | 50.2 | 283 | 275.7 | 63.7 |
| 44 | 42.9 | 9.9 | 104 | 101.3 | 23.4 | 164 | 159.8 | 36.9 | 224 | 218.3 | 50.4 | 284 | 276.7 | 63.9 |
| 45 | 43.8 | 10.1 | 105 | 102.3 | 23.6 | 165 | 160.8 | 37.1 | 225 | 219.2 | 50.6 | 285 | 277.7 | 64.1 |
| 46 | 44.8 | 10.3 | 106 | 103.3 | 23.8 | 166 | 161.7 | 37.3 | 226 | 220.2 | 50.8 | 286 | 278.7 | 64.3 |
| 47 | 45.8 | 10.6 | 107 | 104.3 | 24.1 | 167 | 162.7 | 37.6 | 227 | 221.2 | 51.1 | 287 | 279.6 | 64.6 |
| 48 | 46.8 | 10.8 | 108 | 105.2 | 24.3 | 168 | 163.7 | 37.8 | 228 | 222.2 | 51.3 | 288 | 280.6 | 64.8 |
| 49 | 47.7 | 11.0 | 109 | 106.2 | 24.5 | 169 | 164.7 | 38.0 | 229 | 223.1 | 51.5 | 289 | 281.6 | 65.0 |
| 50 | 48.7 | 11.2 | 110 | 107.2 | 24.7 | 170 | 165.6 | 38.2 | 230 | 224.1 | 51.7 | 290 | 282.6 | 65.2 |
| 51 | 49.7 | 11.5 | 111 | 108.2 | 25.0 | 171 | 166.6 | 38.5 | 231 | 225.1 | 52.0 | 291 | 283.5 | 65.5 |
| 52 | 50.7 | 11.7 | 112 | 109.1 | 25.2 | 172 | 167.6 | 38.7 | 232 | 226.1 | 52.2 | 292 | 284.5 | 65.7 |
| 53 | 51.6 | 11.9 | 113 | 110.1 | 25.4 | 173 | 168.6 | 38.9 | 233 | 227.0 | 52.4 | 293 | 285.5 | 65.9 |
| 54 | 52.6 | 12.1 | 114 | 111.1 | 25.6 | 174 | 169.5 | 39.1 | 234 | 228.0 | 52.6 | 294 | 286.5 | 66.1 |
| 55 | 53.6 | 12.4 | 115 | 112.1 | 25.9 | 175 | 170.5 | 39.4 | 235 | 229.0 | 52.9 | 295 | 287.4 | 66.4 |
| 56 | 54.6 | 12.6 | 116 | 113.0 | 26.1 | 176 | 171.5 | 39.6 | 236 | 230.0 | 53.1 | 296 | 288.4 | 66.6 |
| 57 | 55.5 | 12.8 | 117 | 114.0 | 26.3 | 177 | 172.5 | 39.8 | 237 | 230.9 | 53.3 | 297 | 289.4 | 66.8 |
| 58 | 56.5 | 13.0 | 118 | 115.0 | 26.5 | 178 | 173.4 | 40.0 | 238 | 231.9 | 53.5 | 298 | 290.4 | 67.0 |
| 59 | 57.5 | 13.3 | 119 | 116.0 | 26.8 | 179 | 174.4 | 40.3 | 239 | 232.9 | 53.8 | 299 | 291.3 | 67.3 |
| 60 | 58.5 | 13.5 | 120 | 116.9 | 27.0 | 180 | 175.4 | 40.5 | 240 | 233.8 | 54.0 | 300 | 292.3 | 67.5 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

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## TRAVERSE TABLE TO DEGREES

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| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 293.3 | 67.7 | 361 | 351.8 | 81.2 | 421 | 410.2 | 94.7 | 481 | 468.7 | 108.2 | 541 | 527.2 | 121.7 |
| 302 | 294.3 | 67.9 | 362 | 352.7 | 81.4 | 422 | 411.2 | 94.9 | 482 | 469.7 | 108.4 | 542 | 528.1 | 121.9 |
| 303 | 295.2 | 68.1 | 363 | 353.7 | 81.6 | 423 | 412.2 | 95.1 | 483 | 470.6 | 108.6 | 543 | 529.1 | 122.1 |
| 304 | 296.2 | 68.4 | 364 | 354.7 | 81.9 | 424 | 413.1 | 95.3 | 484 | 471.6 | 108.8 | 544 | 530.1 | 122.3 |
| 305 | 297.2 | 68.6 | 365 | 355.6 | 82.1 | 425 | 414.1 | 95.6 | 485 | 472.6 | 109.0 | 545 | 531.1 | 122.5 |
| 306 | 298.2 | 68.8 | 366 | 356.6 | 82.3 | 426 | 415.1 | 95.8 | 486 | 473.6 | 109.3 | 546 | 532.0 | 122.8 |
| 307 | 299.1 | 69.0 | 367 | 357.6 | 82.5 | 427 | 416.1 | 96.0 | 487 | 474.5 | 109.5 | 547 | 533.0 | 123.0 |
| 308 | 300.1 | 69.3 | 368 | 358.6 | 82.8 | 428 | 417.0 | 96.2 | 488 | 475.5 | 109.7 | 548 | 534.0 | 123.2 |
| 309 | 301.1 | 69.5 | 369 | 359.5 | 83.0 | 429 | 418.0 | 96.5 | 489 | 476.5 | 109.9 | 549 | 535.0 | 123.4 |
| 310 | 302.1 | 69.7 | 370 | 360.5 | 83.2 | 430 | 419.0 | 96.7 | 490 | 477.5 | 110.1 | 550 | 535.9 | 123.7 |
| 311 | 303.0 | 69.9 | 371 | 361.5 | 83.4 | 431 | 420.0 | 96.9 | 491 | 478.4 | 110.4 | 551 | 536.9 | 123.9 |
| 312 | 304.0 | 70.2 | 372 | 362.5 | 83.7 | 432 | 420.9 | 97.1 | 492 | 479.4 | 110.6 | 552 | 537.9 | 124.1 |
| 313 | 305.0 | 70.4 | 373 | 363.4 | 83.9 | 433 | 421.9 | 97.4 | 493 | 480.4 | 110.9 | 553 | 538.9 | 124.4 |
| 314 | 306.0 | 70.6 | 374 | 364.4 | 84.1 | 434 | 422.9 | 97.6 | 494 | 481.4 | 111.1 | 554 | 539.8 | 124.6 |
| 315 | 306.9 | 70.8 | 375 | 365.4 | 84.3 | 435 | 423.9 | 97.8 | 495 | 482.3 | 111.3 | 555 | 540.8 | 124.9 |
| 316 | 307.9 | 71.1 | 376 | 366.4 | 84.6 | 436 | 424.8 | 98.0 | 496 | 483.3 | 111.5 | 556 | 541.8 | 125.1 |
| 317 | 308.9 | 71.3 | 377 | 367.3 | 84.8 | 437 | 425.8 | 98.3 | 497 | 484.3 | 111.8 | 557 | 542.8 | 125.3 |
| 318 | 309.9 | 71.5 | 378 | 368.3 | 85.0 | 438 | 426.8 | 98.5 | 498 | 485.3 | 112.0 | 558 | 543.7 | 125.5 |
| 319 | 310.8 | 71.7 | 379 | 369.3 | 85.2 | 439 | 427.8 | 98.7 | 499 | 486.2 | 112.2 | 559 | 544.7 | 125.8 |
| 320 | 311.8 | 72.0 | 380 | 370.3 | 85.5 | 440 | 428.7 | 98.9 | 500 | 487.2 | 112.4 | 560 | 545.7 | 126.0 |
| 321 | 312.8 | 72.2 | 381 | 371.2 | 85.7 | 441 | 429.7 | 99.2 | 501 | 488.2 | 112.6 | 561 | 546.7 | 126.2 |
| 322 | 313.8 | 72.4 | 382 | 372.2 | 85.9 | 442 | 430.7 | 99.4 | 502 | 489.2 | 112.9 | 562 | 547.6 | 126.4 |
| 323 | 314.7 | 72.6 | 383 | 373.2 | 86.1 | 443 | 431.6 | 99.6 | 503 | 490.1 | 113.1 | 563 | 548.6 | 126.7 |
| 324 | 315.7 | 72.9 | 384 | 374.2 | 86.4 | 444 | 432.6 | 99.8 | 504 | 491.1 | 113.3 | 564 | 549.6 | 126.9 |
| 325 | 316.7 | 73.1 | 385 | 375.1 | 86.6 | 445 | 433.6 | 100.1 | 505 | 492.1 | 113.5 | 565 | 550.6 | 127.1 |
| 326 | 317.6 | 73.3 | 386 | 376.1 | 86.8 | 446 | 434.6 | 100.3 | 506 | 493.1 | 113.8 | 566 | 551.5 | 127.3 |
| 327 | 318.6 | 73.5 | 387 | 377.1 | 87.0 | 447 | 435.5 | 100.5 | 507 | 494.0 | 114.0 | 567 | 552.5 | 127.6 |
| 328 | 319.6 | 73.8 | 388 | 378.1 | 87.3 | 448 | 436.5 | 100.7 | 508 | 495.0 | 114.2 | 568 | 553.5 | 127.8 |
| 329 | 320.6 | 74.0 | 389 | 379.0 | 87.5 | 449 | 437.5 | 101.0 | 509 | 496.0 | 114.5 | 569 | 554.5 | 128.0 |
| 330 | 321.5 | 74.2 | 390 | 380.0 | 87.7 | 450 | 438.5 | 101.2 | 510 | 496.9 | 114.7 | 570 | 555.4 | 128.3 |
| 331 | 322.5 | 74.4 | 391 | 381.0 | 87.9 | 451 | 439.4 | 101.4 | 511 | 497.9 | 114.9 | 571 | 556.4 | 128.5 |
| 332 | 323.5 | 74.7 | 392 | 382.0 | 88.2 | 452 | 440.4 | 101.6 | 512 | 498.9 | 115.1 | 572 | 557.4 | 128.7 |
| 333 | 324.5 | 74.9 | 393 | 382.9 | 88.4 | 453 | 441.4 | 101.9 | 513 | 499.9 | 115.4 | 573 | 558.4 | 128.9 |
| 334 | 325.4 | 75.1 | 394 | 383.9 | 88.6 | 454 | 442.4 | 102.1 | 514 | 500.8 | 115.6 | 574 | 559.3 | 129.2 |
| 335 | 326.4 | 75.3 | 395 | 384.9 | 88.8 | 455 | 443.3 | 102.3 | 515 | 501.8 | 115.8 | 575 | 560.3 | 129.4 |
| 336 | 327.4 | 75.6 | 396 | 385.9 | 89.1 | 456 | 444.3 | 102.5 | 516 | 502.8 | 116.0 | 576 | 561.3 | 129.6 |
| 337 | 328.4 | 75.8 | 397 | 386.8 | 89.3 | 457 | 445.3 | 102.8 | 517 | 503.8 | 116.3 | 577 | 562.3 | 129.8 |
| 338 | 329.3 | 76.0 | 398 | 387.8 | 89.5 | 458 | 446.3 | 103.0 | 518 | 504.7 | 116.5 | 578 | 563.2 | 130.0 |
| 339 | 330.3 | 76.2 | 399 | 388.8 | 89.7 | 459 | 447.2 | 103.2 | 519 | 505.7 | 116.7 | 579 | 564.2 | 130.2 |
| 340 | 331.3 | 76.5 | 400 | 389.8 | 90.0 | 460 | 448.2 | 103.4 | 520 | 506.7 | 116.9 | 580 | 565.2 | 130.4 |
| 341 | 332.3 | 76.7 | 401 | 390.7 | 90.2 | 461 | 449.2 | 103.7 | 521 | 507.7 | 117.2 | 581 | 566.2 | 130.7 |
| 342 | 333.2 | 76.9 | 402 | 391.7 | 90.4 | 462 | 450.2 | 103.9 | 522 | 508.6 | 117.5 | 582 | 567.1 | 131.0 |
| 343 | 334.2 | 77.1 | 403 | 392.7 | 90.6 | 463 | 451.1 | 104.1 | 523 | 509.6 | 117.7 | 583 | 568.1 | 131.2 |
| 344 | 335.2 | 77.4 | 404 | 393.6 | 90.8 | 464 | 452.1 | 104.3 | 524 | 510.6 | 117.9 | 584 | 569.1 | 131.4 |
| 345 | 336.2 | 77.6 | 405 | 394.6 | 91.1 | 465 | 453.1 | 104.6 | 525 | 511.6 | 118.1 | 585 | 570.1 | 131.6 |
| 346 | 337.1 | 77.8 | 406 | 395.6 | 91.3 | 466 | 454.1 | 104.8 | 526 | 512.5 | 118.3 | 586 | 571.0 | 131.8 |
| 347 | 338.1 | 78.0 | 407 | 396.6 | 91.5 | 467 | 455.0 | 105.0 | 527 | 513.5 | 118.5 | 587 | 572.0 | 132.0 |
| 348 | 339.1 | 78.3 | 408 | 397.5 | 91.7 | 468 | 456.0 | 105.2 | 528 | 514.5 | 118.7 | 588 | 573.0 | 132.3 |
| 349 | 340.1 | 78.5 | 409 | 398.5 | 92.0 | 469 | 457.0 | 105.5 | 529 | 515.5 | 119.0 | 589 | 573.9 | 132.5 |
| 350 | 341.0 | 78.7 | 410 | 399.5 | 92.2 | 470 | 458.0 | 105.7 | 530 | 516.4 | 119.2 | 590 | 574.9 | 132.8 |
| 351 | 342.0 | 78.9 | 411 | 400.5 | 92.4 | 471 | 458.9 | 105.9 | 531 | 517.4 | 119.4 | 591 | 575.9 | 133.0 |
| 352 | 343.0 | 79.2 | 412 | 401.4 | 92.6 | 472 | 459.9 | 106.1 | 532 | 518.4 | 119.6 | 592 | 576.9 | 133.2 |
| 353 | 344.0 | 79.4 | 413 | 402.4 | 92.9 | 473 | 460.9 | 106.4 | 533 | 519.4 | 119.9 | 593 | 577.8 | 133.4 |
| 354 | 344.9 | 79.6 | 414 | 403.4 | 93.1 | 474 | 461.9 | 106.6 | 534 | 520.3 | 120.1 | 594 | 578.8 | 133.6 |
| 355 | 345.9 | 79.8 | 415 | 404.4 | 93.3 | 475 | 462.8 | 106.8 | 535 | 521.3 | 120.3 | 595 | 579.8 | 133.8 |
| 356 | 346.9 | 80.1 | 416 | 405.3 | 93.5 | 476 | 463.8 | 107.0 | 536 | 522.3 | 120.5 | 596 | 580.8 | 134.0 |
| 357 | 347.9 | 80.3 | 417 | 406.3 | 93.8 | 477 | 464.8 | 107.3 | 537 | 523.3 | 120.8 | 597 | 581.7 | 134.3 |
| 358 | 348.8 | 80.5 | 418 | 407.3 | 94.0 | 478 | 465.8 | 107.5 | 538 | 524.2 | 121.0 | 598 | 582.7 | 134.5 |
| 359 | 349.8 | 80.7 | 419 | 408.3 | 94.2 | 479 | 466.7 | 107.7 | 539 | 525.2 | 121.2 | 599 | 583.7 | 134.8 |
| 360 | 350.8 | 81.0 | 420 | 409.2 | 94.4 | 480 | 467.7 | 107.9 | 540 | 526.2 | 121.5 | 600 | 584.6 | 135.0 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

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## TRAVERSE TABLE TO DEGREES

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| Dist. | D.Lat | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1·0 | 0·2 | 61 | 59·4 | 13·7 | 121 | 117·9 | 27·2 | 181 | 176·4 | 40·7 | 241 | 234·8 | 54·2 |
| 2 | 1·9 | 0·4 | 62 | 60·4 | 13·9 | 122 | 118·9 | 27·4 | 182 | 177·3 | 40·9 | 242 | 235·8 | 54·4 |
| 3 | 2·9 | 0·7 | 63 | 61·4 | 14·2 | 123 | 119·8 | 27·7 | 183 | 178·3 | 41·2 | 243 | 236·8 | 54·7 |
| 4 | 3·9 | 0·9 | 64 | 62·4 | 14·4 | 124 | 120·8 | 27·9 | 184 | 179·3 | 41·4 | 244 | 237·7 | 54·9 |
| 5 | 4·9 | 1·1 | 65 | 63·3 | 14·6 | 125 | 121·8 | 28·1 | 185 | 180·3 | 41·6 | 245 | 238·7 | 55·1 |
| 6 | 5·8 | 1·3 | 66 | 64·3 | 14·8 | 126 | 122·8 | 28·3 | 186 | 181·2 | 41·8 | 246 | 239·7 | 55·3 |
| 7 | 6·8 | 1·6 | 67 | 65·3 | 15·1 | 127 | 123·7 | 28·6 | 187 | 182·2 | 42·1 | 247 | 240·7 | 55·6 |
| 8 | 7·8 | 1·8 | 68 | 66·3 | 15·3 | 128 | 124·7 | 28·8 | 188 | 183·2 | 42·3 | 248 | 241·6 | 55·8 |
| 9 | 8·8 | 2·0 | 69 | 67·2 | 15·5 | 129 | 125·7 | 29·0 | 189 | 184·2 | 42·5 | 249 | 242·6 | 56·0 |
| 10 | 9·7 | 2·2 | 70 | 68·2 | 15·7 | 130 | 126·7 | 29·2 | 190 | 185·1 | 42·7 | 250 | 243·6 | 56·2 |
| 11 | 10·7 | 2·5 | 71 | 69·2 | 16·0 | 131 | 127·6 | 29·5 | 191 | 186·1 | 43·0 | 251 | 244·6 | 56·5 |
| 12 | 11·7 | 2·7 | 72 | 70·2 | 16·2 | 132 | 128·6 | 29·7 | 192 | 187·1 | 43·2 | 252 | 245·5 | 56·7 |
| 13 | 12·7 | 2·9 | 73 | 71·1 | 16·4 | 133 | 129·6 | 29·9 | 193 | 188·1 | 43·4 | 253 | 246·5 | 56·9 |
| 14 | 13·6 | 3·1 | 74 | 72·1 | 16·6 | 134 | 130·6 | 30·1 | 194 | 189·0 | 43·6 | 254 | 247·5 | 57·1 |
| 15 | 14·6 | 3·4 | 75 | 73·1 | 16·9 | 135 | 131·5 | 30·4 | 195 | 190·0 | 43·9 | 255 | 248·5 | 57·4 |
| 16 | 15·6 | 3·6 | 76 | 74·1 | 17·1 | 136 | 132·5 | 30·6 | 196 | 191·0 | 44·1 | 256 | 249·4 | 57·6 |
| 17 | 16·6 | 3·8 | 77 | 75·0 | 17·3 | 137 | 133·5 | 30·8 | 197 | 192·0 | 44·3 | 257 | 250·4 | 57·8 |
| 18 | 17·5 | 4·0 | 78 | 76·0 | 17·5 | 138 | 134·5 | 31·0 | 198 | 192·9 | 44·5 | 258 | 251·4 | 58·0 |
| 19 | 18·5 | 4·3 | 79 | 77·0 | 17·8 | 139 | 135·4 | 31·3 | 199 | 193·9 | 44·8 | 259 | 252·4 | 58·3 |
| 20 | 19·5 | 4·5 | 80 | 78·0 | 18·0 | 140 | 136·4 | 31·5 | 200 | 194·9 | 45·0 | 260 | 253·3 | 58·5 |
| 21 | 20·5 | 4·7 | 81 | 78·9 | 18·2 | 141 | 137·4 | 31·7 | 201 | 195·8 | 45·2 | 261 | 254·3 | 58·7 |
| 22 | 21·4 | 4·9 | 82 | 79·9 | 18·4 | 142 | 138·4 | 31·9 | 202 | 196·8 | 45·4 | 262 | 255·3 | 58·9 |
| 23 | 22·4 | 5·2 | 83 | 80·9 | 18·7 | 143 | 139·3 | 32·2 | 203 | 197·8 | 45·7 | 263 | 256·3 | 59·2 |
| 24 | 23·4 | 5·4 | 84 | 81·8 | 18·9 | 144 | 140·3 | 32·4 | 204 | 198·8 | 45·9 | 264 | 257·2 | 59·4 |
| 25 | 24·4 | 5·6 | 85 | 82·8 | 19·1 | 145 | 141·3 | 32·6 | 205 | 199·7 | 46·1 | 265 | 258·2 | 59·6 |
| 26 | 25·3 | 5·8 | 86 | 83·8 | 19·3 | 146 | 142·3 | 32·8 | 206 | 200·7 | 46·3 | 266 | 259·2 | 59·8 |
| 27 | 26·3 | 6·1 | 87 | 84·8 | 19·6 | 147 | 143·2 | 33·1 | 207 | 201·7 | 46·6 | 267 | 260·2 | 60·1 |
| 28 | 27·3 | 6·3 | 88 | 85·7 | 19·8 | 148 | 144·2 | 33·3 | 208 | 202·7 | 46·8 | 268 | 261·1 | 60·3 |
| 29 | 28·3 | 6·5 | 89 | 86·7 | 20·0 | 149 | 145·2 | 33·5 | 209 | 203·6 | 47·0 | 269 | 262·1 | 60·5 |
| 30 | 29·2 | 6·7 | 90 | 87·7 | 20·2 | 150 | 146·2 | 33·7 | 210 | 204·6 | 47·2 | 270 | 263·1 | 60·7 |
| 31 | 30·2 | 7·0 | 91 | 88·7 | 20·5 | 151 | 147·1 | 34·0 | 211 | 205·6 | 47·5 | 271 | 264·1 | 61·0 |
| 32 | 31·2 | 7·2 | 92 | 89·6 | 20·7 | 152 | 148·1 | 34·2 | 212 | 206·6 | 47·7 | 272 | 265·0 | 61·2 |
| 33 | 32·2 | 7·4 | 93 | 90·6 | 20·9 | 153 | 149·1 | 34·4 | 213 | 207·5 | 47·9 | 273 | 266·0 | 61·4 |
| 34 | 33·1 | 7·6 | 94 | 91·6 | 21·1 | 154 | 150·1 | 34·6 | 214 | 208·5 | 48·1 | 274 | 267·0 | 61·6 |
| 35 | 34·1 | 7·9 | 95 | 92·6 | 21·4 | 155 | 151·0 | 34·9 | 215 | 209·5 | 48·4 | 275 | 268·0 | 61·9 |
| 36 | 35·1 | 8·1 | 96 | 93·5 | 21·6 | 156 | 152·0 | 35·1 | 216 | 210·5 | 48·6 | 276 | 268·9 | 62·1 |
| 37 | 36·1 | 8·3 | 97 | 94·5 | 21·8 | 157 | 153·0 | 35·3 | 217 | 211·4 | 48·8 | 277 | 269·9 | 62·3 |
| 38 | 37·0 | 8·5 | 98 | 95·5 | 22·0 | 158 | 154·0 | 35·5 | 218 | 212·4 | 49·0 | 278 | 270·9 | 62·5 |
| 39 | 38·0 | 8·8 | 99 | 96·5 | 22·3 | 159 | 154·9 | 35·8 | 219 | 213·4 | 49·3 | 279 | 271·8 | 62·8 |
| 40 | 39·0 | 9·0 | 100 | 97·4 | 22·5 | 160 | 155·9 | 36·0 | 220 | 214·4 | 49·5 | 280 | 272·8 | 63·0 |
| 41 | 39·9 | 9·2 | 101 | 98·4 | 22·7 | 161 | 156·9 | 36·2 | 221 | 215·3 | 49·7 | 281 | 273·8 | 63·2 |
| 42 | 40·9 | 9·4 | 102 | 99·4 | 22·9 | 162 | 157·8 | 36·4 | 222 | 216·3 | 49·9 | 282 | 274·8 | 63·4 |
| 43 | 41·9 | 9·7 | 103 | 100·4 | 23·2 | 163 | 158·8 | 36·7 | 223 | 217·3 | 50·2 | 283 | 275·7 | 63·7 |
| 44 | 42·9 | 9·9 | 104 | 101·3 | 23·4 | 164 | 159·8 | 36·9 | 224 | 218·3 | 50·4 | 284 | 276·7 | 63·9 |
| 45 | 43·8 | 10·1 | 105 | 102·3 | 23·6 | 165 | 160·8 | 37·1 | 225 | 219·2 | 50·6 | 285 | 277·7 | 64·1 |
| 46 | 44·8 | 10·3 | 106 | 103·3 | 23·8 | 166 | 161·7 | 37·3 | 226 | 220·2 | 50·8 | 286 | 278·7 | 64·3 |
| 47 | 45·8 | 10·6 | 107 | 104·3 | 24·1 | 167 | 162·7 | 37·6 | 227 | 221·2 | 51·1 | 287 | 279·6 | 64·6 |
| 48 | 46·8 | 10·8 | 108 | 105·2 | 24·3 | 168 | 163·7 | 37·8 | 228 | 222·2 | 51·3 | 288 | 280·6 | 64·8 |
| 49 | 47·7 | 11·0 | 109 | 106·2 | 24·5 | 169 | 164·7 | 38·0 | 229 | 223·1 | 51·5 | 289 | 281·6 | 65·0 |
| 50 | 48·7 | 11·2 | 110 | 107·2 | 24·7 | 170 | 165·6 | 38·2 | 230 | 224·1 | 51·7 | 290 | 282·6 | 65·2 |
| 51 | 49·7 | 11·5 | 111 | 108·2 | 25·0 | 171 | 166·6 | 38·5 | 231 | 225·1 | 52·0 | 291 | 283·5 | 65·5 |
| 52 | 50·7 | 11·7 | 112 | 109·1 | 25·2 | 172 | 167·6 | 38·7 | 232 | 226·1 | 52·2 | 292 | 284·5 | 65·7 |
| 53 | 51·6 | 11·9 | 113 | 110·1 | 25·4 | 173 | 168·6 | 38·9 | 233 | 227·0 | 52·4 | 293 | 285·5 | 65·9 |
| 54 | 52·6 | 12·1 | 114 | 111·1 | 25·6 | 174 | 169·5 | 39·1 | 234 | 228·0 | 52·6 | 294 | 286·5 | 66·1 |
| 55 | 53·6 | 12·4 | 115 | 112·1 | 25·9 | 175 | 170·5 | 39·4 | 235 | 229·0 | 52·9 | 295 | 287·4 | 66·4 |
| 56 | 54·6 | 12·6 | 116 | 113·0 | 26·1 | 176 | 171·5 | 39·6 | 236 | 230·0 | 53·1 | 296 | 288·4 | 66·6 |
| 57 | 55·5 | 12·8 | 117 | 114·0 | 26·3 | 177 | 172·5 | 39·8 | 237 | 230·9 | 53·3 | 297 | 289·4 | 66·8 |
| 58 | 56·5 | 13·0 | 118 | 115·0 | 26·5 | 178 | 173·4 | 40·0 | 238 | 231·9 | 53·5 | 298 | 290·4 | 67·0 |
| 59 | 57·5 | 13·3 | 119 | 116·0 | 26·8 | 179 | 174·4 | 40·3 | 239 | 232·9 | 53·8 | 299 | 291·3 | 67·3 |
| 60 | 58·5 | 13·5 | 120 | 116·9 | 27·0 | 180 | 175·4 | 40·5 | 240 | 233·8 | 54·0 | 300 | 292·3 | 67·5 |
| Dist. | Dep. | D.Lat | Dist. | Dep. | D.Lat | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

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## TRAVERSE TABLE TO DEGREES

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| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 293·3 | 67·7 | 361 | 351·8 | 81·2 | 421 | 410·2 | 94·7 | 481 | 468·7 | 108·2 | 541 | 527·2 | 121·7 |
| 302 | 294·3 | 67·9 | 362 | 352·7 | 81·4 | 422 | 411·2 | 94·9 | 482 | 469·7 | 108·4 | 542 | 528·1 | 121·9 |
| 303 | 295·2 | 68·1 | 363 | 353·7 | 81·6 | 423 | 412·2 | 95·1 | 483 | 470·6 | 108·6 | 543 | 529·1 | 122·1 |
| 304 | 296·2 | 68·4 | 364 | 354·7 | 81·9 | 424 | 413·1 | 95·3 | 484 | 471·6 | 108·8 | 544 | 530·1 | 122·3 |
| 305 | 297·2 | 68·6 | 365 | 355·6 | 82·1 | 425 | 414·1 | 95·6 | 485 | 472·6 | 109·0 | 545 | 531·1 | 122·5 |
| 306 | 298·2 | 68·8 | 366 | 356·6 | 82·3 | 426 | 415·1 | 95·8 | 486 | 473·6 | 109·3 | 546 | 532·0 | 122·8 |
| 307 | 299·1 | 69·0 | 367 | 357·6 | 82·5 | 427 | 416·1 | 96·0 | 487 | 474·5 | 109·5 | 547 | 533·0 | 123·0 |
| 308 | 300·1 | 69·3 | 368 | 358·6 | 82·8 | 428 | 417·0 | 96·2 | 488 | 475·5 | 109·7 | 548 | 534·0 | 123·2 |
| 309 | 301·1 | 69·5 | 369 | 359·5 | 83·0 | 429 | 418·0 | 96·5 | 489 | 476·5 | 109·9 | 549 | 535·0 | 123·4 |
| 310 | 302·1 | 69·7 | 370 | 360·5 | 83·2 | 430 | 419·0 | 96·7 | 490 | 477·5 | 110·1 | 550 | 535·9 | 123·7 |
| 311 | 303·0 | 69·9 | 371 | 361·5 | 83·4 | 431 | 420·0 | 96·9 | 491 | 478·4 | 110·4 | 551 | 536·9 | 123·9 |
| 312 | 304·0 | 70·2 | 372 | 362·5 | 83·7 | 432 | 420·9 | 97·1 | 492 | 479·4 | 110·6 | 552 | 537·9 | 124·1 |
| 313 | 305·0 | 70·4 | 373 | 363·4 | 83·9 | 433 | 421·9 | 97·4 | 493 | 480·4 | 110·9 | 553 | 538·9 | 124·4 |
| 314 | 306·0 | 70·6 | 374 | 364·4 | 84·1 | 434 | 422·9 | 97·6 | 494 | 481·4 | 111·1 | 554 | 539·8 | 124·6 |
| 315 | 306·9 | 70·8 | 375 | 365·4 | 84·3 | 435 | 423·9 | 97·8 | 495 | 482·3 | 111·3 | 555 | 540·8 | 124·9 |
| 316 | 307·9 | 71·1 | 376 | 366·4 | 84·6 | 436 | 424·8 | 98·0 | 496 | 483·3 | 111·5 | 556 | 541·8 | 125·1 |
| 317 | 308·9 | 71·3 | 377 | 367·3 | 84·8 | 437 | 425·8 | 98·3 | 497 | 484·3 | 111·8 | 557 | 542·8 | 125·3 |
| 318 | 309·9 | 71·5 | 378 | 368·3 | 85·0 | 438 | 426·8 | 98·5 | 498 | 485·3 | 112·0 | 558 | 543·7 | 125·5 |
| 319 | 310·8 | 71·7 | 379 | 369·3 | 85·2 | 439 | 427·8 | 98·7 | 499 | 486·2 | 112·2 | 559 | 544·7 | 125·8 |
| 320 | 311·8 | 72·0 | 380 | 370·3 | 85·5 | 440 | 428·7 | 98·9 | 500 | 487·2 | 112·4 | 560 | 545·7 | 126·0 |
| 321 | 312·8 | 72·2 | 381 | 371·2 | 85·7 | 441 | 429·7 | 99·2 | 501 | 488·2 | 112·6 | 561 | 546·7 | 126·2 |
| 322 | 313·8 | 72·4 | 382 | 372·2 | 85·9 | 442 | 430·7 | 99·4 | 502 | 489·2 | 112·9 | 562 | 547·6 | 126·4 |
| 323 | 314·7 | 72·6 | 383 | 373·2 | 86·1 | 443 | 431·6 | 99·6 | 503 | 490·1 | 113·1 | 563 | 548·6 | 126·7 |
| 324 | 315·7 | 72·9 | 384 | 374·2 | 86·4 | 444 | 432·6 | 99·8 | 504 | 491·1 | 113·3 | 564 | 549·6 | 126·9 |
| 325 | 316·7 | 73·1 | 385 | 375·1 | 86·6 | 445 | 433·6 | 100·1 | 505 | 492·1 | 113·5 | 565 | 550·6 | 127·1 |
| 326 | 317·6 | 73·3 | 386 | 376·1 | 86·8 | 446 | 434·6 | 100·3 | 506 | 493·1 | 113·8 | 566 | 551·5 | 127·3 |
| 327 | 318·6 | 73·5 | 387 | 377·1 | 87·0 | 447 | 435·5 | 100·5 | 507 | 494·0 | 114·0 | 567 | 552·5 | 127·6 |
| 328 | 319·6 | 73·8 | 388 | 378·1 | 87·3 | 448 | 436·5 | 100·7 | 508 | 495·0 | 114·2 | 568 | 553·5 | 127·8 |
| 329 | 320·6 | 74·0 | 389 | 379·0 | 87·5 | 449 | 437·5 | 101·0 | 509 | 496·0 | 114·5 | 569 | 554·5 | 128·0 |
| 330 | 321·5 | 74·2 | 390 | 380·0 | 87·7 | 450 | 438·5 | 101·2 | 510 | 496·9 | 114·7 | 570 | 555·4 | 128·3 |
| 331 | 322·5 | 74·4 | 391 | 381·0 | 87·9 | 451 | 439·4 | 101·4 | 511 | 497·9 | 114·9 | 571 | 556·4 | 128·5 |
| 332 | 323·5 | 74·7 | 392 | 382·0 | 88·2 | 452 | 440·4 | 101·6 | 512 | 498·9 | 115·1 | 572 | 557·4 | 128·7 |
| 333 | 324·5 | 74·9 | 393 | 382·9 | 88·4 | 453 | 441·4 | 101·9 | 513 | 499·9 | 115·4 | 573 | 558·4 | 128·9 |
| 334 | 325·4 | 75·1 | 394 | 383·9 | 88·6 | 454 | 442·4 | 102·1 | 514 | 500·8 | 115·6 | 574 | 559·3 | 129·2 |
| 335 | 326·4 | 75·3 | 395 | 384·9 | 88·8 | 455 | 443·3 | 102·3 | 515 | 501·8 | 115·8 | 575 | 560·3 | 129·4 |
| 336 | 327·4 | 75·6 | 396 | 385·9 | 89·1 | 456 | 444·3 | 102·5 | 516 | 502·8 | 116·0 | 576 | 561·3 | 129·6 |
| 337 | 328·4 | 75·8 | 397 | 386·8 | 89·3 | 457 | 445·3 | 102·8 | 517 | 503·8 | 116·3 | 577 | 562·3 | 129·8 |
| 338 | 329·3 | 76·0 | 398 | 387·8 | 89·5 | 458 | 446·3 | 103·0 | 518 | 504·7 | 116·5 | 578 | 563·2 | 130·0 |
| 339 | 330·3 | 76·2 | 399 | 388·8 | 89·7 | 459 | 447·2 | 103·2 | 519 | 505·7 | 116·7 | 579 | 564·2 | 130·2 |
| 340 | 331·3 | 76·5 | 400 | 389·8 | 90·0 | 460 | 448·2 | 103·4 | 520 | 506·7 | 116·9 | 580 | 565·2 | 130·4 |
| 341 | 332·3 | 76·7 | 401 | 390·7 | 90·2 | 461 | 449·2 | 103·7 | 521 | 507·7 | 117·2 | 581 | 566·2 | 130·7 |
| 342 | 333·2 | 76·9 | 402 | 391·7 | 90·4 | 462 | 450·2 | 103·9 | 522 | 508·6 | 117·5 | 582 | 567·1 | 131·0 |
| 343 | 334·2 | 77·1 | 403 | 392·7 | 90·6 | 463 | 451·1 | 104·1 | 523 | 509·6 | 117·7 | 583 | 568·1 | 131·2 |
| 344 | 335·2 | 77·4 | 404 | 393·6 | 90·8 | 464 | 452·1 | 104·3 | 524 | 510·6 | 117·9 | 584 | 569·1 | 131·4 |
| 345 | 336·2 | 77·6 | 405 | 394·6 | 91·1 | 465 | 453·1 | 104·6 | 525 | 511·6 | 118·1 | 585 | 570·1 | 131·6 |
| 346 | 337·1 | 77·8 | 406 | 395·6 | 91·3 | 466 | 454·1 | 104·8 | 526 | 512·5 | 118·3 | 586 | 571·0 | 131·8 |
| 347 | 338·1 | 78·0 | 407 | 396·6 | 91·5 | 467 | 455·0 | 105·0 | 527 | 513·5 | 118·5 | 587 | 572·0 | 132·0 |
| 348 | 339·1 | 78·3 | 408 | 397·5 | 91·7 | 468 | 456·0 | 105·2 | 528 | 514·5 | 118·7 | 588 | 573·0 | 132·3 |
| 349 | 340·1 | 78·5 | 409 | 398·5 | 92·0 | 469 | 457·0 | 105·5 | 529 | 515·5 | 119·0 | 589 | 573·9 | 132·5 |
| 350 | 341·0 | 78·7 | 410 | 399·5 | 92·2 | 470 | 458·0 | 105·7 | 530 | 516·4 | 119·2 | 590 | 574·9 | 132·8 |
| 351 | 342·0 | 78·9 | 411 | 400·5 | 92·4 | 471 | 458·9 | 105·9 | 531 | 517·4 | 119·4 | 591 | 575·9 | 133·0 |
| 352 | 343·0 | 79·2 | 412 | 401·4 | 92·6 | 472 | 459·9 | 106·1 | 532 | 518·4 | 119·6 | 592 | 576·9 | 133·2 |
| 353 | 344·0 | 79·4 | 413 | 402·4 | 92·9 | 473 | 460·9 | 106·4 | 533 | 519·4 | 119·9 | 593 | 577·8 | 133·4 |
| 354 | 344·9 | 79·6 | 414 | 403·4 | 93·1 | 474 | 461·9 | 106·6 | 534 | 520·3 | 120·1 | 594 | 578·8 | 133·6 |
| 355 | 345·9 | 79·8 | 415 | 404·4 | 93·3 | 475 | 462·8 | 106·8 | 535 | 521·3 | 120·3 | 595 | 579·8 | 133·8 |
| 356 | 346·9 | 80·1 | 416 | 405·3 | 93·5 | 476 | 463·8 | 107·0 | 536 | 522·3 | 120·5 | 596 | 580·8 | 134·0 |
| 357 | 347·9 | 80·3 | 417 | 406·3 | 93·8 | 477 | 464·8 | 107·3 | 537 | 523·3 | 120·8 | 597 | 581·7 | 134·3 |
| 358 | 348·8 | 80·5 | 418 | 407·3 | 94·0 | 478 | 465·8 | 107·5 | 538 | 524·2 | 121·0 | 598 | 582·7 | 134·5 |
| 359 | 349·8 | 80·7 | 419 | 408·3 | 94·2 | 479 | 466·7 | 107·7 | 539 | 525·2 | 121·2 | 599 | 583·7 | 134·8 |
| 360 | 350·8 | 81·0 | 420 | 409·2 | 94·4 | 480 | 467·7 | 107·9 | 540 | 526·2 | 121·5 | 600 | 584·6 | 135·0 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

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## TRAVERSE TABLE TO DEGREES

**14°** — **$0^h\ 56^m$**

| Dist. | D.Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0 | 0.2 | 61 | 59.2 | 14.8 | 121 | 117.4 | 29.3 | 181 | 175.6 | 43.8 | 241 | 233.8 | 58.3 |
| 2 | 1.9 | 0.5 | 62 | 60.2 | 15.0 | 122 | 118.4 | 29.5 | 182 | 176.6 | 44.0 | 242 | 234.8 | 58.5 |
| 3 | 2.9 | 0.7 | 63 | 61.1 | 15.2 | 123 | 119.3 | 29.8 | 183 | 177.6 | 44.3 | 243 | 235.8 | 58.8 |
| 4 | 3.9 | 1.0 | 64 | 62.1 | 15.5 | 124 | 120.3 | 30.0 | 184 | 178.5 | 44.5 | 244 | 236.8 | 59.0 |
| 5 | 4.9 | 1.2 | 65 | 63.1 | 15.7 | 125 | 121.3 | 30.2 | 185 | 179.5 | 44.8 | 245 | 237.7 | 59.3 |
| 6 | 5.8 | 1.5 | 66 | 64.0 | 16.0 | 126 | 122.3 | 30.5 | 186 | 180.5 | 45.0 | 246 | 238.7 | 59.5 |
| 7 | 6.8 | 1.7 | 67 | 65.0 | 16.2 | 127 | 123.2 | 30.7 | 187 | 181.4 | 45.2 | 247 | 239.7 | 59.8 |
| 8 | 7.8 | 1.9 | 68 | 66.0 | 16.5 | 128 | 124.2 | 31.0 | 188 | 182.4 | 45.5 | 248 | 240.6 | 60.0 |
| 9 | 8.7 | 2.2 | 69 | 67.0 | 16.7 | 129 | 125.2 | 31.2 | 189 | 183.4 | 45.7 | 249 | 241.6 | 60.2 |
| 10 | 9.7 | 2.4 | 70 | 67.9 | 16.9 | 130 | 126.1 | 31.4 | 190 | 184.4 | 46.0 | 250 | 242.6 | 60.5 |
| 11 | 10.7 | 2.7 | 71 | 68.9 | 17.2 | 131 | 127.1 | 31.7 | 191 | 185.3 | 46.2 | 251 | 243.5 | 60.7 |
| 12 | 11.6 | 2.9 | 72 | 69.9 | 17.4 | 132 | 128.1 | 31.9 | 192 | 186.3 | 46.4 | 252 | 244.5 | 61.0 |
| 13 | 12.6 | 3.1 | 73 | 70.8 | 17.7 | 133 | 129.0 | 32.2 | 193 | 187.3 | 46.7 | 253 | 245.5 | 61.2 |
| 14 | 13.6 | 3.4 | 74 | 71.8 | 17.9 | 134 | 130.0 | 32.4 | 194 | 188.2 | 46.9 | 254 | 246.5 | 61.4 |
| 15 | 14.6 | 3.6 | 75 | 72.8 | 18.1 | 135 | 131.0 | 32.7 | 195 | 189.2 | 47.2 | 255 | 247.4 | 61.7 |
| 16 | 15.5 | 3.9 | 76 | 73.7 | 18.4 | 136 | 132.0 | 32.9 | 196 | 190.2 | 47.4 | 256 | 248.4 | 61.9 |
| 17 | 16.5 | 4.1 | 77 | 74.7 | 18.6 | 137 | 132.9 | 33.1 | 197 | 191.1 | 47.7 | 257 | 249.4 | 62.2 |
| 18 | 17.5 | 4.4 | 78 | 75.7 | 18.9 | 138 | 133.9 | 33.4 | 198 | 192.1 | 47.9 | 258 | 250.3 | 62.4 |
| 19 | 18.4 | 4.6 | 79 | 76.7 | 19.1 | 139 | 134.9 | 33.6 | 199 | 193.1 | 48.1 | 259 | 251.3 | 62.7 |
| 20 | 19.4 | 4.8 | 80 | 77.6 | 19.4 | 140 | 135.8 | 33.9 | 200 | 194.1 | 48.4 | 260 | 252.3 | 62.9 |
| 21 | 20.4 | 5.1 | 81 | 78.6 | 19.6 | 141 | 136.8 | 34.1 | 201 | 195.0 | 48.6 | 261 | 253.2 | 63.1 |
| 22 | 21.3 | 5.3 | 82 | 79.6 | 19.8 | 142 | 137.8 | 34.4 | 202 | 196.0 | 48.9 | 262 | 254.2 | 63.4 |
| 23 | 22.3 | 5.6 | 83 | 80.5 | 20.1 | 143 | 138.8 | 34.6 | 203 | 197.0 | 49.1 | 263 | 255.2 | 63.6 |
| 24 | 23.3 | 5.8 | 84 | 81.5 | 20.3 | 144 | 139.7 | 34.8 | 204 | 197.9 | 49.4 | 264 | 256.2 | 63.9 |
| 25 | 24.3 | 6.0 | 85 | 82.5 | 20.6 | 145 | 140.7 | 35.1 | 205 | 198.9 | 49.6 | 265 | 257.1 | 64.1 |
| 26 | 25.2 | 6.3 | 86 | 83.4 | 20.8 | 146 | 141.7 | 35.3 | 206 | 199.9 | 49.8 | 266 | 258.1 | 64.4 |
| 27 | 26.2 | 6.5 | 87 | 84.4 | 21.0 | 147 | 142.6 | 35.6 | 207 | 200.9 | 50.1 | 267 | 259.1 | 64.6 |
| 28 | 27.2 | 6.8 | 88 | 85.4 | 21.3 | 148 | 143.6 | 35.8 | 208 | 201.8 | 50.3 | 268 | 260.0 | 64.8 |
| 29 | 28.1 | 7.0 | 89 | 86.4 | 21.5 | 149 | 144.6 | 36.0 | 209 | 202.8 | 50.6 | 269 | 261.0 | 65.1 |
| 30 | 29.1 | 7.3 | 90 | 87.3 | 21.8 | 150 | 145.5 | 36.3 | 210 | 203.8 | 50.8 | 270 | 262.0 | 65.3 |
| 31 | 30.1 | 7.5 | 91 | 88.3 | 22.0 | 151 | 146.5 | 36.5 | 211 | 204.7 | 51.0 | 271 | 263.0 | 65.6 |
| 32 | 31.0 | 7.7 | 92 | 89.3 | 22.3 | 152 | 147.5 | 36.8 | 212 | 205.7 | 51.3 | 272 | 263.9 | 65.8 |
| 33 | 32.0 | 8.0 | 93 | 90.2 | 22.5 | 153 | 148.5 | 37.0 | 213 | 206.7 | 51.5 | 273 | 264.9 | 66.0 |
| 34 | 33.0 | 8.2 | 94 | 91.2 | 22.7 | 154 | 149.4 | 37.3 | 214 | 207.6 | 51.8 | 274 | 265.9 | 66.3 |
| 35 | 34.0 | 8.5 | 95 | 92.2 | 23.0 | 155 | 150.4 | 37.5 | 215 | 208.6 | 52.0 | 275 | 266.8 | 66.5 |
| 36 | 34.9 | 8.7 | 96 | 93.1 | 23.2 | 156 | 151.4 | 37.7 | 216 | 209.6 | 52.3 | 276 | 267.8 | 66.8 |
| 37 | 35.9 | 9.0 | 97 | 94.1 | 23.5 | 157 | 152.3 | 38.0 | 217 | 210.6 | 52.5 | 277 | 268.8 | 67.0 |
| 38 | 36.9 | 9.2 | 98 | 95.1 | 23.7 | 158 | 153.3 | 38.2 | 218 | 211.5 | 52.7 | 278 | 269.7 | 67.3 |
| 39 | 37.8 | 9.4 | 99 | 96.1 | 24.0 | 159 | 154.3 | 38.5 | 219 | 212.5 | 53.0 | 279 | 270.7 | 67.5 |
| 40 | 38.8 | 9.7 | 100 | 97.0 | 24.2 | 160 | 155.2 | 38.7 | 220 | 213.5 | 53.2 | 280 | 271.7 | 67.7 |
| 41 | 39.8 | 9.9 | 101 | 98.0 | 24.4 | 161 | 156.2 | 38.9 | 221 | 214.4 | 53.5 | 281 | 272.7 | 68.0 |
| 42 | 40.8 | 10.2 | 102 | 99.0 | 24.7 | 162 | 157.2 | 39.2 | 222 | 215.4 | 53.7 | 282 | 273.6 | 68.2 |
| 43 | 41.7 | 10.4 | 103 | 99.9 | 24.9 | 163 | 158.2 | 39.4 | 223 | 216.4 | 53.9 | 283 | 274.6 | 68.5 |
| 44 | 42.7 | 10.6 | 104 | 100.9 | 25.2 | 164 | 159.1 | 39.7 | 224 | 217.3 | 54.2 | 284 | 275.6 | 68.7 |
| 45 | 43.7 | 10.9 | 105 | 101.9 | 25.4 | 165 | 160.1 | 39.9 | 225 | 218.3 | 54.4 | 285 | 276.5 | 68.9 |
| 46 | 44.6 | 11.1 | 106 | 102.9 | 25.6 | 166 | 161.1 | 40.2 | 226 | 219.3 | 54.7 | 286 | 277.5 | 69.2 |
| 47 | 45.6 | 11.4 | 107 | 103.8 | 25.9 | 167 | 162.0 | 40.4 | 227 | 220.3 | 54.9 | 287 | 278.5 | 69.4 |
| 48 | 46.6 | 11.6 | 108 | 104.8 | 26.1 | 168 | 163.0 | 40.6 | 228 | 221.2 | 55.2 | 288 | 279.4 | 69.7 |
| 49 | 47.5 | 11.9 | 109 | 105.8 | 26.4 | 169 | 164.0 | 40.9 | 229 | 222.2 | 55.4 | 289 | 280.4 | 69.9 |
| 50 | 48.5 | 12.1 | 110 | 106.7 | 26.6 | 170 | 165.0 | 41.1 | 230 | 223.2 | 55.6 | 290 | 281.4 | 70.2 |
| 51 | 49.5 | 12.3 | 111 | 107.7 | 26.9 | 171 | 165.9 | 41.4 | 231 | 224.1 | 55.9 | 291 | 282.4 | 70.4 |
| 52 | 50.5 | 12.6 | 112 | 108.7 | 27.1 | 172 | 166.9 | 41.6 | 232 | 225.1 | 56.1 | 292 | 283.3 | 70.6 |
| 53 | 51.4 | 12.8 | 113 | 109.6 | 27.3 | 173 | 167.9 | 41.9 | 233 | 226.1 | 56.4 | 293 | 284.3 | 70.9 |
| 54 | 52.4 | 13.1 | 114 | 110.6 | 27.6 | 174 | 168.8 | 42.1 | 234 | 227.0 | 56.6 | 294 | 285.3 | 71.1 |
| 55 | 53.4 | 13.3 | 115 | 111.6 | 27.8 | 175 | 169.8 | 42.3 | 235 | 228.0 | 56.9 | 295 | 286.2 | 71.4 |
| 56 | 54.3 | 13.5 | 116 | 112.6 | 28.1 | 176 | 170.8 | 42.6 | 236 | 229.0 | 57.1 | 296 | 287.2 | 71.6 |
| 57 | 55.3 | 13.8 | 117 | 113.5 | 28.3 | 177 | 171.7 | 42.8 | 237 | 230.0 | 57.3 | 297 | 288.2 | 71.9 |
| 58 | 56.3 | 14.0 | 118 | 114.5 | 28.5 | 178 | 172.7 | 43.1 | 238 | 230.9 | 57.6 | 298 | 289.1 | 72.1 |
| 59 | 57.2 | 14.3 | 119 | 115.5 | 28.8 | 179 | 173.7 | 43.3 | 239 | 231.9 | 57.8 | 299 | 290.1 | 72.3 |
| 60 | 58.2 | 14.5 | 120 | 116.4 | 29.0 | 180 | 174.7 | 43.5 | 240 | 232.9 | 58.1 | 300 | 291.1 | 72.6 |
| Dist. | Dep. | D.Lat. | Dist. | Dep. | D.Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

**76°** — **$5^h\ 4^m$**

## TRAVERSE TABLE TO DEGREES

14° $0^h\ 56^m$

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 292·0 | 72·8 | 361 | 350·2 | 87·3 | 421 | 408·5 | 101·8 | 481 | 466·7 | 116·3 | 541 | 525·0 | 130·9 |
| 302 | 293·0 | 73·0 | 362 | 351·2 | 87·6 | 422 | 409·4 | 102·1 | 482 | 467·7 | 116·6 | 542 | 525·9 | 131·2 |
| 303 | 294·0 | 73·3 | 363 | 352·2 | 87·8 | 423 | 410·4 | 102·3 | 483 | 468·6 | 116·8 | 543 | 526·9 | 131·4 |
| 304 | 294·9 | 73·5 | 364 | 353·2 | 88·0 | 424 | 411·4 | 102·6 | 484 | 469·6 | 117·1 | 544 | 527·9 | 131·6 |
| 305 | 295·9 | 73·8 | 365 | 354·1 | 88·3 | 425 | 412·3 | 102·8 | 485 | 470·6 | 117·3 | 545 | 528·8 | 131·9 |
| 306 | 296·9 | 74·0 | 366 | 355·1 | 88·5 | 426 | 413·3 | 103·0 | 486 | 471·5 | 117·6 | 546 | 529·8 | 132·1 |
| 307 | 297·8 | 74·2 | 367 | 356·1 | 88·8 | 427 | 414·3 | 103·3 | 487 | 472·5 | 117·8 | 547 | 530·8 | 132·3 |
| 308 | 298·8 | 74·5 | 368 | 357·0 | 89·0 | 428 | 415·3 | 103·5 | 488 | 473·5 | 118·0 | 548 | 531·7 | 132·6 |
| 309 | 299·8 | 74·7 | 369 | 358·0 | 89·2 | 429 | 416·2 | 103·8 | 489 | 474·5 | 118·3 | 549 | 532·7 | 132·8 |
| 310 | 300·8 | 75·0 | 370 | 359·0 | 89·5 | 430 | 417·2 | 104·0 | 490 | 475·4 | 118·5 | 550 | 533·7 | 133·0 |
| 311 | 301·7 | 75·2 | 371 | 359·9 | 89·7 | 431 | 418·2 | 104·2 | 491 | 476·4 | 118·8 | 551 | 534·6 | 133·3 |
| 312 | 302·7 | 75·5 | 372 | 360·9 | 90·0 | 432 | 419·1 | 104·5 | 492 | 477·4 | 119·0 | 552 | 535·6 | 133·6 |
| 313 | 303·7 | 75·7 | 373 | 361·9 | 90·2 | 433 | 420·1 | 104·7 | 493 | 478·3 | 119·2 | 553 | 536·6 | 133·8 |
| 314 | 304·6 | 75·9 | 374 | 362·9 | 90·5 | 434 | 421·1 | 105·0 | 494 | 479·3 | 119·5 | 554 | 537·5 | 134·0 |
| 315 | 305·6 | 76·2 | 375 | 363·8 | 90·7 | 435 | 422·0 | 105·2 | 495 | 480·3 | 119·7 | 555 | 538·5 | 134·3 |
| 316 | 306·6 | 76·4 | 376 | 364·8 | 90·9 | 436 | 423·0 | 105·5 | 496 | 481·3 | 120·0 | 556 | 539·5 | 134·5 |
| 317 | 307·6 | 76·7 | 377 | 365·8 | 91·2 | 437 | 424·0 | 105·7 | 497 | 482·2 | 120·2 | 557 | 540·5 | 134·8 |
| 318 | 308·5 | 76·9 | 378 | 366·7 | 91·4 | 438 | 425·0 | 105·9 | 498 | 483·2 | 120·4 | 558 | 541·4 | 135·0 |
| 319 | 309·5 | 77·2 | 379 | 367·7 | 91·7 | 439 | 425·9 | 106·2 | 499 | 484·2 | 120·7 | 559 | 542·4 | 135·2 |
| 320 | 310·5 | 77·4 | 380 | 368·7 | 91·9 | 440 | 426·9 | 106·4 | 500 | 485·1 | 121·0 | 560 | 543·4 | 135·5 |
| 321 | 311·4 | 77·6 | 381 | 369·6 | 92·2 | 441 | 427·9 | 106·7 | 501 | 486·1 | 121·2 | 561 | 544·3 | 135·7 |
| 322 | 312·4 | 77·9 | 382 | 370·6 | 92·4 | 442 | 428·8 | 106·9 | 502 | 487·1 | 121·4 | 562 | 545·3 | 135·9 |
| 323 | 313·4 | 78·1 | 383 | 371·6 | 92·6 | 443 | 429·8 | 107·1 | 503 | 488·0 | 121·7 | 563 | 546·3 | 136·2 |
| 324 | 314·3 | 78·4 | 384 | 372·6 | 92·9 | 444 | 430·8 | 107·4 | 504 | 489·0 | 122·0 | 564 | 547·2 | 136·5 |
| 325 | 315·3 | 78·6 | 385 | 373·5 | 93·1 | 445 | 431·7 | 107·6 | 505 | 490·0 | 122·1 | 565 | 548·2 | 136·6 |
| 326 | 316·3 | 78·8 | 386 | 374·5 | 93·4 | 446 | 432·7 | 107·9 | 506 | 491·0 | 122·4 | 566 | 549·2 | 136·9 |
| 327 | 317·3 | 79·1 | 387 | 375·5 | 93·6 | 447 | 433·7 | 108·1 | 507 | 491·9 | 122·6 | 567 | 550·1 | 137·1 |
| 328 | 318·2 | 79·3 | 388 | 376·4 | 93·8 | 448 | 434·7 | 108·4 | 508 | 492·9 | 122·9 | 568 | 551·1 | 137·4 |
| 329 | 319·2 | 79·6 | 389 | 377·4 | 94·1 | 449 | 435·6 | 108·6 | 509 | 493·9 | 123·1 | 569 | 552·1 | 137·6 |
| 330 | 320·2 | 79·8 | 390 | 378·4 | 94·3 | 450 | 436·6 | 108·8 | 510 | 494·9 | 123·4 | 570 | 553·1 | 137·9 |
| 331 | 321·1 | 80·1 | 391 | 379·4 | 94·6 | 451 | 437·6 | 109·1 | 511 | 495·8 | 123·6 | 571 | 554·0 | 138·1 |
| 332 | 322·1 | 80·3 | 392 | 380·3 | 94·8 | 452 | 438·5 | 109·3 | 512 | 496·8 | 123·8 | 572 | 555·0 | 138·3 |
| 333 | 323·1 | 80·5 | 393 | 381·3 | 95·1 | 453 | 439·5 | 109·6 | 513 | 497·8 | 124·1 | 573 | 556·0 | 138·6 |
| 334 | 324·0 | 80·8 | 394 | 382·3 | 95·3 | 454 | 440·5 | 109·8 | 514 | 498·7 | 124·3 | 574 | 557·0 | 138·8 |
| 335 | 325·0 | 81·0 | 395 | 383·2 | 95·5 | 455 | 441·5 | 110·1 | 515 | 499·7 | 124·6 | 575 | 557·9 | 139·1 |
| 336 | 326·0 | 81·3 | 396 | 384·2 | 95·8 | 456 | 442·4 | 110·3 | 516 | 500·7 | 124·8 | 576 | 558·9 | 139·3 |
| 337 | 327·0 | 81·5 | 397 | 385·2 | 96·0 | 457 | 443·4 | 110·5 | 517 | 501·7 | 125·0 | 577 | 559·9 | 139·5 |
| 338 | 327·9 | 81·7 | 398 | 386·1 | 96·3 | 458 | 444·4 | 110·8 | 518 | 502·6 | 125·3 | 578 | 560·9 | 139·8 |
| 339 | 328·9 | 82·0 | 399 | 387·1 | 96·5 | 459 | 445·3 | 111·0 | 519 | 503·6 | 125·6 | 579 | 561·8 | 140·0 |
| 340 | 329·9 | 82·2 | 400 | 388·1 | 96·7 | 460 | 446·3 | 111·3 | 520 | 504·6 | 125·8 | 580 | 562·8 | 140·3 |
| 341 | 330·8 | 82·5 | 401 | 389·1 | 97·0 | 461 | 447·3 | 111·5 | 521 | 505·5 | 126·0 | 581 | 563·8 | 140·5 |
| 342 | 331·8 | 82·7 | 402 | 390·0 | 97·2 | 462 | 448·2 | 111·7 | 522 | 506·5 | 126·2 | 582 | 564·7 | 140·8 |
| 343 | 332·8 | 83·0 | 403 | 391·0 | 97·5 | 463 | 449·2 | 112·0 | 523 | 507·5 | 126·5 | 583 | 565·7 | 141·0 |
| 344 | 333·7 | 83·2 | 404 | 392·0 | 97·7 | 464 | 450·2 | 112·2 | 524 | 508·4 | 126·8 | 584 | 566·7 | 141·3 |
| 345 | 334·7 | 83·4 | 405 | 392·9 | 98·0 | 465 | 451·2 | 112·5 | 525 | 509·4 | 127·0 | 585 | 567·6 | 141·5 |
| 346 | 335·7 | 83·7 | 406 | 393·9 | 98·2 | 466 | 452·1 | 112·7 | 526 | 510·4 | 127·2 | 586 | 568·6 | 141·8 |
| 347 | 336·7 | 83·9 | 407 | 394·9 | 98·4 | 467 | 453·1 | 113·0 | 527 | 511·4 | 127·5 | 587 | 569·6 | 142·0 |
| 348 | 337·6 | 84·2 | 408 | 395·8 | 98·7 | 468 | 454·1 | 113·2 | 528 | 512·3 | 127·8 | 588 | 570·6 | 142·3 |
| 349 | 338·6 | 84·4 | 409 | 396·8 | 98·9 | 469 | 455·0 | 113·4 | 529 | 513·3 | 128·0 | 589 | 571·5 | 142·5 |
| 350 | 339·6 | 84·7 | 410 | 397·8 | 99·2 | 470 | 456·0 | 113·7 | 530 | 514·3 | 128·2 | 590 | 572·5 | 142·8 |
| 351 | 340·5 | 84·9 | 411 | 398·8 | 99·4 | 471 | 457·0 | 113·9 | 531 | 515·3 | 128·5 | 591 | 573·5 | 143·0 |
| 352 | 341·5 | 85·1 | 412 | 399·7 | 99·7 | 472 | 457·9 | 114·2 | 532 | 516·2 | 128·8 | 592 | 574·4 | 143·3 |
| 353 | 342·5 | 85·4 | 413 | 400·7 | 99·9 | 473 | 458·9 | 114·4 | 533 | 517·2 | 129·0 | 593 | 575·4 | 143·5 |
| 354 | 343·5 | 85·6 | 414 | 401·7 | 100·1 | 474 | 459·9 | 114·6 | 534 | 518·2 | 129·2 | 594 | 576·4 | 143·8 |
| 355 | 344·4 | 85·9 | 415 | 402·6 | 100·4 | 475 | 460·9 | 114·9 | 535 | 519·1 | 129·4 | 595 | 577·3 | 144·0 |
| 356 | 345·4 | 86·1 | 416 | 403·6 | 100·6 | 476 | 461·8 | 115·1 | 536 | 520·1 | 129·7 | 596 | 578·3 | 144·2 |
| 357 | 346·4 | 86·3 | 417 | 404·6 | 100·9 | 477 | 462·8 | 115·4 | 537 | 521·1 | 129·9 | 597 | 579·3 | 144·5 |
| 358 | 347·3 | 86·6 | 418 | 405·5 | 101·1 | 478 | 463·8 | 115·6 | 538 | 522·1 | 130·2 | 598 | 580·3 | 144·7 |
| 359 | 348·3 | 86·8 | 419 | 406·5 | 101·3 | 479 | 464·7 | 115·9 | 539 | 523·0 | 130·4 | 599 | 581·2 | 144·9 |
| 360 | 349·3 | 87·1 | 420 | 407·5 | 101·6 | 480 | 465·7 | 116·1 | 540 | 524·0 | 130·6 | 600 | 582·2 | 145·1 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

76° $5^h\ 4^m$

## TRAVERSE TABLE TO DEGREES

| 15° | | | | | | | | | | | | | | 1h 0m |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
| 1 | 1·0 | 0·3 | 61 | 58·9 | 15·8 | 121 | 116·9 | 31·3 | 181 | 174·8 | 46·8 | 241 | 232·8 | 62·4 |
| 2 | 1·9 | 0·5 | 62 | 59·9 | 16·0 | 122 | 117·8 | 31·6 | 182 | 175·8 | 47·1 | 242 | 233·8 | 62·6 |
| 3 | 2·9 | 0·8 | 63 | 60·9 | 16·3 | 123 | 118·8 | 31·8 | 183 | 176·8 | 47·4 | 243 | 234·7 | 62·9 |
| 4 | 3·9 | 1·0 | 64 | 61·8 | 16·6 | 124 | 119·8 | 32·1 | 184 | 177·7 | 47·6 | 244 | 235·7 | 63·2 |
| 5 | 4·8 | 1·3 | 65 | 62·8 | 16·8 | 125 | 120·7 | 32·4 | 185 | 178·7 | 47·9 | 245 | 236·7 | 63·4 |
| 6 | 5·8 | 1·6 | 66 | 63·8 | 17·1 | 126 | 121·7 | 32·6 | 186 | 179·7 | 48·1 | 246 | 237·6 | 63·7 |
| 7 | 6·8 | 1·8 | 67 | 64·7 | 17·3 | 127 | 122·7 | 32·9 | 187 | 180·6 | 48·4 | 247 | 238·6 | 63·9 |
| 8 | 7·7 | 2·1 | 68 | 65·7 | 17·6 | 128 | 123·6 | 33·1 | 188 | 181·6 | 48·7 | 248 | 239·5 | 64·2 |
| 9 | 8·7 | 2·3 | 69 | 66·6 | 17·9 | 129 | 124·6 | 33·4 | 189 | 182·6 | 48·9 | 249 | 240·5 | 64·4 |
| 10 | 9·7 | 2·6 | 70 | 67·6 | 18·1 | 130 | 125·6 | 33·6 | 190 | 183·5 | 49·2 | 250 | 241·5 | 64·7 |
| 11 | 10·6 | 2·8 | 71 | 68·6 | 18·4 | 131 | 126·5 | 33·9 | 191 | 184·5 | 49·4 | 251 | 242·4 | 65·0 |
| 12 | 11·6 | 3·1 | 72 | 69·5 | 18·6 | 132 | 127·5 | 34·2 | 192 | 185·5 | 49·7 | 252 | 243·4 | 65·2 |
| 13 | 12·6 | 3·4 | 73 | 70·5 | 18·9 | 133 | 128·5 | 34·4 | 193 | 186·4 | 50·0 | 253 | 244·4 | 65·5 |
| 14 | 13·5 | 3·6 | 74 | 71·5 | 19·2 | 134 | 129·4 | 34·7 | 194 | 187·4 | 50·2 | 254 | 245·3 | 65·7 |
| 15 | 14·5 | 3·9 | 75 | 72·4 | 19·4 | 135 | 130·4 | 34·9 | 195 | 188·4 | 50·5 | 255 | 246·3 | 66·0 |
| 16 | 15·5 | 4·1 | 76 | 73·4 | 19·7 | 136 | 131·4 | 35·2 | 196 | 189·3 | 50·7 | 256 | 247·3 | 66·3 |
| 17 | 16·4 | 4·4 | 77 | 74·4 | 19·9 | 137 | 132·3 | 35·5 | 197 | 190·3 | 51·0 | 257 | 248·2 | 66·5 |
| 18 | 17·4 | 4·7 | 78 | 75·3 | 20·2 | 138 | 133·3 | 35·7 | 198 | 191·3 | 51·2 | 258 | 249·2 | 66·8 |
| 19 | 18·4 | 4·9 | 79 | 76·3 | 20·4 | 139 | 134·3 | 36·0 | 199 | 192·2 | 51·5 | 259 | 250·2 | 67·0 |
| 20 | 19·3 | 5·2 | 80 | 77·3 | 20·7 | 140 | 135·2 | 36·2 | 200 | 193·2 | 51·8 | 260 | 251·1 | 67·3 |
| 21 | 20·3 | 5·4 | 81 | 78·2 | 21·0 | 141 | 136·2 | 36·5 | 201 | 194·2 | 52·0 | 261 | 252·1 | 67·6 |
| 22 | 21·2 | 5·7 | 82 | 79·2 | 21·2 | 142 | 137·2 | 36·8 | 202 | 195·1 | 52·3 | 262 | 253·1 | 67·8 |
| 23 | 22·2 | 6·0 | 83 | 80·2 | 21·5 | 143 | 138·1 | 37·0 | 203 | 196·1 | 52·5 | 263 | 254·0 | 68·1 |
| 24 | 23·2 | 6·2 | 84 | 81·1 | 21·7 | 144 | 139·1 | 37·3 | 204 | 197·0 | 52·8 | 264 | 255·0 | 68·3 |
| 25 | 24·1 | 6·5 | 85 | 82·1 | 22·0 | 145 | 140·1 | 37·5 | 205 | 198·0 | 53·1 | 265 | 256·0 | 68·6 |
| 26 | 25·1 | 6·7 | 86 | 83·1 | 22·3 | 146 | 141·0 | 37·8 | 206 | 199·0 | 53·3 | 266 | 256·9 | 68·8 |
| 27 | 26·1 | 7·0 | 87 | 84·0 | 22·5 | 147 | 142·0 | 38·0 | 207 | 199·9 | 53·6 | 267 | 257·9 | 69·1 |
| 28 | 27·0 | 7·2 | 88 | 85·0 | 22·8 | 148 | 143·0 | 38·3 | 208 | 200·9 | 53·8 | 268 | 258·9 | 69·4 |
| 29 | 28·0 | 7·5 | 89 | 86·0 | 23·0 | 149 | 143·9 | 38·6 | 209 | 201·9 | 54·1 | 269 | 259·8 | 69·6 |
| 30 | 29·0 | 7·8 | 90 | 86·9 | 23·3 | 150 | 144·9 | 38·8 | 210 | 202·8 | 54·4 | 270 | 260·8 | 69·9 |
| 31 | 29·9 | 8·0 | 91 | 87·9 | 23·6 | 151 | 145·9 | 39·1 | 211 | 203·8 | 54·6 | 271 | 261·8 | 70·1 |
| 32 | 30·9 | 8·3 | 92 | 88·9 | 23·8 | 152 | 146·8 | 39·3 | 212 | 204·8 | 54·9 | 272 | 262·7 | 70·4 |
| 33 | 31·9 | 8·5 | 93 | 89·8 | 24·1 | 153 | 147·8 | 39·6 | 213 | 205·7 | 55·1 | 273 | 263·7 | 70·7 |
| 34 | 32·8 | 8·8 | 94 | 90·8 | 24·3 | 154 | 148·8 | 39·9 | 214 | 206·7 | 55·4 | 274 | 264·7 | 70·9 |
| 35 | 33·8 | 9·1 | 95 | 91·8 | 24·6 | 155 | 149·7 | 40·1 | 215 | 207·7 | 55·6 | 275 | 265·6 | 71·2 |
| 36 | 34·8 | 9·3 | 96 | 92·7 | 24·8 | 156 | 150·7 | 40·4 | 216 | 208·6 | 55·9 | 276 | 266·6 | 71·4 |
| 37 | 35·7 | 9·6 | 97 | 93·7 | 25·1 | 157 | 151·7 | 40·6 | 217 | 209·6 | 56·2 | 277 | 267·6 | 71·7 |
| 38 | 36·7 | 9·8 | 98 | 94·7 | 25·4 | 158 | 152·6 | 40·9 | 218 | 210·6 | 56·4 | 278 | 268·5 | 72·0 |
| 39 | 37·7 | 10·1 | 99 | 95·6 | 25·6 | 159 | 153·6 | 41·2 | 219 | 211·5 | 56·7 | 279 | 269·5 | 72·2 |
| 40 | 38·6 | 10·4 | 100 | 96·6 | 25·9 | 160 | 154·5 | 41·4 | 220 | 212·5 | 56·9 | 280 | 270·5 | 72·5 |
| 41 | 39·6 | 10·6 | 101 | 97·6 | 26·1 | 161 | 155·5 | 41·7 | 221 | 213·5 | 57·2 | 281 | 271·4 | 72·7 |
| 42 | 40·6 | 10·9 | 102 | 98·5 | 26·4 | 162 | 156·5 | 41·9 | 222 | 214·4 | 57·5 | 282 | 272·4 | 73·0 |
| 43 | 41·5 | 11·1 | 103 | 99·5 | 26·7 | 163 | 157·4 | 42·2 | 223 | 215·4 | 57·7 | 283 | 273·4 | 73·2 |
| 44 | 42·5 | 11·4 | 104 | 100·5 | 26·9 | 164 | 158·4 | 42·4 | 224 | 216·4 | 58·0 | 284 | 274·3 | 73·5 |
| 45 | 43·5 | 11·6 | 105 | 101·4 | 27·2 | 165 | 159·4 | 42·7 | 225 | 217·3 | 58·2 | 285 | 275·3 | 73·8 |
| 46 | 44·4 | 11·9 | 106 | 102·4 | 27·4 | 166 | 160·3 | 43·0 | 226 | 218·3 | 58·5 | 286 | 276·3 | 74·0 |
| 47 | 45·4 | 12·2 | 107 | 103·4 | 27·7 | 167 | 161·3 | 43·2 | 227 | 219·3 | 58·8 | 287 | 277·2 | 74·3 |
| 48 | 46·4 | 12·4 | 108 | 104·3 | 28·0 | 168 | 162·3 | 43·5 | 228 | 220·2 | 59·0 | 288 | 278·2 | 74·5 |
| 49 | 47·3 | 12·7 | 109 | 105·3 | 28·2 | 169 | 163·2 | 43·7 | 229 | 221·2 | 59·3 | 289 | 279·2 | 74·8 |
| 50 | 48·3 | 12·9 | 110 | 106·3 | 28·5 | 170 | 164·2 | 44·0 | 230 | 222·2 | 59·5 | 290 | 280·1 | 75·1 |
| 51 | 49·3 | 13·2 | 111 | 107·2 | 28·7 | 171 | 165·2 | 44·3 | 231 | 223·1 | 59·8 | 291 | 281·1 | 75·3 |
| 52 | 50·2 | 13·5 | 112 | 108·2 | 29·0 | 172 | 166·1 | 44·5 | 232 | 224·1 | 60·0 | 292 | 282·1 | 75·6 |
| 53 | 51·2 | 13·7 | 113 | 109·1 | 29·2 | 173 | 167·1 | 44·8 | 233 | 225·1 | 60·3 | 293 | 283·0 | 75·8 |
| 54 | 52·2 | 14·0 | 114 | 110·1 | 29·5 | 174 | 168·1 | 45·0 | 234 | 226·0 | 60·6 | 294 | 284·0 | 76·1 |
| 55 | 53·1 | 14·2 | 115 | 111·1 | 29·8 | 175 | 169·0 | 45·3 | 235 | 227·0 | 60·8 | 295 | 284·9 | 76·4 |
| 56 | 54·1 | 14·5 | 116 | 112·0 | 30·0 | 176 | 170·0 | 45·6 | 236 | 228·0 | 61·1 | 296 | 285·9 | 76·6 |
| 57 | 55·1 | 14·8 | 117 | 113·0 | 30·3 | 177 | 171·0 | 45·8 | 237 | 228·9 | 61·3 | 297 | 286·9 | 76·9 |
| 58 | 56·0 | 15·0 | 118 | 114·0 | 30·5 | 178 | 171·9 | 46·1 | 238 | 229·9 | 61·6 | 298 | 287·8 | 77·1 |
| 59 | 57·0 | 15·3 | 119 | 114·9 | 30·8 | 179 | 172·9 | 46·3 | 239 | 230·9 | 61·9 | 299 | 288·8 | 77·4 |
| 60 | 58·0 | 15·5 | 120 | 115·9 | 31·1 | 180 | 173·9 | 46·6 | 240 | 231·8 | 62·1 | 300 | 289·8 | 77·6 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |
| 75° | | | | | | | | | | | | | | 5h 0m |

## TRAVERSE TABLE TO DEGREES

15° 1h 0m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 290.7 | 77.9 | 361 | 348.7 | 93.4 | 421 | 406.6 | 109.0 | 481 | 464.6 | 124.5 | 541 | 522.6 | 140.0 |
| 302 | 291.7 | 78.2 | 362 | 349.6 | 93.7 | 422 | 407.6 | 109.2 | 482 | 465.6 | 124.8 | 542 | 523.5 | 140.3 |
| 303 | 292.7 | 78.4 | 363 | 350.6 | 94.0 | 423 | 408.6 | 109.5 | 483 | 466.5 | 125.0 | 543 | 524.5 | 140.5 |
| 304 | 293.6 | 78.7 | 364 | 351.6 | 94.2 | 424 | 409.5 | 109.7 | 484 | 467.5 | 125.3 | 544 | 525.5 | 140.8 |
| 305 | 294.6 | 78.9 | 365 | 352.5 | 94.5 | 425 | 410.5 | 110.0 | 485 | 468.5 | 125.6 | 545 | 526.4 | 141.1 |
| 306 | 295.6 | 79.2 | 366 | 353.5 | 94.7 | 426 | 411.5 | 110.3 | 486 | 469.4 | 125.8 | 546 | 527.4 | 141.4 |
| 307 | 296.5 | 79.5 | 367 | 354.5 | 95.0 | 427 | 412.4 | 110.5 | 487 | 470.4 | 126.1 | 547 | 528.4 | 141.6 |
| 308 | 297.5 | 79.7 | 368 | 355.4 | 95.3 | 428 | 413.4 | 110.8 | 488 | 471.4 | 126.4 | 548 | 529.3 | 141.9 |
| 309 | 298.4 | 80.0 | 369 | 356.4 | 95.5 | 429 | 414.4 | 111.0 | 489 | 472.3 | 126.6 | 549 | 530.3 | 142.1 |
| 310 | 299.4 | 80.2 | 370 | 357.4 | 95.8 | 430 | 415.3 | 111.3 | 490 | 473.3 | 126.9 | 550 | 531.3 | 142.4 |
| 311 | 300.4 | 80.5 | 371 | 358.3 | 96.0 | 431 | 416.3 | 111.6 | 491 | 474.3 | 127.1 | 551 | 532.2 | 142.6 |
| 312 | 301.3 | 80.8 | 372 | 359.3 | 96.3 | 432 | 417.3 | 111.8 | 492 | 475.2 | 127.4 | 552 | 533.2 | 142.9 |
| 313 | 302.3 | 81.0 | 373 | 360.3 | 96.5 | 433 | 418.2 | 112.1 | 493 | 476.2 | 127.6 | 553 | 534.2 | 143.1 |
| 314 | 303.3 | 81.3 | 374 | 361.2 | 96.8 | 434 | 419.2 | 112.3 | 494 | 477.2 | 127.9 | 554 | 535.1 | 143.4 |
| 315 | 304.2 | 81.5 | 375 | 362.2 | 97.1 | 435 | 420.2 | 112.6 | 495 | 478.1 | 128.1 | 555 | 536.1 | 143.7 |
| 316 | 305.2 | 81.8 | 376 | 363.2 | 97.3 | 436 | 421.1 | 112.9 | 496 | 479.1 | 128.4 | 556 | 537.1 | 143.9 |
| 317 | 306.2 | 82.1 | 377 | 364.1 | 97.6 | 437 | 422.1 | 113.1 | 497 | 480.1 | 128.6 | 557 | 538.0 | 144.2 |
| 318 | 307.1 | 82.3 | 378 | 365.1 | 97.8 | 438 | 423.1 | 113.4 | 498 | 481.0 | 128.9 | 558 | 539.0 | 144.4 |
| 319 | 308.1 | 82.6 | 379 | 366.1 | 98.1 | 439 | 424.0 | 113.6 | 499 | 482.0 | 129.1 | 559 | 540.0 | 144.7 |
| 320 | 309.1 | 82.8 | 380 | 367.0 | 98.4 | 440 | 425.0 | 113.9 | 500 | 483.0 | 129.4 | 560 | 540.9 | 144.9 |
| 321 | 310.0 | 83.1 | 381 | 368.0 | 98.6 | 441 | 426.0 | 114.1 | 501 | 483.9 | 129.7 | 561 | 541.9 | 145.2 |
| 322 | 311.0 | 83.3 | 382 | 369.0 | 98.9 | 442 | 426.9 | 114.4 | 502 | 484.9 | 129.9 | 562 | 542.9 | 145.4 |
| 323 | 312.0 | 83.6 | 383 | 369.9 | 99.1 | 443 | 427.9 | 114.7 | 503 | 485.9 | 130.2 | 563 | 543.8 | 145.7 |
| 324 | 312.9 | 83.9 | 384 | 370.9 | 99.4 | 444 | 428.8 | 114.9 | 504 | 486.8 | 130.4 | 564 | 544.8 | 146.0 |
| 325 | 313.9 | 84.1 | 385 | 371.9 | 99.6 | 445 | 429.8 | 115.2 | 505 | 487.8 | 130.7 | 565 | 545.8 | 146.2 |
| 326 | 314.9 | 84.4 | 386 | 372.8 | 99.9 | 446 | 430.8 | 115.4 | 506 | 488.8 | 131.0 | 566 | 546.7 | 146.5 |
| 327 | 315.8 | 84.6 | 387 | 373.8 | 100.2 | 447 | 431.7 | 115.7 | 507 | 489.7 | 131.2 | 567 | 547.7 | 146.7 |
| 328 | 316.8 | 84.9 | 388 | 374.8 | 100.4 | 448 | 432.7 | 116.0 | 508 | 490.7 | 131.5 | 568 | 548.7 | 147.0 |
| 329 | 317.8 | 85.1 | 389 | 375.7 | 100.7 | 449 | 433.7 | 116.2 | 509 | 491.7 | 131.7 | 569 | 549.6 | 147.2 |
| 330 | 318.7 | 85.4 | 390 | 376.7 | 100.9 | 450 | 434.6 | 116.5 | 510 | 492.6 | 132.0 | 570 | 550.6 | 147.5 |
| 331 | 319.7 | 85.7 | 391 | 377.7 | 101.2 | 451 | 435.6 | 116.7 | 511 | 493.6 | 132.3 | 571 | 551.6 | 147.8 |
| 332 | 320.7 | 85.9 | 392 | 378.6 | 101.5 | 452 | 436.6 | 117.0 | 512 | 494.5 | 132.5 | 572 | 552.5 | 148.0 |
| 333 | 321.6 | 86.2 | 393 | 379.6 | 101.7 | 453 | 437.5 | 117.3 | 513 | 495.5 | 132.8 | 573 | 553.5 | 148.3 |
| 334 | 322.6 | 86.5 | 394 | 380.6 | 102.0 | 454 | 438.5 | 117.5 | 514 | 496.5 | 133.0 | 574 | 554.4 | 148.5 |
| 335 | 323.6 | 86.7 | 395 | 381.5 | 102.2 | 455 | 439.5 | 117.8 | 515 | 497.4 | 133.3 | 575 | 555.4 | 148.8 |
| 336 | 324.5 | 87.0 | 396 | 382.5 | 102.5 | 456 | 440.4 | 118.0 | 516 | 498.4 | 133.5 | 576 | 556.4 | 149.0 |
| 337 | 325.5 | 87.2 | 397 | 383.4 | 102.8 | 457 | 441.4 | 118.3 | 517 | 499.4 | 133.8 | 577 | 557.3 | 149.3 |
| 338 | 326.5 | 87.5 | 398 | 384.4 | 103.0 | 458 | 442.4 | 118.5 | 518 | 500.3 | 134.0 | 578 | 558.3 | 149.5 |
| 339 | 327.4 | 87.7 | 399 | 385.4 | 103.3 | 459 | 443.3 | 118.8 | 519 | 501.3 | 134.3 | 579 | 559.3 | 149.8 |
| 340 | 328.4 | 88.0 | 400 | 386.3 | 103.5 | 460 | 444.3 | 119.1 | 520 | 502.3 | 134.6 | 580 | 560.2 | 150.1 |
| 341 | 329.4 | 88.3 | 401 | 387.3 | 103.8 | 461 | 445.3 | 119.3 | 521 | 503.2 | 134.8 | 581 | 561.2 | 150.3 |
| 342 | 330.3 | 88.5 | 402 | 388.3 | 104.1 | 462 | 446.2 | 119.6 | 522 | 504.2 | 135.1 | 582 | 562.2 | 150.6 |
| 343 | 331.3 | 88.8 | 403 | 389.2 | 104.3 | 463 | 447.2 | 119.8 | 523 | 505.2 | 135.3 | 583 | 563.1 | 150.8 |
| 344 | 332.3 | 89.0 | 404 | 390.2 | 104.6 | 464 | 448.2 | 120.1 | 524 | 506.1 | 135.6 | 584 | 564.1 | 151.1 |
| 345 | 333.2 | 89.3 | 405 | 391.2 | 104.8 | 465 | 449.1 | 120.4 | 525 | 507.1 | 135.9 | 585 | 565.1 | 151.4 |
| 346 | 334.2 | 89.6 | 406 | 392.1 | 105.1 | 466 | 450.1 | 120.6 | 526 | 508.1 | 136.1 | 586 | 566.0 | 151.6 |
| 347 | 335.2 | 89.8 | 407 | 393.1 | 105.3 | 467 | 451.1 | 120.9 | 527 | 509.0 | 136.4 | 587 | 567.0 | 151.9 |
| 348 | 336.1 | 90.1 | 408 | 394.1 | 105.6 | 468 | 452.0 | 121.1 | 528 | 510.0 | 136.6 | 588 | 568.0 | 152.2 |
| 349 | 337.1 | 90.3 | 409 | 395.0 | 105.9 | 469 | 453.0 | 121.4 | 529 | 511.0 | 136.9 | 589 | 568.9 | 152.4 |
| 350 | 338.1 | 90.6 | 410 | 396.0 | 106.1 | 470 | 454.0 | 121.7 | 530 | 511.9 | 137.2 | 590 | 569.9 | 152.7 |
| 351 | 339.0 | 90.9 | 411 | 397.0 | 106.4 | 471 | 454.9 | 121.9 | 531 | 512.9 | 137.4 | 591 | 570.9 | 153.0 |
| 352 | 340.0 | 91.1 | 412 | 397.9 | 106.6 | 472 | 455.9 | 122.2 | 532 | 513.9 | 137.7 | 592 | 571.8 | 153.2 |
| 353 | 340.9 | 91.4 | 413 | 398.9 | 106.9 | 473 | 456.9 | 122.4 | 533 | 514.8 | 137.9 | 593 | 572.8 | 153.5 |
| 354 | 341.9 | 91.6 | 414 | 399.9 | 107.2 | 474 | 457.8 | 122.7 | 534 | 515.8 | 138.2 | 594 | 573.8 | 153.7 |
| 355 | 342.9 | 91.9 | 415 | 400.8 | 107.4 | 475 | 458.8 | 122.9 | 535 | 516.8 | 138.4 | 595 | 574.7 | 154.0 |
| 356 | 343.8 | 92.1 | 416 | 401.8 | 107.7 | 476 | 459.8 | 123.2 | 536 | 517.7 | 138.7 | 596 | 575.7 | 154.2 |
| 357 | 344.8 | 92.4 | 417 | 402.8 | 107.9 | 477 | 460.7 | 123.5 | 537 | 518.7 | 139.0 | 597 | 576.7 | 154.5 |
| 358 | 345.8 | 92.7 | 418 | 403.7 | 108.2 | 478 | 461.7 | 123.7 | 538 | 519.7 | 139.2 | 598 | 577.6 | 154.8 |
| 359 | 346.7 | 92.9 | 419 | 404.7 | 108.5 | 479 | 462.7 | 124.0 | 539 | 520.6 | 139.5 | 599 | 578.6 | 155.0 |
| 360 | 347.7 | 93.2 | 420 | 405.7 | 108.7 | 480 | 463.6 | 124.2 | 540 | 521.6 | 139.7 | 600 | 579.5 | 155.3 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

75° 5h 0m

## TRAVERSE TABLE TO DEGREES

16° 1h 4m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0 | 0.3 | 61 | 58.6 | 16.8 | 121 | 116.3 | 33.4 | 181 | 174.0 | 49.9 | 241 | 231.7 | 66.4 |
| 2 | 1.9 | 0.6 | 62 | 59.6 | 17.1 | 122 | 117.3 | 33.6 | 182 | 174.9 | 50.2 | 242 | 232.6 | 66.7 |
| 3 | 2.9 | 0.8 | 63 | 60.6 | 17.4 | 123 | 118.2 | 33.9 | 183 | 175.9 | 50.4 | 243 | 233.6 | 67.0 |
| 4 | 3.8 | 1.1 | 64 | 61.5 | 17.6 | 124 | 119.2 | 34.2 | 184 | 176.9 | 50.7 | 244 | 234.5 | 67.3 |
| 5 | 4.8 | 1.4 | 65 | 62.5 | 17.9 | 125 | 120.2 | 34.5 | 185 | 177.8 | 51.0 | 245 | 235.5 | 67.5 |
| 6 | 5.8 | 1.7 | 66 | 63.4 | 18.2 | 126 | 121.1 | 34.7 | 186 | 178.8 | 51.3 | 246 | 236.5 | 67.8 |
| 7 | 6.7 | 1.9 | 67 | 64.4 | 18.5 | 127 | 122.1 | 35.0 | 187 | 179.8 | 51.5 | 247 | 237.4 | 68.1 |
| 8 | 7.7 | 2.2 | 68 | 65.4 | 18.7 | 128 | 123.0 | 35.3 | 188 | 180.7 | 51.8 | 248 | 238.4 | 68.4 |
| 9 | 8.7 | 2.5 | 69 | 66.3 | 19.0 | 129 | 124.0 | 35.6 | 189 | 181.7 | 52.1 | 249 | 239.4 | 68.6 |
| 10 | 9.6 | 2.8 | 70 | 67.3 | 19.3 | 130 | 125.0 | 35.8 | 190 | 182.6 | 52.4 | 250 | 240.3 | 68.9 |
| 11 | 10.6 | 3.0 | 71 | 68.2 | 19.6 | 131 | 125.9 | 36.1 | 191 | 183.6 | 52.6 | 251 | 241.3 | 69.2 |
| 12 | 11.5 | 3.3 | 72 | 69.2 | 19.8 | 132 | 126.9 | 36.4 | 192 | 184.6 | 52.9 | 252 | 242.2 | 69.5 |
| 13 | 12.5 | 3.6 | 73 | 70.2 | 20.1 | 133 | 127.8 | 36.7 | 193 | 185.5 | 53.2 | 253 | 243.2 | 69.7 |
| 14 | 13.5 | 3.9 | 74 | 71.1 | 20.4 | 134 | 128.8 | 36.9 | 194 | 186.5 | 53.5 | 254 | 244.2 | 70.0 |
| 15 | 14.4 | 4.1 | 75 | 72.1 | 20.7 | 135 | 129.8 | 37.2 | 195 | 187.4 | 53.7 | 255 | 245.1 | 70.3 |
| 16 | 15.4 | 4.4 | 76 | 73.1 | 20.9 | 136 | 130.7 | 37.5 | 196 | 188.4 | 54.0 | 256 | 246.1 | 70.6 |
| 17 | 16.3 | 4.7 | 77 | 74.0 | 21.2 | 137 | 131.7 | 37.8 | 197 | 189.4 | 54.3 | 257 | 247.0 | 70.8 |
| 18 | 17.3 | 5.0 | 78 | 75.0 | 21.5 | 138 | 132.7 | 38.0 | 198 | 190.3 | 54.6 | 258 | 248.0 | 71.1 |
| 19 | 18.3 | 5.2 | 79 | 75.9 | 21.8 | 139 | 133.6 | 38.3 | 199 | 191.3 | 54.9 | 259 | 249.0 | 71.4 |
| 20 | 19.2 | 5.5 | 80 | 76.9 | 22.1 | 140 | 134.6 | 38.6 | 200 | 192.3 | 55.1 | 260 | 249.9 | 71.7 |
| 21 | 20.2 | 5.8 | 81 | 77.9 | 22.3 | 141 | 135.5 | 38.9 | 201 | 193.2 | 55.4 | 261 | 250.9 | 71.9 |
| 22 | 21.1 | 6.1 | 82 | 78.8 | 22.6 | 142 | 136.5 | 39.1 | 202 | 194.2 | 55.7 | 262 | 251.9 | 72.2 |
| 23 | 22.1 | 6.3 | 83 | 79.8 | 22.9 | 143 | 137.5 | 39.4 | 203 | 195.1 | 56.0 | 263 | 252.8 | 72.5 |
| 24 | 23.1 | 6.6 | 84 | 80.7 | 23.2 | 144 | 138.4 | 39.7 | 204 | 196.1 | 56.2 | 264 | 253.8 | 72.8 |
| 25 | 24.0 | 6.9 | 85 | 81.7 | 23.4 | 145 | 139.4 | 40.0 | 205 | 197.1 | 56.5 | 265 | 254.7 | 73.0 |
| 26 | 25.0 | 7.2 | 86 | 82.7 | 23.7 | 146 | 140.3 | 40.2 | 206 | 198.0 | 56.8 | 266 | 255.7 | 73.3 |
| 27 | 26.0 | 7.4 | 87 | 83.6 | 24.0 | 147 | 141.3 | 40.5 | 207 | 199.0 | 57.1 | 267 | 256.7 | 73.6 |
| 28 | 26.9 | 7.7 | 88 | 84.6 | 24.3 | 148 | 142.3 | 40.8 | 208 | 199.9 | 57.3 | 268 | 257.6 | 73.9 |
| 29 | 27.9 | 8.0 | 89 | 85.6 | 24.5 | 149 | 143.2 | 41.1 | 209 | 200.9 | 57.6 | 269 | 258.6 | 74.1 |
| 30 | 28.8 | 8.3 | 90 | 86.5 | 24.8 | 150 | 144.2 | 41.3 | 210 | 201.9 | 57.9 | 270 | 259.5 | 74.4 |
| 31 | 29.8 | 8.5 | 91 | 87.5 | 25.1 | 151 | 145.2 | 41.6 | 211 | 202.8 | 58.2 | 271 | 260.5 | 74.7 |
| 32 | 30.8 | 8.8 | 92 | 88.4 | 25.4 | 152 | 146.1 | 41.9 | 212 | 203.8 | 58.4 | 272 | 261.5 | 75.0 |
| 33 | 31.7 | 9.1 | 93 | 89.4 | 25.6 | 153 | 147.1 | 42.2 | 213 | 204.7 | 58.7 | 273 | 262.4 | 75.2 |
| 34 | 32.7 | 9.4 | 94 | 90.4 | 25.9 | 154 | 148.0 | 42.4 | 214 | 205.7 | 59.0 | 274 | 263.4 | 75.5 |
| 35 | 33.6 | 9.6 | 95 | 91.3 | 26.2 | 155 | 149.0 | 42.7 | 215 | 206.7 | 59.3 | 275 | 264.3 | 75.8 |
| 36 | 34.6 | 9.9 | 96 | 92.3 | 26.5 | 156 | 150.0 | 43.0 | 216 | 207.6 | 59.5 | 276 | 265.3 | 76.1 |
| 37 | 35.6 | 10.2 | 97 | 93.2 | 26.7 | 157 | 150.9 | 43.3 | 217 | 208.6 | 59.8 | 277 | 266.3 | 76.4 |
| 38 | 36.5 | 10.5 | 98 | 94.2 | 27.0 | 158 | 151.9 | 43.6 | 218 | 209.6 | 60.1 | 278 | 267.2 | 76.6 |
| 39 | 37.5 | 10.7 | 99 | 95.2 | 27.3 | 159 | 152.8 | 43.8 | 219 | 210.5 | 60.4 | 279 | 268.2 | 76.9 |
| 40 | 38.5 | 11.0 | 100 | 96.1 | 27.6 | 160 | 153.8 | 44.1 | 220 | 211.5 | 60.6 | 280 | 269.2 | 77.2 |
| 41 | 39.4 | 11.3 | 101 | 97.1 | 27.8 | 161 | 154.8 | 44.4 | 221 | 212.4 | 60.9 | 281 | 270.1 | 77.5 |
| 42 | 40.4 | 11.6 | 102 | 98.0 | 28.1 | 162 | 155.7 | 44.7 | 222 | 213.4 | 61.2 | 282 | 271.1 | 77.7 |
| 43 | 41.3 | 11.9 | 103 | 99.0 | 28.4 | 163 | 156.7 | 44.9 | 223 | 214.4 | 61.5 | 283 | 272.0 | 78.0 |
| 44 | 42.3 | 12.1 | 104 | 100.0 | 28.7 | 164 | 157.6 | 45.2 | 224 | 215.3 | 61.7 | 284 | 273.0 | 78.3 |
| 45 | 43.3 | 12.4 | 105 | 100.9 | 28.9 | 165 | 158.6 | 45.5 | 225 | 216.3 | 62.0 | 285 | 274.0 | 78.6 |
| 46 | 44.2 | 12.7 | 106 | 101.9 | 29.2 | 166 | 159.6 | 45.8 | 226 | 217.3 | 62.3 | 286 | 274.9 | 78.8 |
| 47 | 45.2 | 13.0 | 107 | 102.9 | 29.5 | 167 | 160.5 | 46.0 | 227 | 218.2 | 62.6 | 287 | 275.9 | 79.1 |
| 48 | 46.1 | 13.2 | 108 | 103.8 | 29.8 | 168 | 161.5 | 46.3 | 228 | 219.2 | 62.8 | 288 | 276.8 | 79.4 |
| 49 | 47.1 | 13.5 | 109 | 104.8 | 30.0 | 169 | 162.5 | 46.6 | 229 | 220.1 | 63.1 | 289 | 277.8 | 79.7 |
| 50 | 48.1 | 13.8 | 110 | 105.7 | 30.3 | 170 | 163.4 | 46.9 | 230 | 221.1 | 63.4 | 290 | 278.8 | 79.9 |
| 51 | 49.0 | 14.1 | 111 | 106.7 | 30.6 | 171 | 164.4 | 47.1 | 231 | 222.1 | 63.7 | 291 | 279.7 | 80.2 |
| 52 | 50.0 | 14.3 | 112 | 107.7 | 30.9 | 172 | 165.3 | 47.4 | 232 | 223.0 | 63.9 | 292 | 280.7 | 80.5 |
| 53 | 50.9 | 14.6 | 113 | 108.6 | 31.1 | 173 | 166.3 | 47.7 | 233 | 224.0 | 64.2 | 293 | 281.6 | 80.8 |
| 54 | 51.9 | 14.9 | 114 | 109.6 | 31.4 | 174 | 167.3 | 48.0 | 234 | 224.9 | 64.5 | 294 | 282.6 | 81.0 |
| 55 | 52.9 | 15.2 | 115 | 110.5 | 31.7 | 175 | 168.2 | 48.2 | 235 | 225.9 | 64.8 | 295 | 283.6 | 81.3 |
| 56 | 53.8 | 15.4 | 116 | 111.5 | 32.0 | 176 | 169.2 | 48.5 | 236 | 226.9 | 65.1 | 296 | 284.5 | 81.6 |
| 57 | 54.8 | 15.7 | 117 | 112.5 | 32.2 | 177 | 170.1 | 48.8 | 237 | 227.8 | 65.3 | 297 | 285.5 | 81.9 |
| 58 | 55.8 | 16.0 | 118 | 113.4 | 32.5 | 178 | 171.1 | 49.1 | 238 | 228.8 | 65.6 | 298 | 286.5 | 82.1 |
| 59 | 56.7 | 16.3 | 119 | 114.4 | 32.8 | 179 | 172.1 | 49.3 | 239 | 229.7 | 65.9 | 299 | 287.4 | 82.4 |
| 60 | 57.7 | 16.5 | 120 | 115.4 | 33.1 | 180 | 173.0 | 49.6 | 240 | 230.7 | 66.2 | 300 | 288.4 | 82.7 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

74° 4h 56m

## TRAVERSE TABLE TO DEGREES

16° 1h 4m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 289.3 | 82.9 | 361 | 347.0 | 99.5 | 421 | 404.7 | 116.0 | 481 | 462.4 | 132.5 | 541 | 520.1 | 149.1 |
| 302 | 290.3 | 83.2 | 362 | 348.0 | 99.7 | 422 | 405.6 | 116.3 | 482 | 463.3 | 132.8 | 542 | 521.0 | 149.4 |
| 303 | 291.2 | 83.5 | 363 | 348.9 | 100.0 | 423 | 406.6 | 116.6 | 483 | 464.3 | 133.1 | 543 | 522.0 | 149.7 |
| 304 | 292.2 | 83.8 | 364 | 349.9 | 100.3 | 424 | 407.6 | 116.8 | 484 | 465.2 | 133.4 | 544 | 523.0 | 150.0 |
| 305 | 293.2 | 84.0 | 365 | 350.8 | 100.6 | 425 | 408.5 | 117.1 | 485 | 466.2 | 133.6 | 545 | 523.9 | 150.2 |
| 306 | 294.1 | 84.3 | 366 | 351.8 | 100.8 | 426 | 409.5 | 117.4 | 486 | 467.2 | 133.9 | 546 | 524.9 | 150.4 |
| 307 | 295.1 | 84.6 | 367 | 352.8 | 101.1 | 427 | 410.4 | 117.7 | 487 | 468.1 | 134.2 | 547 | 525.9 | 150.7 |
| 308 | 296.0 | 84.9 | 368 | 353.7 | 101.4 | 428 | 411.4 | 117.9 | 488 | 469.1 | 134.5 | 548 | 526.8 | 151.0 |
| 309 | 297.0 | 85.1 | 369 | 354.7 | 101.7 | 429 | 412.4 | 118.2 | 489 | 470.1 | 134.8 | 549 | 527.8 | 151.3 |
| 310 | 298.0 | 85.4 | 370 | 355.6 | 101.9 | 430 | 413.3 | 118.5 | 490 | 471.0 | 135.0 | 550 | 528.7 | 151.6 |
| 311 | 298.9 | 85.7 | 371 | 356.6 | 102.2 | 431 | 414.3 | 118.8 | 491 | 472.0 | 135.3 | 551 | 529.7 | 151.9 |
| 312 | 299.9 | 86.0 | 372 | 357.6 | 102.5 | 432 | 415.2 | 119.0 | 492 | 472.9 | 135.6 | 552 | 530.6 | 152.2 |
| 313 | 300.9 | 86.2 | 373 | 358.5 | 102.8 | 433 | 416.2 | 119.3 | 493 | 473.9 | 135.9 | 553 | 531.6 | 152.5 |
| 314 | 301.8 | 86.5 | 374 | 359.5 | 103.1 | 434 | 417.2 | 119.6 | 494 | 474.9 | 136.2 | 554 | 532.6 | 152.8 |
| 315 | 302.8 | 86.8 | 375 | 360.4 | 103.3 | 435 | 418.1 | 119.9 | 495 | 475.8 | 136.4 | 555 | 533.5 | 153.0 |
| 316 | 303.7 | 87.1 | 376 | 361.4 | 103.6 | 436 | 419.1 | 120.1 | 496 | 476.8 | 136.7 | 556 | 534.5 | 153.2 |
| 317 | 304.7 | 87.3 | 377 | 362.4 | 103.9 | 437 | 420.0 | 120.4 | 497 | 477.7 | 137.0 | 557 | 535.4 | 153.5 |
| 318 | 305.7 | 87.6 | 378 | 363.3 | 104.2 | 438 | 421.0 | 120.7 | 498 | 478.7 | 137.3 | 558 | 536.4 | 153.8 |
| 319 | 306.6 | 87.9 | 379 | 364.3 | 104.4 | 439 | 422.0 | 121.0 | 499 | 479.7 | 137.5 | 559 | 537.4 | 154.1 |
| 320 | 307.6 | 88.2 | 380 | 365.3 | 104.7 | 440 | 422.9 | 121.2 | 500 | 480.6 | 137.8 | 560 | 538.3 | 154.4 |
| 321 | 308.5 | 88.4 | 381 | 366.2 | 105.0 | 441 | 423.9 | 121.5 | 501 | 481.6 | 138.1 | 561 | 539.3 | 154.7 |
| 322 | 309.5 | 88.7 | 382 | 367.2 | 105.3 | 442 | 424.9 | 121.8 | 502 | 482.6 | 138.3 | 562 | 540.3 | 154.9 |
| 323 | 310.5 | 89.0 | 383 | 368.1 | 105.5 | 443 | 425.8 | 122.1 | 503 | 483.5 | 138.6 | 563 | 541.2 | 155.2 |
| 324 | 311.4 | 89.3 | 384 | 369.1 | 105.8 | 444 | 426.8 | 122.3 | 504 | 484.5 | 138.9 | 564 | 542.2 | 155.4 |
| 325 | 312.4 | 89.5 | 385 | 370.1 | 106.1 | 445 | 427.7 | 122.6 | 505 | 485.4 | 139.2 | 565 | 543.1 | 155.7 |
| 326 | 313.3 | 89.8 | 386 | 371.0 | 106.4 | 446 | 428.7 | 122.9 | 506 | 486.4 | 139.4 | 566 | 544.1 | 156.0 |
| 327 | 314.3 | 90.1 | 387 | 372.0 | 106.6 | 447 | 429.7 | 123.2 | 507 | 487.3 | 139.7 | 567 | 545.1 | 156.3 |
| 328 | 315.3 | 90.4 | 388 | 372.9 | 106.9 | 448 | 430.6 | 123.4 | 508 | 488.3 | 140.0 | 568 | 546.0 | 156.6 |
| 329 | 316.2 | 90.6 | 389 | 373.9 | 107.2 | 449 | 431.6 | 123.7 | 509 | 489.3 | 140.3 | 569 | 547.0 | 156.9 |
| 330 | 317.2 | 90.9 | 390 | 374.9 | 107.5 | 450 | 432.6 | 124.0 | 510 | 490.2 | 140.6 | 570 | 547.9 | 157.1 |
| 331 | 318.2 | 91.2 | 391 | 375.8 | 107.7 | 451 | 433.5 | 124.3 | 511 | 491.2 | 140.8 | 571 | 548.9 | 157.3 |
| 332 | 319.1 | 91.5 | 392 | 376.8 | 108.0 | 452 | 434.5 | 124.6 | 512 | 492.1 | 141.1 | 572 | 549.8 | 157.6 |
| 333 | 320.1 | 91.8 | 393 | 377.8 | 108.3 | 453 | 435.4 | 124.8 | 513 | 493.1 | 141.4 | 573 | 550.8 | 157.9 |
| 334 | 321.0 | 92.0 | 394 | 378.7 | 108.6 | 454 | 436.4 | 125.1 | 514 | 494.1 | 141.7 | 574 | 551.8 | 158.2 |
| 335 | 322.0 | 92.3 | 395 | 379.7 | 108.8 | 455 | 437.4 | 125.4 | 515 | 495.0 | 141.9 | 575 | 552.7 | 158.4 |
| 336 | 323.0 | 92.6 | 396 | 380.6 | 109.1 | 456 | 438.3 | 125.7 | 516 | 496.0 | 142.2 | 576 | 553.7 | 158.7 |
| 337 | 323.9 | 92.9 | 397 | 381.6 | 109.4 | 457 | 439.3 | 125.9 | 517 | 496.9 | 142.5 | 577 | 554.6 | 159.0 |
| 338 | 324.9 | 93.1 | 398 | 382.6 | 109.7 | 458 | 440.2 | 126.2 | 518 | 497.9 | 142.8 | 578 | 555.6 | 159.3 |
| 339 | 325.8 | 93.4 | 399 | 383.5 | 109.9 | 459 | 441.2 | 126.5 | 519 | 498.9 | 143.0 | 579 | 556.5 | 159.5 |
| 340 | 326.8 | 93.7 | 400 | 384.5 | 110.2 | 460 | 442.2 | 126.8 | 520 | 499.8 | 143.3 | 580 | 557.5 | 159.8 |
| 341 | 327.8 | 94.0 | 401 | 385.4 | 110.5 | 461 | 443.1 | 127.0 | 521 | 500.8 | 143.6 | 581 | 558.4 | 160.1 |
| 342 | 328.7 | 94.2 | 402 | 386.4 | 110.8 | 462 | 444.1 | 127.3 | 522 | 501.7 | 143.9 | 582 | 559.4 | 160.4 |
| 343 | 329.7 | 94.5 | 403 | 387.4 | 111.0 | 463 | 445.0 | 127.6 | 523 | 502.7 | 144.1 | 583 | 560.4 | 160.6 |
| 344 | 330.7 | 94.8 | 404 | 388.3 | 111.3 | 464 | 446.0 | 127.9 | 524 | 503.7 | 144.4 | 584 | 561.3 | 161.0 |
| 345 | 331.6 | 95.1 | 405 | 389.3 | 111.6 | 465 | 447.0 | 128.1 | 525 | 504.6 | 144.7 | 585 | 562.3 | 161.3 |
| 346 | 332.6 | 95.3 | 406 | 390.2 | 111.9 | 466 | 447.9 | 128.4 | 526 | 505.6 | 145.0 | 586 | 563.2 | 161.6 |
| 347 | 333.5 | 95.6 | 407 | 391.2 | 112.1 | 467 | 448.9 | 128.7 | 527 | 506.6 | 145.3 | 587 | 564.2 | 161.8 |
| 348 | 334.5 | 95.9 | 408 | 392.2 | 112.4 | 468 | 449.8 | 129.0 | 528 | 507.5 | 145.6 | 588 | 565.2 | 162.1 |
| 349 | 335.5 | 96.2 | 409 | 393.1 | 112.7 | 469 | 450.8 | 129.2 | 529 | 508.5 | 145.8 | 589 | 566.1 | 162.4 |
| 350 | 336.4 | 96.4 | 410 | 394.1 | 113.0 | 470 | 451.8 | 129.5 | 530 | 509.4 | 146.1 | 590 | 567.1 | 162.7 |
| 351 | 337.4 | 96.7 | 411 | 395.1 | 113.3 | 471 | 452.7 | 129.8 | 531 | 510.4 | 146.4 | 591 | 568.1 | 162.9 |
| 352 | 338.3 | 97.0 | 412 | 396.0 | 113.5 | 472 | 453.7 | 130.1 | 532 | 511.4 | 146.7 | 592 | 569.0 | 163.2 |
| 353 | 339.3 | 97.3 | 413 | 397.0 | 113.8 | 473 | 454.7 | 130.3 | 533 | 512.3 | 146.9 | 593 | 570.0 | 163.5 |
| 354 | 340.3 | 97.5 | 414 | 397.9 | 114.1 | 474 | 455.6 | 130.6 | 534 | 513.3 | 147.2 | 594 | 571.0 | 163.8 |
| 355 | 341.2 | 97.8 | 415 | 398.9 | 114.4 | 475 | 456.6 | 130.9 | 535 | 514.3 | 147.5 | 595 | 571.9 | 164.0 |
| 356 | 342.2 | 98.1 | 416 | 399.9 | 114.6 | 476 | 457.5 | 131.2 | 536 | 515.2 | 147.8 | 596 | 572.9 | 164.3 |
| 357 | 343.1 | 98.4 | 417 | 400.8 | 114.9 | 477 | 458.5 | 131.4 | 537 | 516.2 | 148.0 | 597 | 573.9 | 164.6 |
| 358 | 344.1 | 98.6 | 418 | 401.8 | 115.2 | 478 | 459.5 | 131.7 | 538 | 517.2 | 148.2 | 598 | 574.8 | 164.9 |
| 359 | 345.1 | 98.9 | 419 | 402.7 | 115.5 | 479 | 460.4 | 132.0 | 539 | 518.1 | 148.5 | 599 | 575.8 | 165.1 |
| 360 | 346.0 | 99.2 | 420 | 403.7 | 115.8 | 480 | 461.4 | 132.3 | 540 | 519.1 | 148.8 | 600 | 576.8 | 165.4 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

74° 4h 56m

## TRAVERSE TABLE TO DEGREES

17° — $1^h\ 8^m$

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1·0 | 0·3 | 61 | 58·3 | 17·8 | 121 | 115·7 | 35·4 | 181 | 173·1 | 52·9 | 241 | 230·5 | 70·5 |
| 2 | 1·9 | 0·6 | 62 | 59·3 | 18·1 | 122 | 116·7 | 35·7 | 182 | 174·0 | 53·2 | 242 | 231·4 | 70·8 |
| 3 | 2·9 | 0·9 | 63 | 60·2 | 18·4 | 123 | 117·6 | 36·0 | 183 | 175·0 | 53·5 | 243 | 232·4 | 71·0 |
| 4 | 3·8 | 1·2 | 64 | 61·2 | 18·7 | 124 | 118·6 | 36·3 | 184 | 176·0 | 53·8 | 244 | 233·3 | 71·3 |
| 5 | 4·8 | 1·5 | 65 | 62·2 | 19·0 | 125 | 119·5 | 36·5 | 185 | 176·9 | 54·1 | 245 | 234·3 | 71·6 |
| 6 | 5·7 | 1·8 | 66 | 63·1 | 19·3 | 126 | 120·5 | 36·8 | 186 | 177·9 | 54·4 | 246 | 235·3 | 71·9 |
| 7 | 6·7 | 2·0 | 67 | 64·1 | 19·6 | 127 | 121·5 | 37·1 | 187 | 178·8 | 54·7 | 247 | 236·2 | 72·2 |
| 8 | 7·7 | 2·3 | 68 | 65·0 | 19·9 | 128 | 122·4 | 37·4 | 188 | 179·8 | 55·0 | 248 | 237·2 | 72·5 |
| 9 | 8·6 | 2·6 | 69 | 66·0 | 20·2 | 129 | 123·4 | 37·7 | 189 | 180·7 | 55·3 | 249 | 238·1 | 72·8 |
| 10 | 9·6 | 2·9 | 70 | 66·9 | 20·5 | 130 | 124·3 | 38·0 | 190 | 181·7 | 55·6 | 250 | 239·1 | 73·1 |
| 11 | 10·5 | 3·2 | 71 | 67·9 | 20·8 | 131 | 125·3 | 38·3 | 191 | 182·7 | 55·8 | 251 | 240·0 | 73·4 |
| 12 | 11·5 | 3·5 | 72 | 68·9 | 21·1 | 132 | 126·2 | 38·6 | 192 | 183·6 | 56·1 | 252 | 241·0 | 73·7 |
| 13 | 12·4 | 3·8 | 73 | 69·8 | 21·3 | 133 | 127·2 | 38·9 | 193 | 184·6 | 56·4 | 253 | 241·9 | 74·0 |
| 14 | 13·4 | 4·1 | 74 | 70·8 | 21·6 | 134 | 128·1 | 39·2 | 194 | 185·5 | 56·7 | 254 | 242·9 | 74·3 |
| 15 | 14·3 | 4·4 | 75 | 71·7 | 21·9 | 135 | 129·1 | 39·5 | 195 | 186·5 | 57·0 | 255 | 243·9 | 74·6 |
| 16 | 15·3 | 4·7 | 76 | 72·7 | 22·2 | 136 | 130·1 | 39·8 | 196 | 187·4 | 57·3 | 256 | 244·8 | 74·8 |
| 17 | 16·3 | 5·0 | 77 | 73·6 | 22·5 | 137 | 131·0 | 40·1 | 197 | 188·4 | 57·6 | 257 | 245·8 | 75·1 |
| 18 | 17·2 | 5·3 | 78 | 74·6 | 22·8 | 138 | 132·0 | 40·3 | 198 | 189·3 | 57·9 | 258 | 246·7 | 75·4 |
| 19 | 18·2 | 5·6 | 79 | 75·5 | 23·1 | 139 | 132·9 | 40·6 | 199 | 190·3 | 58·2 | 259 | 247·7 | 75·7 |
| 20 | 19·1 | 5·8 | 80 | 76·5 | 23·4 | 140 | 133·9 | 40·9 | 200 | 191·3 | 58·5 | 260 | 248·6 | 76·0 |
| 21 | 20·1 | 6·1 | 81 | 77·5 | 23·7 | 141 | 134·8 | 41·2 | 201 | 192·2 | 58·8 | 261 | 249·6 | 76·3 |
| 22 | 21·0 | 6·4 | 82 | 78·4 | 24·0 | 142 | 135·8 | 41·5 | 202 | 193·2 | 59·1 | 262 | 250·6 | 76·6 |
| 23 | 22·0 | 6·7 | 83 | 79·4 | 24·3 | 143 | 136·8 | 41·8 | 203 | 194·1 | 59·4 | 263 | 251·5 | 76·9 |
| 24 | 23·0 | 7·0 | 84 | 80·3 | 24·6 | 144 | 137·7 | 42·1 | 204 | 195·1 | 59·6 | 264 | 252·5 | 77·2 |
| 25 | 23·9 | 7·3 | 85 | 81·3 | 24·9 | 145 | 138·7 | 42·4 | 205 | 196·0 | 59·9 | 265 | 253·4 | 77·5 |
| 26 | 24·9 | 7·6 | 86 | 82·2 | 25·1 | 146 | 139·6 | 42·7 | 206 | 197·0 | 60·2 | 266 | 254·4 | 77·8 |
| 27 | 25·8 | 7·9 | 87 | 83·2 | 25·4 | 147 | 140·6 | 43·0 | 207 | 198·0 | 60·5 | 267 | 255·3 | 78·1 |
| 28 | 26·8 | 8·2 | 88 | 84·2 | 25·7 | 148 | 141·5 | 43·3 | 208 | 198·9 | 60·8 | 268 | 256·3 | 78·4 |
| 29 | 27·7 | 8·5 | 89 | 85·1 | 26·0 | 149 | 142·5 | 43·6 | 209 | 199·9 | 61·1 | 269 | 257·2 | 78·6 |
| 30 | 28·7 | 8·8 | 90 | 86·1 | 26·3 | 150 | 143·4 | 43·9 | 210 | 200·8 | 61·4 | 270 | 258·2 | 78·9 |
| 31 | 29·6 | 9·1 | 91 | 87·0 | 26·6 | 151 | 144·4 | 44·1 | 211 | 201·8 | 61·7 | 271 | 259·2 | 79·2 |
| 32 | 30·6 | 9·4 | 92 | 88·0 | 26·9 | 152 | 145·4 | 44·4 | 212 | 202·7 | 62·0 | 272 | 260·1 | 79·5 |
| 33 | 31·6 | 9·6 | 93 | 88·9 | 27·2 | 153 | 146·3 | 44·7 | 213 | 203·7 | 62·3 | 273 | 261·1 | 79·8 |
| 34 | 32·5 | 9·9 | 94 | 89·9 | 27·5 | 154 | 147·3 | 45·0 | 214 | 204·6 | 62·6 | 274 | 262·0 | 80·1 |
| 35 | 33·5 | 10·2 | 95 | 90·8 | 27·8 | 155 | 148·2 | 45·3 | 215 | 205·6 | 62·9 | 275 | 263·0 | 80·4 |
| 36 | 34·4 | 10·5 | 96 | 91·8 | 28·1 | 156 | 149·2 | 45·6 | 216 | 206·6 | 63·2 | 276 | 263·9 | 80·7 |
| 37 | 35·4 | 10·8 | 97 | 92·8 | 28·4 | 157 | 150·1 | 45·9 | 217 | 207·5 | 63·4 | 277 | 264·9 | 81·0 |
| 38 | 36·3 | 11·1 | 98 | 93·7 | 28·7 | 158 | 151·1 | 46·2 | 218 | 208·5 | 63·7 | 278 | 265·9 | 81·3 |
| 39 | 37·3 | 11·4 | 99 | 94·7 | 28·9 | 159 | 152·1 | 46·5 | 219 | 209·4 | 64·0 | 279 | 266·8 | 81·6 |
| 40 | 38·3 | 11·7 | 100 | 95·6 | 29·2 | 160 | 153·0 | 46·8 | 220 | 210·4 | 64·3 | 280 | 267·8 | 81·9 |
| 41 | 39·2 | 12·0 | 101 | 96·6 | 29·5 | 161 | 154·0 | 47·1 | 221 | 211·3 | 64·6 | 281 | 268·7 | 82·2 |
| 42 | 40·2 | 12·3 | 102 | 97·5 | 29·8 | 162 | 154·9 | 47·4 | 222 | 212·3 | 64·9 | 282 | 269·7 | 82·4 |
| 43 | 41·1 | 12·6 | 103 | 98·5 | 30·1 | 163 | 155·9 | 47·7 | 223 | 213·3 | 65·2 | 283 | 270·6 | 82·7 |
| 44 | 42·1 | 12·9 | 104 | 99·5 | 30·4 | 164 | 156·8 | 47·9 | 224 | 214·2 | 65·5 | 284 | 271·6 | 83·0 |
| 45 | 43·0 | 13·2 | 105 | 100·4 | 30·7 | 165 | 157·8 | 48·2 | 225 | 215·2 | 65·8 | 285 | 272·5 | 83·3 |
| 46 | 44·0 | 13·4 | 106 | 101·4 | 31·0 | 166 | 158·7 | 48·5 | 226 | 216·1 | 66·1 | 286 | 273·5 | 83·6 |
| 47 | 44·9 | 13·7 | 107 | 102·3 | 31·3 | 167 | 159·7 | 48·8 | 227 | 217·1 | 66·4 | 287 | 274·5 | 83·9 |
| 48 | 45·9 | 14·0 | 108 | 103·3 | 31·6 | 168 | 160·7 | 49·1 | 228 | 218·0 | 66·7 | 288 | 275·4 | 84·2 |
| 49 | 46·9 | 14·3 | 109 | 104·2 | 31·9 | 169 | 161·6 | 49·4 | 229 | 219·0 | 67·0 | 289 | 276·4 | 84·5 |
| 50 | 47·8 | 14·6 | 110 | 105·2 | 32·2 | 170 | 162·6 | 49·7 | 230 | 220·0 | 67·2 | 290 | 277·3 | 84·8 |
| 51 | 48·8 | 14·9 | 111 | 106·1 | 32·5 | 171 | 163·5 | 50·0 | 231 | 220·9 | 67·5 | 291 | 278·3 | 85·1 |
| 52 | 49·7 | 15·2 | 112 | 107·1 | 32·7 | 172 | 164·5 | 50·3 | 232 | 221·9 | 67·8 | 292 | 279·2 | 85·4 |
| 53 | 50·7 | 15·5 | 113 | 108·1 | 33·0 | 173 | 165·4 | 50·6 | 233 | 222·8 | 68·1 | 293 | 280·2 | 85·7 |
| 54 | 51·6 | 15·8 | 114 | 109·0 | 33·3 | 174 | 166·4 | 50·9 | 234 | 223·8 | 68·4 | 294 | 281·2 | 86·0 |
| 55 | 52·6 | 16·1 | 115 | 110·0 | 33·6 | 175 | 167·4 | 51·2 | 235 | 224·7 | 68·7 | 295 | 282·1 | 86·2 |
| 56 | 53·6 | 16·4 | 116 | 110·9 | 33·9 | 176 | 168·3 | 51·5 | 236 | 225·7 | 69·0 | 296 | 283·1 | 86·5 |
| 57 | 54·5 | 16·7 | 117 | 111·9 | 34·2 | 177 | 169·3 | 51·7 | 237 | 226·6 | 69·3 | 297 | 284·0 | 86·8 |
| 58 | 55·5 | 17·0 | 118 | 112·8 | 34·5 | 178 | 170·2 | 52·0 | 238 | 227·6 | 69·6 | 298 | 285·0 | 87·1 |
| 59 | 56·4 | 17·2 | 119 | 113·8 | 34·8 | 179 | 171·2 | 52·3 | 239 | 228·6 | 69·9 | 299 | 285·9 | 87·4 |
| 60 | 57·4 | 17·5 | 120 | 114·8 | 35·1 | 180 | 172·1 | 52·6 | 240 | 229·5 | 70·2 | 300 | 286·9 | 87·7 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

73° — $4^h\ 52^m$

## TRAVERSE TABLE TO DEGREES

17° 1h 8m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 287·8 | 88·0 | 361 | 345·2 | 105·5 | 421 | 402·6 | 123·1 | 481 | 460·0 | 140·6 | 541 | 517·3 | 158·2 |
| 302 | 288·8 | 88·3 | 362 | 346·1 | 105·8 | 422 | 403·5 | 123·4 | 482 | 460·9 | 140·9 | 542 | 518·3 | 158·5 |
| 303 | 289·7 | 88·6 | 363 | 347·1 | 106·1 | 423 | 404·5 | 123·7 | 483 | 461·9 | 141·2 | 543 | 519·2 | 158·8 |
| 304 | 290·7 | 88·9 | 364 | 348·1 | 106·4 | 424 | 405·4 | 124·0 | 484 | 462·8 | 141·5 | 544 | 520·2 | 159·1 |
| 305 | 291·6 | 89·2 | 365 | 349·0 | 106·7 | 425 | 406·4 | 124·3 | 485 | 463·8 | 141·8 | 545 | 521·2 | 159·3 |
| 306 | 292·6 | 89·5 | 366 | 350·0 | 107·0 | 426 | 407·3 | 124·6 | 486 | 464·7 | 142·1 | 546 | 522·1 | 159·6 |
| 307 | 293·5 | 89·8 | 367 | 350·9 | 107·3 | 427 | 408·3 | 124·8 | 487 | 465·7 | 142·3 | 547 | 523·1 | 159·9 |
| 308 | 294·5 | 90·1 | 368 | 351·9 | 107·6 | 428 | 409·3 | 125·1 | 488 | 466·7 | 142·6 | 548 | 524·0 | 160·2 |
| 309 | 295·5 | 90·3 | 369 | 352·8 | 107·9 | 429 | 410·2 | 125·4 | 489 | 467·6 | 142·9 | 549 | 525·0 | 160·5 |
| 310 | 296·4 | 90·6 | 370 | 353·8 | 108·2 | 430 | 411·2 | 125·7 | 490 | 468·6 | 143·2 | 550 | 526·0 | 160·8 |
| 311 | 297·4 | 90·9 | 371 | 354·8 | 108·5 | 431 | 412·1 | 126·0 | 491 | 469·5 | 143·5 | 551 | 526·9 | 161·1 |
| 312 | 298·3 | 91·2 | 372 | 355·7 | 108·8 | 432 | 413·1 | 126·3 | 492 | 470·5 | 143·8 | 552 | 527·9 | 161·4 |
| 313 | 299·3 | 91·5 | 373 | 356·7 | 109·1 | 433 | 414·0 | 126·6 | 493 | 471·4 | 144·1 | 553 | 528·8 | 161·7 |
| 314 | 300·2 | 91·8 | 374 | 357·6 | 109·4 | 434 | 415·0 | 126·9 | 494 | 472·4 | 144·4 | 554 | 529·8 | 162·0 |
| 315 | 301·2 | 92·1 | 375 | 358·6 | 109·6 | 435 | 416·0 | 127·2 | 495 | 473·4 | 144·7 | 555 | 530·8 | 162·3 |
| 316 | 302·2 | 92·4 | 376 | 359·5 | 109·9 | 436 | 416·9 | 127·5 | 496 | 474·3 | 145·0 | 556 | 531·7 | 162·6 |
| 317 | 303·1 | 92·7 | 377 | 360·5 | 110·2 | 437 | 417·9 | 127·8 | 497 | 475·3 | 145·3 | 557 | 532·7 | 162·9 |
| 318 | 304·1 | 93·0 | 378 | 361·4 | 110·5 | 438 | 418·8 | 128·1 | 498 | 476·2 | 145·6 | 558 | 533·6 | 163·2 |
| 319 | 305·0 | 93·3 | 379 | 362·4 | 110·8 | 439 | 419·8 | 128·4 | 499 | 477·2 | 145·9 | 559 | 534·6 | 163·5 |
| 320 | 306·0 | 93·6 | 380 | 363·4 | 111·1 | 440 | 420·7 | 128·6 | 500 | 478·1 | 146·2 | 560 | 535·5 | 163·8 |
| 321 | 306·9 | 93·9 | 381 | 364·3 | 111·4 | 441 | 421·7 | 128·9 | 501 | 479·1 | 146·5 | 561 | 536·5 | 164·1 |
| 322 | 307·9 | 94·1 | 382 | 365·3 | 111·7 | 442 | 422·7 | 129·2 | 502 | 480·1 | 146·8 | 562 | 537·5 | 164·4 |
| 323 | 308·8 | 94·4 | 383 | 366·2 | 112·0 | 443 | 423·6 | 129·5 | 503 | 481·0 | 147·1 | 563 | 538·4 | 164·6 |
| 324 | 309·8 | 94·7 | 384 | 367·2 | 112·3 | 444 | 424·6 | 129·8 | 504 | 482·0 | 147·4 | 564 | 539·4 | 164·8 |
| 325 | 310·8 | 95·0 | 385 | 368·1 | 112·6 | 445 | 425·5 | 130·1 | 505 | 482·9 | 147·7 | 565 | 540·3 | 165·1 |
| 326 | 311·7 | 95·3 | 386 | 369·1 | 112·9 | 446 | 426·5 | 130·4 | 506 | 483·9 | 148·0 | 566 | 541·3 | 165·4 |
| 327 | 312·7 | 95·6 | 387 | 370·1 | 113·2 | 447 | 427·4 | 130·7 | 507 | 484·8 | 148·3 | 567 | 542·2 | 165·7 |
| 328 | 313·6 | 95·9 | 388 | 371·0 | 113·4 | 448 | 428·4 | 131·0 | 508 | 485·8 | 148·6 | 568 | 543·2 | 166·0 |
| 329 | 314·6 | 96·2 | 389 | 372·0 | 113·7 | 449 | 429·3 | 131·3 | 509 | 486·7 | 148·9 | 569 | 544·1 | 166·4 |
| 330 | 315·5 | 96·5 | 390 | 372·9 | 114·0 | 450 | 430·3 | 131·6 | 510 | 487·7 | 149·1 | 570 | 545·1 | 166·7 |
| 331 | 316·5 | 96·8 | 391 | 373·9 | 114·3 | 451 | 431·3 | 131·9 | 511 | 488·7 | 149·4 | 571 | 546·1 | 167·0 |
| 332 | 317·5 | 97·1 | 392 | 374·8 | 114·6 | 452 | 432·2 | 132·2 | 512 | 489·6 | 149·7 | 572 | 547·0 | 167·2 |
| 333 | 318·4 | 97·4 | 393 | 375·8 | 114·9 | 453 | 433·2 | 132·4 | 513 | 490·6 | 150·0 | 573 | 548·0 | 167·5 |
| 334 | 319·4 | 97·7 | 394 | 376·7 | 115·2 | 454 | 434·1 | 132·7 | 514 | 491·5 | 150·2 | 574 | 548·9 | 167·8 |
| 335 | 320·3 | 97·9 | 395 | 377·7 | 115·5 | 455 | 435·1 | 133·0 | 515 | 492·5 | 150·5 | 575 | 549·9 | 168·1 |
| 336 | 321·3 | 98·2 | 396 | 378·7 | 115·8 | 456 | 436·0 | 133·3 | 516 | 493·4 | 150·8 | 576 | 550·8 | 168·4 |
| 337 | 322·2 | 98·5 | 397 | 379·6 | 116·1 | 457 | 437·0 | 133·6 | 517 | 494·4 | 151·1 | 577 | 551·8 | 168·7 |
| 338 | 323·2 | 98·8 | 398 | 380·6 | 116·4 | 458 | 438·0 | 133·9 | 518 | 495·3 | 151·4 | 578 | 552·7 | 169·0 |
| 339 | 324·2 | 99·1 | 399 | 381·5 | 116·7 | 459 | 438·9 | 134·2 | 519 | 496·3 | 151·7 | 579 | 553·7 | 169·3 |
| 340 | 325·1 | 99·4 | 400 | 382·5 | 117·0 | 460 | 439·9 | 134·5 | 520 | 497·2 | 152·0 | 580 | 554·6 | 169·6 |
| 341 | 326·1 | 99·7 | 401 | 383·4 | 117·2 | 461 | 440·8 | 134·8 | 521 | 498·2 | 152·3 | 581 | 555·6 | 169·9 |
| 342 | 327·0 | 100·0 | 402 | 384·4 | 117·5 | 462 | 441·8 | 135·1 | 522 | 499·2 | 152·6 | 582 | 556·5 | 170·2 |
| 343 | 328·0 | 100·3 | 403 | 385·4 | 117·8 | 463 | 442·7 | 135·4 | 523 | 500·1 | 152·9 | 583 | 557·5 | 170·5 |
| 344 | 328·9 | 100·6 | 404 | 386·3 | 118·1 | 464 | 443·7 | 135·7 | 524 | 501·1 | 153·2 | 584 | 558·4 | 170·8 |
| 345 | 329·9 | 100·9 | 405 | 387·3 | 118·4 | 465 | 444·6 | 136·0 | 525 | 502·0 | 153·5 | 585 | 559·4 | 171·1 |
| 346 | 330·8 | 101·2 | 406 | 388·2 | 118·7 | 466 | 445·6 | 136·2 | 526 | 503·0 | 153·8 | 586 | 560·4 | 171·3 |
| 347 | 331·8 | 101·5 | 407 | 389·2 | 119·0 | 467 | 446·6 | 136·5 | 527 | 503·9 | 154·1 | 587 | 561·3 | 171·6 |
| 348 | 332·8 | 101·8 | 408 | 390·1 | 119·3 | 468 | 447·5 | 136·8 | 528 | 504·9 | 154·4 | 588 | 562·3 | 171·9 |
| 349 | 333·7 | 102·0 | 409 | 391·1 | 119·6 | 469 | 448·5 | 137·1 | 529 | 505·9 | 154·7 | 589 | 563·2 | 172·2 |
| 350 | 334·7 | 102·3 | 410 | 392·0 | 119·9 | 470 | 449·4 | 137·4 | 530 | 506·8 | 155·0 | 590 | 564·2 | 172·5 |
| 351 | 335·6 | 102·6 | 411 | 393·0 | 120·2 | 471 | 450·4 | 137·7 | 531 | 507·8 | 155·3 | 591 | 565·1 | 172·8 |
| 352 | 336·6 | 102·9 | 412 | 394·0 | 120·5 | 472 | 451·3 | 138·0 | 532 | 508·7 | 155·6 | 592 | 566·1 | 173·1 |
| 353 | 337·5 | 103·2 | 413 | 394·9 | 120·8 | 473 | 452·3 | 138·3 | 533 | 509·7 | 155·9 | 593 | 567·1 | 173·4 |
| 354 | 338·5 | 103·5 | 414 | 395·9 | 121·0 | 474 | 453·3 | 138·6 | 534 | 510·6 | 156·2 | 594 | 568·0 | 173·7 |
| 355 | 339·5 | 103·8 | 415 | 396·8 | 121·3 | 475 | 454·2 | 138·9 | 535 | 511·6 | 156·5 | 595 | 569·0 | 174·0 |
| 356 | 340·4 | 104·1 | 416 | 397·8 | 121·6 | 476 | 455·2 | 139·2 | 536 | 512·6 | 156·8 | 596 | 569·9 | 174·3 |
| 357 | 341·4 | 104·4 | 417 | 398·7 | 121·9 | 477 | 456·1 | 139·5 | 537 | 513·5 | 157·1 | 597 | 570·9 | 174·6 |
| 358 | 342·3 | 104·7 | 418 | 399·7 | 122·2 | 478 | 457·1 | 139·8 | 538 | 514·5 | 157·3 | 598 | 571·8 | 174·9 |
| 359 | 343·3 | 105·0 | 419 | 400·7 | 122·5 | 479 | 458·0 | 140·0 | 539 | 515·4 | 157·6 | 599 | 572·8 | 175·2 |
| 360 | 344·2 | 105·3 | 420 | 401·6 | 122·8 | 480 | 459·0 | 140·3 | 540 | 516·4 | 157·9 | 600 | 573·8 | 175·4 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

73° 4h 52m

## TRAVERSE TABLE TO DEGREES

18° — 1h 12m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0 | 0.3 | 61 | 58.0 | 18.9 | 121 | 115.1 | 37.4 | 181 | 172.1 | 55.9 | 241 | 229.2 | 74.5 |
| 2 | 1.9 | 0.6 | 62 | 59.0 | 19.2 | 122 | 116.0 | 37.7 | 182 | 173.1 | 56.2 | 242 | 230.2 | 74.8 |
| 3 | 2.9 | 0.9 | 63 | 59.9 | 19.5 | 123 | 117.0 | 38.0 | 183 | 174.0 | 56.6 | 243 | 231.1 | 75.1 |
| 4 | 3.8 | 1.2 | 64 | 60.9 | 19.8 | 124 | 117.9 | 38.3 | 184 | 175.0 | 56.9 | 244 | 232.1 | 75.4 |
| 5 | 4.8 | 1.5 | 65 | 61.8 | 20.1 | 125 | 118.9 | 38.6 | 185 | 175.9 | 57.2 | 245 | 233.0 | 75.7 |
| 6 | 5.7 | 1.9 | 66 | 62.8 | 20.4 | 126 | 119.8 | 38.9 | 186 | 176.9 | 57.5 | 246 | 234.0 | 76.0 |
| 7 | 6.7 | 2.2 | 67 | 63.7 | 20.7 | 127 | 120.8 | 39.2 | 187 | 177.8 | 57.8 | 247 | 234.9 | 76.3 |
| 8 | 7.6 | 2.5 | 68 | 64.7 | 21.0 | 128 | 121.7 | 39.6 | 188 | 178.8 | 58.1 | 248 | 235.9 | 76.6 |
| 9 | 8.6 | 2.8 | 69 | 65.6 | 21.3 | 129 | 122.7 | 39.9 | 189 | 179.7 | 58.4 | 249 | 236.8 | 76.9 |
| 10 | 9.5 | 3.1 | 70 | 66.6 | 21.6 | 130 | 123.6 | 40.2 | 190 | 180.7 | 58.7 | 250 | 237.8 | 77.3 |
| 11 | 10.5 | 3.4 | 71 | 67.5 | 21.9 | 131 | 124.6 | 40.5 | 191 | 181.7 | 59.0 | 251 | 238.7 | 77.6 |
| 12 | 11.4 | 3.7 | 72 | 68.5 | 22.2 | 132 | 125.5 | 40.8 | 192 | 182.6 | 59.3 | 252 | 239.7 | 77.9 |
| 13 | 12.4 | 4.0 | 73 | 69.4 | 22.6 | 133 | 126.5 | 41.1 | 193 | 183.6 | 59.6 | 253 | 240.6 | 78.2 |
| 14 | 13.3 | 4.3 | 74 | 70.4 | 22.9 | 134 | 127.4 | 41.4 | 194 | 184.5 | 59.9 | 254 | 241.6 | 78.5 |
| 15 | 14.3 | 4.6 | 75 | 71.3 | 23.2 | 135 | 128.4 | 41.7 | 195 | 185.5 | 60.3 | 255 | 242.5 | 78.8 |
| 16 | 15.2 | 4.9 | 76 | 72.3 | 23.5 | 136 | 129.3 | 42.0 | 196 | 186.4 | 60.6 | 256 | 243.5 | 79.1 |
| 17 | 16.2 | 5.3 | 77 | 73.2 | 23.8 | 137 | 130.3 | 42.3 | 197 | 187.4 | 60.9 | 257 | 244.4 | 79.4 |
| 18 | 17.1 | 5.6 | 78 | 74.2 | 24.1 | 138 | 131.2 | 42.6 | 198 | 188.3 | 61.2 | 258 | 245.4 | 79.7 |
| 19 | 18.1 | 5.9 | 79 | 75.1 | 24.4 | 139 | 132.2 | 43.0 | 199 | 189.3 | 61.5 | 259 | 246.3 | 80.0 |
| 20 | 19.0 | 6.2 | 80 | 76.1 | 24.7 | 140 | 133.1 | 43.3 | 200 | 190.2 | 61.8 | 260 | 247.3 | 80.3 |
| 21 | 20.0 | 6.5 | 81 | 77.0 | 25.0 | 141 | 134.1 | 43.6 | 201 | 191.2 | 62.1 | 261 | 248.2 | 80.7 |
| 22 | 20.9 | 6.8 | 82 | 78.0 | 25.3 | 142 | 135.1 | 43.9 | 202 | 192.1 | 62.4 | 262 | 249.2 | 81.0 |
| 23 | 21.9 | 7.1 | 83 | 78.9 | 25.6 | 143 | 136.0 | 44.2 | 203 | 193.1 | 62.7 | 263 | 250.1 | 81.3 |
| 24 | 22.8 | 7.4 | 84 | 79.9 | 26.0 | 144 | 137.0 | 44.5 | 204 | 194.0 | 63.0 | 264 | 251.1 | 81.6 |
| 25 | 23.8 | 7.7 | 85 | 80.8 | 26.3 | 145 | 137.9 | 44.8 | 205 | 195.0 | 63.3 | 265 | 252.0 | 81.9 |
| 26 | 24.7 | 8.0 | 86 | 81.8 | 26.6 | 146 | 138.9 | 45.1 | 206 | 195.9 | 63.7 | 266 | 253.0 | 82.2 |
| 27 | 25.7 | 8.3 | 87 | 82.7 | 26.9 | 147 | 139.8 | 45.4 | 207 | 196.9 | 64.0 | 267 | 253.9 | 82.5 |
| 28 | 26.6 | 8.7 | 88 | 83.7 | 27.2 | 148 | 140.8 | 45.7 | 208 | 197.8 | 64.3 | 268 | 254.9 | 82.8 |
| 29 | 27.6 | 9.0 | 89 | 84.6 | 27.5 | 149 | 141.7 | 46.0 | 209 | 198.8 | 64.6 | 269 | 255.8 | 83.1 |
| 30 | 28.5 | 9.3 | 90 | 85.6 | 27.8 | 150 | 142.7 | 46.4 | 210 | 199.7 | 64.9 | 270 | 256.8 | 83.4 |
| 31 | 29.5 | 9.6 | 91 | 86.5 | 28.1 | 151 | 143.6 | 46.7 | 211 | 200.7 | 65.2 | 271 | 257.7 | 83.7 |
| 32 | 30.4 | 9.9 | 92 | 87.5 | 28.4 | 152 | 144.6 | 47.0 | 212 | 201.6 | 65.5 | 272 | 258.7 | 84.1 |
| 33 | 31.4 | 10.2 | 93 | 88.4 | 28.7 | 153 | 145.5 | 47.3 | 213 | 202.6 | 65.8 | 273 | 259.6 | 84.4 |
| 34 | 32.3 | 10.5 | 94 | 89.4 | 29.0 | 154 | 146.5 | 47.6 | 214 | 203.5 | 66.1 | 274 | 260.6 | 84.7 |
| 35 | 33.3 | 10.8 | 95 | 90.4 | 29.4 | 155 | 147.4 | 47.9 | 215 | 204.5 | 66.4 | 275 | 261.5 | 85.0 |
| 36 | 34.2 | 11.1 | 96 | 91.3 | 29.7 | 156 | 148.4 | 48.2 | 216 | 205.4 | 66.7 | 276 | 262.5 | 85.3 |
| 37 | 35.2 | 11.4 | 97 | 92.3 | 30.0 | 157 | 149.3 | 48.5 | 217 | 206.4 | 67.1 | 277 | 263.4 | 85.6 |
| 38 | 36.1 | 11.7 | 98 | 93.2 | 30.3 | 158 | 150.3 | 48.8 | 218 | 207.3 | 67.4 | 278 | 264.4 | 85.9 |
| 39 | 37.1 | 12.1 | 99 | 94.2 | 30.6 | 159 | 151.2 | 49.1 | 219 | 208.3 | 67.7 | 279 | 265.3 | 86.2 |
| 40 | 38.0 | 12.4 | 100 | 95.1 | 30.9 | 160 | 152.2 | 49.4 | 220 | 209.2 | 68.0 | 280 | 266.3 | 86.5 |
| 41 | 39.0 | 12.7 | 101 | 96.1 | 31.2 | 161 | 153.1 | 49.8 | 221 | 210.2 | 68.3 | 281 | 267.2 | 86.8 |
| 42 | 39.9 | 13.0 | 102 | 97.0 | 31.5 | 162 | 154.1 | 50.1 | 222 | 211.1 | 68.6 | 282 | 268.2 | 87.1 |
| 43 | 40.9 | 13.3 | 103 | 98.0 | 31.8 | 163 | 155.0 | 50.4 | 223 | 212.1 | 68.9 | 283 | 269.1 | 87.5 |
| 44 | 41.8 | 13.6 | 104 | 98.9 | 32.1 | 164 | 156.0 | 50.7 | 224 | 213.0 | 69.2 | 284 | 270.1 | 87.8 |
| 45 | 42.8 | 13.9 | 105 | 99.9 | 32.4 | 165 | 156.9 | 51.0 | 225 | 214.0 | 69.5 | 285 | 271.1 | 88.1 |
| 46 | 43.7 | 14.2 | 106 | 100.8 | 32.8 | 166 | 157.9 | 51.3 | 226 | 214.9 | 69.8 | 286 | 272.0 | 88.4 |
| 47 | 44.7 | 14.5 | 107 | 101.8 | 33.1 | 167 | 158.8 | 51.6 | 227 | 215.9 | 70.1 | 287 | 273.0 | 88.7 |
| 48 | 45.7 | 14.8 | 108 | 102.7 | 33.4 | 168 | 159.8 | 51.9 | 228 | 216.8 | 70.5 | 288 | 273.9 | 89.0 |
| 49 | 46.6 | 15.1 | 109 | 103.7 | 33.7 | 169 | 160.7 | 52.2 | 229 | 217.8 | 70.8 | 289 | 274.9 | 89.3 |
| 50 | 47.6 | 15.5 | 110 | 104.6 | 34.0 | 170 | 161.7 | 52.5 | 230 | 218.7 | 71.1 | 290 | 275.8 | 89.6 |
| 51 | 48.5 | 15.8 | 111 | 105.6 | 34.3 | 171 | 162.6 | 52.8 | 231 | 219.7 | 71.4 | 291 | 276.8 | 89.9 |
| 52 | 49.5 | 16.1 | 112 | 106.5 | 34.6 | 172 | 163.6 | 53.2 | 232 | 220.6 | 71.7 | 292 | 277.7 | 90.2 |
| 53 | 50.4 | 16.4 | 113 | 107.5 | 34.9 | 173 | 164.5 | 53.5 | 233 | 221.6 | 72.0 | 293 | 278.7 | 90.5 |
| 54 | 51.4 | 16.7 | 114 | 108.4 | 35.2 | 174 | 165.5 | 53.8 | 234 | 222.5 | 72.3 | 294 | 279.6 | 90.9 |
| 55 | 52.3 | 17.0 | 115 | 109.4 | 35.5 | 175 | 166.4 | 54.1 | 235 | 223.5 | 72.6 | 295 | 280.6 | 91.2 |
| 56 | 53.3 | 17.3 | 116 | 110.3 | 35.8 | 176 | 167.4 | 54.4 | 236 | 224.4 | 72.9 | 296 | 281.5 | 91.5 |
| 57 | 54.2 | 17.6 | 117 | 111.3 | 36.2 | 177 | 168.3 | 54.7 | 237 | 225.4 | 73.2 | 297 | 282.5 | 91.8 |
| 58 | 55.2 | 17.9 | 118 | 112.2 | 36.5 | 178 | 169.3 | 55.0 | 238 | 226.4 | 73.5 | 298 | 283.4 | 92.1 |
| 59 | 56.1 | 18.2 | 119 | 113.2 | 36.8 | 179 | 170.2 | 55.3 | 239 | 227.3 | 73.9 | 299 | 284.4 | 92.4 |
| 60 | 57.1 | 18.5 | 120 | 114.1 | 37.1 | 180 | 171.2 | 55.6 | 240 | 228.3 | 74.2 | 300 | 285.3 | 92.7 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

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## TRAVERSE TABLE TO DEGREES

18° 1h 12m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 286·3 | 93·0 | 361 | 343·3 | 111·6 | 421 | 400·4 | 130·1 | 481 | 457·5 | 148·6 | 541 | 514·5 | 167·2 |
| 302 | 287·2 | 93·3 | 362 | 344·3 | 111·9 | 422 | 401·4 | 130·4 | 482 | 458·5 | 148·9 | 542 | 515·5 | 167·5 |
| 303 | 288·2 | 93·7 | 363 | 345·2 | 112·2 | 423 | 402·3 | 130·7 | 483 | 459·4 | 149·3 | 543 | 516·4 | 167·9 |
| 304 | 289·1 | 94·0 | 364 | 346·2 | 112·5 | 424 | 403·3 | 131·0 | 484 | 460·4 | 149·6 | 544 | 517·4 | 168·2 |
| 305 | 290·1 | 94·3 | 365 | 347·1 | 112·8 | 425 | 404·2 | 131·3 | 485 | 461·3 | 149·9 | 545 | 518·3 | 168·5 |
| 306 | 291·0 | 94·6 | 366 | 348·1 | 113·1 | 426 | 405·2 | 131·7 | 486 | 462·3 | 150·2 | 546 | 519·3 | 168·8 |
| 307 | 292·0 | 94·9 | 367 | 349·0 | 113·4 | 427 | 406·1 | 132·0 | 487 | 463·2 | 150·5 | 547 | 520·2 | 169·1 |
| 308 | 292·9 | 95·2 | 368 | 350·0 | 113·7 | 428 | 407·1 | 132·3 | 488 | 464·2 | 150·8 | 548 | 521·2 | 169·4 |
| 309 | 293·9 | 95·5 | 369 | 350·9 | 114·0 | 429 | 408·0 | 132·6 | 489 | 465·1 | 151·1 | 549 | 522·1 | 169·7 |
| 310 | 294·8 | 95·8 | 370 | 351·9 | 114·3 | 430 | 409·0 | 132·9 | 490 | 466·1 | 151·4 | 550 | 523·1 | 170·0 |
| 311 | 295·8 | 96·1 | 371 | 352·9 | 114·7 | 431 | 409·9 | 133·2 | 491 | 467·0 | 151·7 | 551 | 524·0 | 170·3 |
| 312 | 296·7 | 96·4 | 372 | 353·8 | 115·0 | 432 | 410·9 | 133·5 | 492 | 468·0 | 152·0 | 552 | 525·0 | 170·6 |
| 313 | 297·7 | 96·7 | 373 | 354·8 | 115·3 | 433 | 411·8 | 133·8 | 493 | 468·9 | 152·3 | 553 | 525·9 | 170·9 |
| 314 | 298·6 | 97·0 | 374 | 355·7 | 115·6 | 434 | 412·8 | 134·1 | 494 | 469·8 | 152·6 | 554 | 526·9 | 171·2 |
| 315 | 299·6 | 97·4 | 375 | 356·7 | 115·9 | 435 | 413·7 | 134·4 | 495 | 470·8 | 153·0 | 555 | 527·8 | 171·5 |
| 316 | 300·5 | 97·7 | 376 | 357·6 | 116·2 | 436 | 414·7 | 134·7 | 496 | 471·7 | 153·3 | 556 | 528·8 | 171·8 |
| 317 | 301·5 | 98·0 | 377 | 358·6 | 116·5 | 437 | 415·6 | 135·1 | 497 | 472·7 | 153·6 | 557 | 529·7 | 172·1 |
| 318 | 302·4 | 98·3 | 378 | 359·5 | 116·8 | 438 | 416·6 | 135·4 | 498 | 473·6 | 153·9 | 558 | 530·7 | 172·4 |
| 319 | 303·4 | 98·6 | 379 | 360·5 | 117·1 | 439 | 417·5 | 135·7 | 499 | 474·6 | 154·2 | 559 | 531·6 | 172·7 |
| 320 | 304·3 | 98·9 | 380 | 361·4 | 117·4 | 440 | 418·5 | 136·0 | 500 | 475·5 | 154·5 | 560 | 532·6 | 173·0 |
| 321 | 305·3 | 99·2 | 381 | 362·4 | 117·7 | 441 | 419·4 | 136·3 | 501 | 476·5 | 154·8 | 561 | 533·5 | 173·3 |
| 322 | 306·2 | 99·5 | 382 | 363·3 | 118·1 | 442 | 420·4 | 136·6 | 502 | 477·4 | 155·1 | 562 | 534·5 | 173·6 |
| 323 | 307·2 | 99·8 | 383 | 364·3 | 118·4 | 443 | 421·3 | 136·9 | 503 | 478·4 | 155·4 | 563 | 535·4 | 173·9 |
| 324 | 308·2 | 100·1 | 384 | 365·2 | 118·7 | 444 | 422·3 | 137·2 | 504 | 479·3 | 155·7 | 564 | 536·4 | 174·2 |
| 325 | 309·1 | 100·4 | 385 | 366·2 | 119·0 | 445 | 423·2 | 137·5 | 505 | 480·3 | 156·1 | 565 | 537·3 | 174·6 |
| 326 | 310·1 | 100·7 | 386 | 367·1 | 119·3 | 446 | 424·2 | 137·8 | 506 | 481·2 | 156·4 | 566 | 538·3 | 174·9 |
| 327 | 311·0 | 101·1 | 387 | 368·1 | 119·6 | 447 | 425·1 | 138·1 | 507 | 482·2 | 156·7 | 567 | 539·2 | 175·2 |
| 328 | 312·0 | 101·4 | 388 | 369·0 | 119·9 | 448 | 426·1 | 138·4 | 508 | 483·2 | 157·0 | 568 | 540·2 | 175·5 |
| 329 | 312·9 | 101·7 | 389 | 370·0 | 120·2 | 449 | 427·0 | 138·8 | 509 | 484·1 | 157·3 | 569 | 541·1 | 175·8 |
| 330 | 313·9 | 102·0 | 390 | 370·9 | 120·5 | 450 | 428·0 | 139·1 | 510 | 485·1 | 157·6 | 570 | 542·1 | 176·1 |
| 331 | 314·8 | 102·3 | 391 | 371·9 | 120·8 | 451 | 428·9 | 139·4 | 511 | 486·0 | 157·9 | 571 | 543·0 | 176·4 |
| 332 | 315·8 | 102·6 | 392 | 372·8 | 121·1 | 452 | 429·9 | 139·7 | 512 | 487·0 | 158·2 | 572 | 544·0 | 176·7 |
| 333 | 316·7 | 102·9 | 393 | 373·8 | 121·5 | 453 | 430·8 | 140·0 | 513 | 487·9 | 158·5 | 573 | 544·9 | 177·0 |
| 334 | 317·7 | 103·2 | 394 | 374·7 | 121·8 | 454 | 431·8 | 140·3 | 514 | 488·9 | 158·8 | 574 | 545·9 | 177·3 |
| 335 | 318·6 | 103·5 | 395 | 375·7 | 122·1 | 455 | 432·7 | 140·6 | 515 | 489·8 | 159·1 | 575 | 546·8 | 177·6 |
| 336 | 319·6 | 103·8 | 396 | 376·6 | 122·4 | 456 | 433·7 | 140·9 | 516 | 490·8 | 159·4 | 576 | 547·8 | 178·0 |
| 337 | 320·5 | 104·1 | 397 | 377·6 | 122·7 | 457 | 434·6 | 141·2 | 517 | 491·7 | 159·7 | 577 | 548·7 | 178·3 |
| 338 | 321·5 | 104·5 | 398 | 378·5 | 123·0 | 458 | 435·6 | 141·5 | 518 | 492·7 | 160·0 | 578 | 549·7 | 178·6 |
| 339 | 322·4 | 104·8 | 399 | 379·5 | 123·3 | 459 | 436·5 | 141·8 | 519 | 493·6 | 160·3 | 579 | 550·6 | 178·9 |
| 340 | 323·4 | 105·1 | 400 | 380·4 | 123·6 | 460 | 437·5 | 142·2 | 520 | 494·6 | 160·7 | 580 | 551·6 | 179·2 |
| 341 | 324·3 | 105·4 | 401 | 381·4 | 123·9 | 461 | 438·4 | 142·5 | 521 | 495·5 | 161·0 | 581 | 552·5 | 179·5 |
| 342 | 325·3 | 105·7 | 402 | 382·3 | 124·2 | 462 | 439·4 | 142·8 | 522 | 496·5 | 161·3 | 582 | 553·5 | 179·8 |
| 343 | 326·2 | 106·0 | 403 | 383·3 | 124·5 | 463 | 440·3 | 143·1 | 523 | 497·4 | 161·6 | 583 | 554·4 | 180·1 |
| 344 | 327·2 | 106·3 | 404 | 384·2 | 124·9 | 464 | 441·3 | 143·4 | 524 | 498·4 | 161·9 | 584 | 555·4 | 180·4 |
| 345 | 328·1 | 106·6 | 405 | 385·2 | 125·2 | 465 | 442·2 | 143·7 | 525 | 499·3 | 162·2 | 585 | 556·3 | 180·7 |
| 346 | 329·1 | 106·9 | 406 | 386·1 | 125·5 | 466 | 443·2 | 144·0 | 526 | 500·3 | 162·5 | 586 | 557·3 | 181·1 |
| 347 | 330·0 | 107·2 | 407 | 387·1 | 125·8 | 467 | 444·2 | 144·3 | 527 | 501·2 | 162·9 | 587 | 558·2 | 181·4 |
| 348 | 331·0 | 107·5 | 408 | 388·0 | 126·1 | 468 | 445·1 | 144·6 | 528 | 502·2 | 163·2 | 588 | 559·2 | 181·7 |
| 349 | 331·9 | 107·9 | 409 | 389·0 | 126·4 | 469 | 446·1 | 144·9 | 529 | 503·1 | 163·5 | 589 | 560·1 | 182·0 |
| 350 | 332·9 | 108·2 | 410 | 389·9 | 126·7 | 470 | 447·0 | 145·2 | 530 | 504·1 | 163·8 | 590 | 561·1 | 182·3 |
| 351 | 333·8 | 108·5 | 411 | 390·9 | 127·0 | 471 | 448·0 | 145·6 | 531 | 505·0 | 164·1 | 591 | 562·0 | 182·7 |
| 352 | 334·8 | 108·8 | 412 | 391·8 | 127·3 | 472 | 448·9 | 145·9 | 532 | 506·0 | 164·4 | 592 | 563·0 | 183·0 |
| 353 | 335·7 | 109·1 | 413 | 392·8 | 127·6 | 473 | 449·9 | 146·2 | 533 | 506·9 | 164·7 | 593 | 563·9 | 183·3 |
| 354 | 336·7 | 109·4 | 414 | 393·7 | 127·9 | 474 | 450·8 | 146·5 | 534 | 507·9 | 165·0 | 594 | 564·9 | 183·6 |
| 355 | 337·6 | 109·7 | 415 | 394·7 | 128·3 | 475 | 451·8 | 146·8 | 535 | 508·8 | 165·3 | 595 | 565·8 | 183·9 |
| 356 | 338·6 | 110·0 | 416 | 395·6 | 128·6 | 476 | 452·7 | 147·1 | 536 | 509·8 | 165·6 | 596 | 566·8 | 184·2 |
| 357 | 339·5 | 110·3 | 417 | 396·6 | 128·9 | 477 | 453·7 | 147·4 | 537 | 510·7 | 165·9 | 597 | 567·7 | 184·5 |
| 358 | 340·5 | 110·6 | 418 | 397·5 | 129·2 | 478 | 454·6 | 147·7 | 538 | 511·7 | 166·2 | 598 | 568·7 | 184·8 |
| 359 | 341·4 | 110·9 | 419 | 398·5 | 129·5 | 479 | 455·6 | 148·0 | 539 | 512·6 | 166·5 | 599 | 569·6 | 185·1 |
| 360 | 342·4 | 111·3 | 420 | 399·5 | 129·8 | 480 | 456·5 | 148·3 | 540 | 513·6 | 166·9 | 600 | 570·6 | 185·4 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat | Dist | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

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TRAVERSE TABLE TO DEGREES

19° 1h 16m

| Dist. | D.Lat. | Dep. | Dist. | D.Lat. | Dep. | Dist. | D.Lat. | Dep. | Dist. | D.Lat. | Dep. | Dist. | D.Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0·9 | 0·3 | 61 | 57·7 | 19·9 | 121 | 114·4 | 39·4 | 181 | 171·1 | 58·9 | 241 | 227·9 | 78·5 |
| 2 | 1·9 | 0·7 | 62 | 58·6 | 20·2 | 122 | 115·4 | 39·7 | 182 | 172·1 | 59·3 | 242 | 228·8 | 78·8 |
| 3 | 2·8 | 1·0 | 63 | 59·6 | 20·5 | 123 | 116·3 | 40·0 | 183 | 173·0 | 59·6 | 243 | 229·8 | 79·1 |
| 4 | 3·8 | 1·3 | 64 | 60·5 | 20·8 | 124 | 117·2 | 40·4 | 184 | 174·0 | 59·9 | 244 | 230·7 | 79·4 |
| 5 | 4·7 | 1·6 | 65 | 61·5 | 21·2 | 125 | 118·2 | 40·7 | 185 | 174·9 | 60·2 | 245 | 231·7 | 79·8 |
| 6 | 5·7 | 2·0 | 66 | 62·4 | 21·5 | 126 | 119·1 | 41·0 | 186 | 175·9 | 60·6 | 246 | 232·6 | 80·1 |
| 7 | 6·6 | 2·3 | 67 | 63·3 | 21·8 | 127 | 120·1 | 41·3 | 187 | 176·8 | 60·9 | 247 | 233·5 | 80·4 |
| 8 | 7·6 | 2·6 | 68 | 64·3 | 22·1 | 128 | 121·0 | 41·7 | 188 | 177·8 | 61·2 | 248 | 234·5 | 80·7 |
| 9 | 8·5 | 2·9 | 69 | 65·2 | 22·5 | 129 | 122·0 | 42·0 | 189 | 178·7 | 61·5 | 249 | 235·4 | 81·1 |
| 10 | 9·5 | 3·3 | 70 | 66·2 | 22·8 | 130 | 122·9 | 42·3 | 190 | 179·6 | 61·9 | 250 | 236·4 | 81·4 |
| 11 | 10·4 | 3·6 | 71 | 67·1 | 23·1 | 131 | 123·9 | 42·6 | 191 | 180·6 | 62·2 | 251 | 237·3 | 81·7 |
| 12 | 11·3 | 3·9 | 72 | 68·1 | 23·4 | 132 | 124·8 | 43·0 | 192 | 181·5 | 62·5 | 252 | 238·3 | 82·0 |
| 13 | 12·3 | 4·2 | 73 | 69·0 | 23·8 | 133 | 125·8 | 43·3 | 193 | 182·5 | 62·8 | 253 | 239·2 | 82·4 |
| 14 | 13·2 | 4·6 | 74 | 70·0 | 24·1 | 134 | 126·7 | 43·6 | 194 | 183·4 | 63·2 | 254 | 240·2 | 82·7 |
| 15 | 14·2 | 4·9 | 75 | 70·9 | 24·4 | 135 | 127·6 | 44·0 | 195 | 184·4 | 63·5 | 255 | 241·1 | 83·0 |
| 16 | 15·1 | 5·2 | 76 | 71·9 | 24·7 | 136 | 128·6 | 44·3 | 196 | 185·3 | 63·8 | 256 | 242·1 | 83·3 |
| 17 | 16·1 | 5·5 | 77 | 72·8 | 25·1 | 137 | 129·5 | 44·6 | 197 | 186·3 | 64·1 | 257 | 243·0 | 83·7 |
| 18 | 17·0 | 5·9 | 78 | 73·8 | 25·4 | 138 | 130·5 | 44·9 | 198 | 187·2 | 64·5 | 258 | 243·9 | 84·0 |
| 19 | 18·0 | 6·2 | 79 | 74·7 | 25·7 | 139 | 131·4 | 45·3 | 199 | 188·2 | 64·8 | 259 | 244·9 | 84·3 |
| 20 | 18·9 | 6·5 | 80 | 75·6 | 26·0 | 140 | 132·4 | 45·6 | 200 | 189·1 | 65·1 | 260 | 245·8 | 84·6 |
| 21 | 19·9 | 6·8 | 81 | 76·6 | 26·4 | 141 | 133·3 | 45·9 | 201 | 190·0 | 65·4 | 261 | 246·8 | 85·0 |
| 22 | 20·8 | 7·2 | 82 | 77·5 | 26·7 | 142 | 134·3 | 46·2 | 202 | 191·0 | 65·8 | 262 | 247·7 | 85·3 |
| 23 | 21·7 | 7·5 | 83 | 78·5 | 27·0 | 143 | 135·2 | 46·6 | 203 | 191·9 | 66·1 | 263 | 248·7 | 85·6 |
| 24 | 22·7 | 7·8 | 84 | 79·4 | 27·3 | 144 | 136·2 | 46·9 | 204 | 192·9 | 66·4 | 264 | 249·6 | 86·0 |
| 25 | 23·6 | 8·1 | 85 | 80·4 | 27·7 | 145 | 137·1 | 47·2 | 205 | 193·8 | 66·7 | 265 | 250·6 | 86·3 |
| 26 | 24·6 | 8·5 | 86 | 81·3 | 28·0 | 146 | 138·0 | 47·5 | 206 | 194·8 | 67·1 | 266 | 251·5 | 86·6 |
| 27 | 25·5 | 8·8 | 87 | 82·3 | 28·3 | 147 | 139·0 | 47·9 | 207 | 195·7 | 67·4 | 267 | 252·5 | 86·9 |
| 28 | 26·5 | 9·1 | 88 | 83·2 | 28·6 | 148 | 139·9 | 48·2 | 208 | 196·7 | 67·7 | 268 | 253·4 | 87·3 |
| 29 | 27·4 | 9·4 | 89 | 84·2 | 29·0 | 149 | 140·9 | 48·5 | 209 | 197·6 | 68·0 | 269 | 254·3 | 87·6 |
| 30 | 28·4 | 9·8 | 90 | 85·1 | 29·3 | 150 | 141·8 | 48·8 | 210 | 198·6 | 68·4 | 270 | 255·3 | 87·9 |
| 31 | 29·3 | 10·1 | 91 | 86·0 | 29·6 | 151 | 142·8 | 49·2 | 211 | 199·5 | 68·7 | 271 | 256·2 | 88·2 |
| 32 | 30·3 | 10·4 | 92 | 87·0 | 30·0 | 152 | 143·7 | 49·5 | 212 | 200·4 | 69·0 | 272 | 257·2 | 88·6 |
| 33 | 31·2 | 10·7 | 93 | 87·9 | 30·3 | 153 | 144·7 | 49·8 | 213 | 201·4 | 69·3 | 273 | 258·1 | 88·9 |
| 34 | 32·1 | 11·1 | 94 | 88·9 | 30·6 | 154 | 145·6 | 50·1 | 214 | 202·3 | 69·7 | 274 | 259·1 | 89·2 |
| 35 | 33·1 | 11·4 | 95 | 89·8 | 30·9 | 155 | 146·6 | 50·5 | 215 | 203·3 | 70·0 | 275 | 260·0 | 89·5 |
| 36 | 34·0 | 11·7 | 96 | 90·8 | 31·3 | 156 | 147·5 | 50·8 | 216 | 204·2 | 70·3 | 276 | 261·0 | 89·9 |
| 37 | 35·0 | 12·0 | 97 | 91·7 | 31·6 | 157 | 148·4 | 51·1 | 217 | 205·2 | 70·6 | 277 | 261·9 | 90·2 |
| 38 | 35·9 | 12·4 | 98 | 92·7 | 31·9 | 158 | 149·4 | 51·4 | 218 | 206·1 | 71·0 | 278 | 262·9 | 90·5 |
| 39 | 36·9 | 12·7 | 99 | 93·6 | 32·2 | 159 | 150·3 | 51·8 | 219 | 207·1 | 71·3 | 279 | 263·8 | 90·8 |
| 40 | 37·8 | 13·0 | 100 | 94·6 | 32·6 | 160 | 151·3 | 52·1 | 220 | 208·0 | 71·6 | 280 | 264·7 | 91·2 |
| 41 | 38·8 | 13·3 | 101 | 95·5 | 32·9 | 161 | 152·2 | 52·4 | 221 | 209·0 | 72·0 | 281 | 265·7 | 91·5 |
| 42 | 39·7 | 13·7 | 102 | 96·4 | 33·2 | 162 | 153·2 | 52·7 | 222 | 209·9 | 72·3 | 282 | 266·6 | 91·8 |
| 43 | 40·7 | 14·0 | 103 | 97·4 | 33·5 | 163 | 154·1 | 53·1 | 223 | 210·9 | 72·6 | 283 | 267·6 | 92·1 |
| 44 | 41·6 | 14·3 | 104 | 98·3 | 33·9 | 164 | 155·1 | 53·4 | 224 | 211·8 | 72·9 | 284 | 268·5 | 92·5 |
| 45 | 42·5 | 14·7 | 105 | 99·3 | 34·2 | 165 | 156·0 | 53·7 | 225 | 212·7 | 73·3 | 285 | 269·5 | 92·8 |
| 46 | 43·5 | 15·0 | 106 | 100·2 | 34·5 | 166 | 157·0 | 54·0 | 226 | 213·7 | 73·6 | 286 | 270·4 | 93·1 |
| 47 | 44·4 | 15·3 | 107 | 101·2 | 34·8 | 167 | 157·9 | 54·4 | 227 | 214·6 | 73·9 | 287 | 271·4 | 93·4 |
| 48 | 45·4 | 15·6 | 108 | 102·1 | 35·2 | 168 | 158·8 | 54·7 | 228 | 215·6 | 74·2 | 288 | 272·3 | 93·8 |
| 49 | 46·3 | 16·0 | 109 | 103·1 | 35·5 | 169 | 159·8 | 55·0 | 229 | 216·5 | 74·6 | 289 | 273·3 | 94·1 |
| 50 | 47·3 | 16·3 | 110 | 104·0 | 35·8 | 170 | 160·7 | 55·3 | 230 | 217·5 | 74·9 | 290 | 274·2 | 94·4 |
| 51 | 48·2 | 16·6 | 111 | 105·0 | 36·1 | 171 | 161·7 | 55·7 | 231 | 218·4 | 75·2 | 291 | 275·1 | 94·7 |
| 52 | 49·2 | 16·9 | 112 | 105·9 | 36·5 | 172 | 162·6 | 56·0 | 232 | 219·4 | 75·5 | 292 | 276·1 | 95·1 |
| 53 | 50·1 | 17·3 | 113 | 106·8 | 36·8 | 173 | 163·6 | 56·3 | 233 | 220·3 | 75·9 | 293 | 277·0 | 95·4 |
| 54 | 51·1 | 17·6 | 114 | 107·8 | 37·1 | 174 | 164·5 | 56·6 | 234 | 221·3 | 76·2 | 294 | 278·0 | 95·7 |
| 55 | 52·0 | 17·9 | 115 | 108·7 | 37·4 | 175 | 165·5 | 57·0 | 235 | 222·2 | 76·5 | 295 | 278·9 | 96·0 |
| 56 | 52·9 | 18·2 | 116 | 109·7 | 37·8 | 176 | 166·4 | 57·3 | 236 | 223·1 | 76·8 | 296 | 279·9 | 96·4 |
| 57 | 53·9 | 18·6 | 117 | 110·6 | 38·1 | 177 | 167·4 | 57·6 | 237 | 224·1 | 77·2 | 297 | 280·8 | 96·7 |
| 58 | 54·8 | 18·9 | 118 | 111·6 | 38·4 | 178 | 168·3 | 58·0 | 238 | 225·0 | 77·5 | 298 | 281·8 | 97·0 |
| 59 | 55·8 | 19·2 | 119 | 112·5 | 38·7 | 179 | 169·2 | 58·3 | 239 | 226·0 | 77·8 | 299 | 282·7 | 97·3 |
| 60 | 56·7 | 19·5 | 120 | 113·5 | 39·1 | 180 | 170·2 | 58·6 | 240 | 226·9 | 78·1 | 300 | 283·7 | 97·7 |
| Dist. | Dep. | D.Lat. | Dist. | Dep. | D.Lat. | Dist. | Dep. | D.Lat. | Dist. | Dep. | D.Lat. | Dist. | Dep. | D.Lat. |

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## TRAVERSE TABLE TO DEGREES

19° 1h 16m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 284.6 | 98.0 | 361 | 341.3 | 117.5 | 421 | 398.1 | 137.0 | 481 | 454.8 | 156.6 | 541 | 511.5 | 176.1 |
| 302 | 285.5 | 98.3 | 362 | 342.3 | 117.8 | 422 | 399.0 | 137.4 | 482 | 455.7 | 156.9 | 542 | 512.4 | 176.4 |
| 303 | 286.5 | 98.6 | 363 | 343.2 | 118.2 | 423 | 400.0 | 137.7 | 483 | 456.7 | 157.2 | 543 | 513.4 | 176.8 |
| 304 | 287.4 | 99.0 | 364 | 344.2 | 118.5 | 424 | 400.9 | 138.0 | 484 | 457.6 | 157.6 | 544 | 514.3 | 177.1 |
| 305 | 288.4 | 99.3 | 365 | 345.1 | 118.8 | 425 | 401.8 | 138.4 | 485 | 458.6 | 157.9 | 545 | 515.3 | 177.4 |
| 306 | 289.3 | 99.6 | 366 | 346.1 | 119.1 | 426 | 402.8 | 138.7 | 486 | 459.5 | 158.2 | 546 | 516.2 | 177.7 |
| 307 | 290.3 | 99.9 | 367 | 347.0 | 119.5 | 427 | 403.7 | 139.0 | 487 | 460.5 | 158.5 | 547 | 517.2 | 178.1 |
| 308 | 291.2 | 100.3 | 368 | 348.0 | 119.8 | 428 | 404.7 | 139.3 | 488 | 461.4 | 158.9 | 548 | 518.1 | 178.4 |
| 309 | 292.2 | 100.6 | 369 | 348.9 | 120.1 | 429 | 405.6 | 139.7 | 489 | 462.4 | 159.2 | 549 | 519.1 | 178.7 |
| 310 | 293.1 | 100.9 | 370 | 349.8 | 120.4 | 430 | 406.6 | 140.0 | 490 | 463.3 | 159.5 | 550 | 520.0 | 179.0 |
| 311 | 294.1 | 101.2 | 371 | 350.8 | 120.8 | 431 | 407.5 | 140.3 | 491 | 464.3 | 159.8 | 551 | 521.0 | 179.4 |
| 312 | 295.0 | 101.6 | 372 | 351.7 | 121.1 | 432 | 408.5 | 140.6 | 492 | 465.2 | 160.2 | 552 | 521.9 | 179.7 |
| 313 | 295.9 | 101.9 | 373 | 352.7 | 121.4 | 433 | 409.4 | 141.0 | 493 | 466.1 | 160.5 | 553 | 522.8 | 180.0 |
| 314 | 296.9 | 102.2 | 374 | 353.6 | 121.7 | 434 | 410.4 | 141.3 | 494 | 467.1 | 160.8 | 554 | 523.8 | 180.3 |
| 315 | 297.8 | 102.5 | 375 | 354.6 | 122.1 | 435 | 411.3 | 141.6 | 495 | 468.0 | 161.1 | 555 | 524.7 | 180.7 |
| 316 | 298.8 | 102.9 | 376 | 355.5 | 122.4 | 436 | 412.2 | 141.9 | 496 | 469.0 | 161.5 | 556 | 525.7 | 181.0 |
| 317 | 299.7 | 103.2 | 377 | 356.5 | 122.7 | 437 | 413.2 | 142.3 | 497 | 469.9 | 161.8 | 557 | 526.6 | 181.3 |
| 318 | 300.7 | 103.5 | 378 | 357.4 | 123.0 | 438 | 414.1 | 142.6 | 498 | 470.9 | 162.1 | 558 | 527.6 | 181.6 |
| 319 | 301.6 | 103.8 | 379 | 358.4 | 123.4 | 439 | 415.1 | 142.9 | 499 | 471.8 | 162.4 | 559 | 528.5 | 182.0 |
| 320 | 302.6 | 104.2 | 380 | 359.3 | 123.7 | 440 | 416.0 | 143.2 | 500 | 472.8 | 162.8 | 560 | 529.5 | 182.3 |
| 321 | 303.5 | 104.5 | 381 | 360.2 | 124.0 | 441 | 417.0 | 143.6 | 501 | 473.7 | 163.1 | 561 | 530.4 | 182.6 |
| 322 | 304.5 | 104.8 | 382 | 361.2 | 124.4 | 442 | 417.9 | 143.9 | 502 | 474.7 | 163.4 | 562 | 531.4 | 182.9 |
| 323 | 305.4 | 105.1 | 383 | 362.1 | 124.7 | 443 | 418.9 | 144.2 | 503 | 475.6 | 163.7 | 563 | 532.3 | 183.3 |
| 324 | 306.3 | 105.5 | 384 | 363.1 | 125.0 | 444 | 419.8 | 144.5 | 504 | 476.5 | 164.1 | 564 | 533.2 | 183.6 |
| 325 | 307.3 | 105.8 | 385 | 364.0 | 125.3 | 445 | 420.8 | 144.9 | 505 | 477.5 | 164.4 | 565 | 534.2 | 183.9 |
| 326 | 308.2 | 106.1 | 386 | 365.0 | 125.7 | 446 | 421.7 | 145.2 | 506 | 478.4 | 164.7 | 566 | 535.1 | 184.2 |
| 327 | 309.2 | 106.4 | 387 | 365.9 | 126.0 | 447 | 422.6 | 145.5 | 507 | 479.4 | 165.0 | 567 | 536.1 | 184.6 |
| 328 | 310.1 | 106.8 | 388 | 366.9 | 126.3 | 448 | 423.6 | 145.8 | 508 | 480.3 | 165.4 | 568 | 537.0 | 184.9 |
| 329 | 311.1 | 107.1 | 389 | 367.8 | 126.6 | 449 | 424.5 | 146.2 | 509 | 481.2 | 165.7 | 569 | 538.0 | 185.2 |
| 330 | 312.0 | 107.4 | 390 | 368.8 | 127.0 | 450 | 425.5 | 146.5 | 510 | 482.2 | 166.1 | 570 | 538.9 | 185.6 |
| 331 | 313.0 | 107.7 | 391 | 369.7 | 127.3 | 451 | 426.4 | 146.8 | 511 | 483.1 | 166.4 | 571 | 539.9 | 185.9 |
| 332 | 313.9 | 108.1 | 392 | 370.6 | 127.6 | 452 | 427.4 | 147.1 | 512 | 484.1 | 166.7 | 572 | 540.8 | 186.2 |
| 333 | 314.9 | 108.4 | 393 | 371.6 | 127.9 | 453 | 428.3 | 147.5 | 513 | 485.0 | 167.0 | 573 | 541.7 | 186.5 |
| 334 | 315.8 | 108.7 | 394 | 372.5 | 128.3 | 454 | 429.3 | 147.8 | 514 | 486.0 | 167.4 | 574 | 542.7 | 186.9 |
| 335 | 316.7 | 109.1 | 395 | 373.5 | 128.6 | 455 | 430.2 | 148.1 | 515 | 486.9 | 167.7 | 575 | 543.6 | 187.2 |
| 336 | 317.7 | 109.4 | 396 | 374.4 | 128.9 | 456 | 431.2 | 148.4 | 516 | 487.9 | 168.0 | 576 | 544.6 | 187.5 |
| 337 | 318.6 | 109.7 | 397 | 375.4 | 129.2 | 457 | 432.1 | 148.8 | 517 | 488.8 | 168.3 | 577 | 545.5 | 187.8 |
| 338 | 319.6 | 110.0 | 398 | 376.3 | 129.6 | 458 | 433.0 | 149.1 | 518 | 489.7 | 168.7 | 578 | 546.5 | 188.2 |
| 339 | 320.5 | 110.4 | 399 | 377.3 | 129.9 | 459 | 434.0 | 149.4 | 519 | 490.7 | 169.0 | 579 | 547.4 | 188.5 |
| 340 | 321.5 | 110.7 | 400 | 378.2 | 130.2 | 460 | 434.9 | 149.7 | 520 | 491.6 | 169.3 | 580 | 548.4 | 188.8 |
| 341 | 322.4 | 111.0 | 401 | 379.2 | 130.5 | 461 | 435.9 | 150.1 | 521 | 492.6 | 169.6 | 581 | 549.3 | 189.1 |
| 342 | 323.4 | 111.3 | 402 | 380.1 | 130.9 | 462 | 436.8 | 150.4 | 522 | 493.5 | 170.0 | 582 | 550.3 | 189.5 |
| 343 | 324.3 | 111.7 | 403 | 381.0 | 131.2 | 463 | 437.8 | 150.7 | 523 | 494.5 | 170.3 | 583 | 551.2 | 189.8 |
| 344 | 325.3 | 112.0 | 404 | 382.0 | 131.5 | 464 | 438.7 | 151.0 | 524 | 495.4 | 170.6 | 584 | 552.2 | 190.1 |
| 345 | 326.2 | 112.3 | 405 | 382.9 | 131.8 | 465 | 439.7 | 151.4 | 525 | 496.4 | 170.9 | 585 | 553.1 | 190.4 |
| 346 | 327.1 | 112.6 | 406 | 383.9 | 132.2 | 466 | 440.6 | 151.7 | 526 | 497.3 | 171.2 | 586 | 554.1 | 190.8 |
| 347 | 328.1 | 113.0 | 407 | 384.8 | 132.5 | 467 | 441.6 | 152.0 | 527 | 498.3 | 171.6 | 587 | 555.0 | 191.1 |
| 348 | 329.0 | 113.3 | 408 | 385.8 | 132.8 | 468 | 442.5 | 152.4 | 528 | 499.2 | 171.9 | 588 | 555.9 | 191.4 |
| 349 | 330.0 | 113.6 | 409 | 386.7 | 133.1 | 469 | 443.4 | 152.7 | 529 | 500.1 | 172.2 | 589 | 556.9 | 191.7 |
| 350 | 330.9 | 113.9 | 410 | 387.7 | 133.5 | 470 | 444.4 | 153.0 | 530 | 501.1 | 172.5 | 590 | 557.8 | 192.1 |
| 351 | 331.9 | 114.3 | 411 | 388.6 | 133.8 | 471 | 445.3 | 153.3 | 531 | 502.0 | 172.9 | 591 | 558.8 | 192.4 |
| 352 | 332.8 | 114.6 | 412 | 389.6 | 134.1 | 472 | 446.3 | 153.7 | 532 | 503.0 | 173.2 | 592 | 559.7 | 192.7 |
| 353 | 333.8 | 114.9 | 413 | 390.5 | 134.4 | 473 | 447.2 | 154.0 | 533 | 503.9 | 173.5 | 593 | 560.7 | 193.0 |
| 354 | 334.7 | 115.2 | 414 | 391.4 | 134.8 | 474 | 448.2 | 154.3 | 534 | 504.9 | 173.8 | 594 | 561.6 | 193.4 |
| 355 | 335.7 | 115.6 | 415 | 392.4 | 135.1 | 475 | 449.1 | 154.6 | 535 | 505.8 | 174.2 | 595 | 562.6 | 193.7 |
| 356 | 336.6 | 115.9 | 416 | 393.3 | 135.4 | 476 | 450.1 | 155.0 | 536 | 506.8 | 174.5 | 596 | 563.5 | 194.0 |
| 357 | 337.5 | 116.2 | 417 | 394.3 | 135.7 | 477 | 451.0 | 155.3 | 537 | 507.7 | 174.8 | 597 | 564.5 | 194.3 |
| 358 | 338.5 | 116.5 | 418 | 395.2 | 136.1 | 478 | 452.0 | 155.6 | 538 | 508.7 | 175.1 | 598 | 565.4 | 194.7 |
| 359 | 339.4 | 116.9 | 419 | 396.2 | 136.4 | 479 | 452.9 | 155.9 | 539 | 509.6 | 175.5 | 599 | 566.4 | 195.0 |
| 360 | 340.4 | 117.2 | 420 | 397.1 | 136.7 | 480 | 453.8 | 156.3 | 540 | 510.6 | 175.8 | 600 | 567.3 | 195.3 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

71° 4h 44m

## TRAVERSE TABLE TO DEGREES

**20°** 1h 20m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.9 | 0.3 | 61 | 57.3 | 20.9 | 121 | 113.7 | 41.4 | 181 | 170.1 | 61.9 | 241 | 226.5 | 82.4 |
| 2 | 1.9 | 0.7 | 62 | 58.3 | 21.2 | 122 | 114.6 | 41.7 | 182 | 171.0 | 62.2 | 242 | 227.4 | 82.8 |
| 3 | 2.8 | 1.0 | 63 | 59.2 | 21.5 | 123 | 115.6 | 42.1 | 183 | 172.0 | 62.6 | 243 | 228.3 | 83.1 |
| 4 | 3.8 | 1.4 | 64 | 60.1 | 21.9 | 124 | 116.5 | 42.4 | 184 | 172.9 | 62.9 | 244 | 229.3 | 83.5 |
| 5 | 4.7 | 1.7 | 65 | 61.1 | 22.2 | 125 | 117.5 | 42.8 | 185 | 173.8 | 63.3 | 245 | 230.2 | 83.8 |
| 6 | 5.6 | 2.1 | 66 | 62.0 | 22.6 | 126 | 118.4 | 43.1 | 186 | 174.8 | 63.6 | 246 | 231.2 | 84.1 |
| 7 | 6.6 | 2.4 | 67 | 63.0 | 22.9 | 127 | 119.3 | 43.4 | 187 | 175.7 | 64.0 | 247 | 232.1 | 84.5 |
| 8 | 7.5 | 2.7 | 68 | 63.9 | 23.3 | 128 | 120.3 | 43.8 | 188 | 176.7 | 64.3 | 248 | 233.0 | 84.8 |
| 9 | 8.5 | 3.1 | 69 | 64.8 | 23.6 | 129 | 121.2 | 44.1 | 189 | 177.6 | 64.6 | 249 | 234.0 | 85.2 |
| 10 | 9.4 | 3.4 | 70 | 65.8 | 23.9 | 130 | 122.2 | 44.5 | 190 | 178.5 | 65.0 | 250 | 234.9 | 85.5 |
| 11 | 10.3 | 3.8 | 71 | 66.7 | 24.3 | 131 | 123.1 | 44.8 | 191 | 179.5 | 65.3 | 251 | 235.9 | 85.8 |
| 12 | 11.3 | 4.1 | 72 | 67.7 | 24.6 | 132 | 124.0 | 45.1 | 192 | 180.4 | 65.7 | 252 | 236.8 | 86.2 |
| 13 | 12.2 | 4.4 | 73 | 68.6 | 25.0 | 133 | 125.0 | 45.5 | 193 | 181.4 | 66.0 | 253 | 237.7 | 86.5 |
| 14 | 13.2 | 4.8 | 74 | 69.5 | 25.3 | 134 | 125.9 | 45.8 | 194 | 182.3 | 66.4 | 254 | 238.7 | 86.9 |
| 15 | 14.1 | 5.1 | 75 | 70.5 | 25.7 | 135 | 126.9 | 46.2 | 195 | 183.2 | 66.7 | 255 | 239.6 | 87.2 |
| 16 | 15.0 | 5.5 | 76 | 71.4 | 26.0 | 136 | 127.8 | 46.5 | 196 | 184.2 | 67.0 | 256 | 240.6 | 87.6 |
| 17 | 16.0 | 5.8 | 77 | 72.4 | 26.3 | 137 | 128.7 | 46.9 | 197 | 185.1 | 67.4 | 257 | 241.5 | 87.9 |
| 18 | 16.9 | 6.2 | 78 | 73.3 | 26.7 | 138 | 129.7 | 47.2 | 198 | 186.1 | 67.7 | 258 | 242.4 | 88.2 |
| 19 | 17.9 | 6.5 | 79 | 74.2 | 27.0 | 139 | 130.6 | 47.5 | 199 | 187.0 | 68.1 | 259 | 243.4 | 88.6 |
| 20 | 18.8 | 6.8 | 80 | 75.2 | 27.4 | 140 | 131.6 | 47.9 | 200 | 187.9 | 68.4 | 260 | 244.3 | 88.9 |
| 21 | 19.7 | 7.2 | 81 | 76.1 | 27.7 | 141 | 132.5 | 48.2 | 201 | 188.9 | 68.7 | 261 | 245.3 | 89.3 |
| 22 | 20.7 | 7.5 | 82 | 77.1 | 28.0 | 142 | 133.4 | 48.6 | 202 | 189.8 | 69.1 | 262 | 246.2 | 89.6 |
| 23 | 21.6 | 7.9 | 83 | 78.0 | 28.4 | 143 | 134.4 | 48.9 | 203 | 190.8 | 69.4 | 263 | 247.1 | 90.0 |
| 24 | 22.6 | 8.2 | 84 | 78.9 | 28.7 | 144 | 135.3 | 49.3 | 204 | 191.7 | 69.8 | 264 | 248.1 | 90.3 |
| 25 | 23.5 | 8.6 | 85 | 79.9 | 29.1 | 145 | 136.3 | 49.6 | 205 | 192.6 | 70.1 | 265 | 249.0 | 90.6 |
| 26 | 24.4 | 8.9 | 86 | 80.8 | 29.4 | 146 | 137.2 | 49.9 | 206 | 193.6 | 70.5 | 266 | 250.0 | 91.0 |
| 27 | 25.4 | 9.2 | 87 | 81.8 | 29.8 | 147 | 138.1 | 50.3 | 207 | 194.5 | 70.8 | 267 | 250.9 | 91.3 |
| 28 | 26.3 | 9.6 | 88 | 82.7 | 30.1 | 148 | 139.1 | 50.6 | 208 | 195.5 | 71.1 | 268 | 251.8 | 91.7 |
| 29 | 27.3 | 9.9 | 89 | 83.6 | 30.4 | 149 | 140.0 | 51.0 | 209 | 196.4 | 71.5 | 269 | 252.8 | 92.0 |
| 30 | 28.2 | 10.3 | 90 | 84.6 | 30.8 | 150 | 141.0 | 51.3 | 210 | 197.3 | 71.8 | 270 | 253.7 | 92.3 |
| 31 | 29.1 | 10.6 | 91 | 85.5 | 31.1 | 151 | 141.9 | 51.6 | 211 | 198.3 | 72.2 | 271 | 254.7 | 92.7 |
| 32 | 30.1 | 10.9 | 92 | 86.5 | 31.5 | 152 | 142.8 | 52.0 | 212 | 199.2 | 72.5 | 272 | 255.6 | 93.0 |
| 33 | 31.0 | 11.3 | 93 | 87.4 | 31.8 | 153 | 143.8 | 52.3 | 213 | 200.2 | 72.9 | 273 | 256.5 | 93.4 |
| 34 | 31.9 | 11.6 | 94 | 88.3 | 32.1 | 154 | 144.7 | 52.7 | 214 | 201.1 | 73.2 | 274 | 257.5 | 93.7 |
| 35 | 32.9 | 12.0 | 95 | 89.3 | 32.5 | 155 | 145.7 | 53.0 | 215 | 202.0 | 73.5 | 275 | 258.4 | 94.1 |
| 36 | 33.8 | 12.3 | 96 | 90.2 | 32.8 | 156 | 146.6 | 53.4 | 216 | 203.0 | 73.9 | 276 | 259.4 | 94.4 |
| 37 | 34.8 | 12.7 | 97 | 91.2 | 33.2 | 157 | 147.5 | 53.7 | 217 | 203.9 | 74.2 | 277 | 260.3 | 94.7 |
| 38 | 35.7 | 13.0 | 98 | 92.1 | 33.5 | 158 | 148.5 | 54.0 | 218 | 204.9 | 74.6 | 278 | 261.2 | 95.1 |
| 39 | 36.6 | 13.3 | 99 | 93.0 | 33.9 | 159 | 149.4 | 54.4 | 219 | 205.8 | 74.9 | 279 | 262.2 | 95.4 |
| 40 | 37.6 | 13.7 | 100 | 94.0 | 34.2 | 160 | 150.4 | 54.7 | 220 | 206.7 | 75.2 | 280 | 263.1 | 95.8 |
| 41 | 38.5 | 14.0 | 101 | 94.9 | 34.5 | 161 | 151.3 | 55.1 | 221 | 207.7 | 75.6 | 281 | 264.1 | 96.1 |
| 42 | 39.5 | 14.4 | 102 | 95.8 | 34.9 | 162 | 152.2 | 55.4 | 222 | 208.6 | 75.9 | 282 | 265.0 | 96.4 |
| 43 | 40.4 | 14.7 | 103 | 96.8 | 35.2 | 163 | 153.2 | 55.7 | 223 | 209.6 | 76.3 | 283 | 265.9 | 96.8 |
| 44 | 41.3 | 15.0 | 104 | 97.7 | 35.6 | 164 | 154.1 | 56.1 | 224 | 210.5 | 76.6 | 284 | 266.9 | 97.1 |
| 45 | 42.3 | 15.4 | 105 | 98.7 | 35.9 | 165 | 155.0 | 56.4 | 225 | 211.4 | 77.0 | 285 | 267.8 | 97.5 |
| 46 | 43.2 | 15.7 | 106 | 99.6 | 36.3 | 166 | 156.0 | 56.8 | 226 | 212.4 | 77.3 | 286 | 268.8 | 97.8 |
| 47 | 44.2 | 16.1 | 107 | 100.5 | 36.6 | 167 | 156.9 | 57.1 | 227 | 213.3 | 77.6 | 287 | 269.7 | 98.2 |
| 48 | 45.1 | 16.4 | 108 | 101.5 | 36.9 | 168 | 157.9 | 57.5 | 228 | 214.2 | 78.0 | 288 | 270.6 | 98.5 |
| 49 | 46.0 | 16.8 | 109 | 102.4 | 37.3 | 169 | 158.8 | 57.8 | 229 | 215.2 | 78.3 | 289 | 271.6 | 98.8 |
| 50 | 47.0 | 17.1 | 110 | 103.4 | 37.6 | 170 | 159.7 | 58.1 | 230 | 216.1 | 78.7 | 290 | 272.5 | 99.2 |
| 51 | 47.9 | 17.4 | 111 | 104.3 | 38.0 | 171 | 160.7 | 58.5 | 231 | 217.1 | 79.0 | 291 | 273.5 | 99.5 |
| 52 | 48.9 | 17.8 | 112 | 105.2 | 38.3 | 172 | 161.6 | 58.8 | 232 | 218.0 | 79.3 | 292 | 274.4 | 99.9 |
| 53 | 49.8 | 18.1 | 113 | 106.2 | 38.6 | 173 | 162.6 | 59.2 | 233 | 218.9 | 79.7 | 293 | 275.3 | 100.2 |
| 54 | 50.7 | 18.5 | 114 | 107.1 | 39.0 | 174 | 163.5 | 59.5 | 234 | 219.9 | 80.0 | 294 | 276.3 | 100.6 |
| 55 | 51.7 | 18.8 | 115 | 108.1 | 39.3 | 175 | 164.4 | 59.9 | 235 | 220.8 | 80.4 | 295 | 277.2 | 100.9 |
| 56 | 52.6 | 19.2 | 116 | 109.0 | 39.7 | 176 | 165.4 | 60.2 | 236 | 221.8 | 80.7 | 296 | 278.1 | 101.2 |
| 57 | 53.6 | 19.5 | 117 | 109.9 | 40.0 | 177 | 166.3 | 60.5 | 237 | 222.7 | 81.1 | 297 | 279.1 | 101.6 |
| 58 | 54.5 | 19.8 | 118 | 110.9 | 40.4 | 178 | 167.3 | 60.9 | 238 | 223.6 | 81.4 | 298 | 280.0 | 101.9 |
| 59 | 55.4 | 20.2 | 119 | 111.8 | 40.7 | 179 | 168.2 | 61.2 | 239 | 224.6 | 81.7 | 299 | 281.0 | 102.3 |
| 60 | 56.4 | 20.5 | 120 | 112.8 | 41.0 | 180 | 169.1 | 61.6 | 240 | 225.5 | 82.1 | 300 | 281.9 | 102.6 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

**70°** 4h 40m

## TRAVERSE TABLE TO DEGREES

20° 1h 20m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 282.9 | 103.0 | 361 | 339.2 | 123.5 | 421 | 395.6 | 144.0 | 481 | 452.0 | 164.5 | 541 | 508.4 | 185.0 |
| 302 | 283.8 | 103.3 | 362 | 340.2 | 123.8 | 422 | 396.6 | 144.3 | 482 | 453.0 | 164.8 | 542 | 509.3 | 185.4 |
| 303 | 284.7 | 103.6 | 363 | 341.1 | 124.2 | 423 | 397.5 | 144.7 | 483 | 453.9 | 165.2 | 543 | 510.3 | 185.7 |
| 304 | 285.7 | 104.0 | 364 | 342.1 | 124.5 | 424 | 398.4 | 145.0 | 484 | 454.8 | 165.5 | 544 | 511.2 | 186.0 |
| 305 | 286.6 | 104.3 | 365 | 343.0 | 124.8 | 425 | 399.4 | 145.4 | 485 | 455.8 | 165.9 | 545 | 512.1 | 186.4 |
| 306 | 287.6 | 104.7 | 366 | 343.9 | 125.2 | 426 | 400.3 | 145.7 | 486 | 456.7 | 166.3 | 546 | 513.1 | 186.8 |
| 307 | 288.5 | 105.0 | 367 | 344.9 | 125.5 | 427 | 401.3 | 146.1 | 487 | 457.7 | 166.6 | 547 | 514.0 | 187.1 |
| 308 | 289.4 | 105.4 | 368 | 345.8 | 125.9 | 428 | 402.2 | 146.4 | 488 | 458.6 | 166.9 | 548 | 515.0 | 187.4 |
| 309 | 290.4 | 105.7 | 369 | 346.8 | 126.2 | 429 | 403.1 | 146.7 | 489 | 459.5 | 167.3 | 549 | 515.9 | 187.8 |
| 310 | 291.3 | 106.0 | 370 | 347.7 | 126.6 | 430 | 404.1 | 147.1 | 490 | 460.5 | 167.7 | 550 | 516.8 | 188.2 |
| 311 | 292.3 | 106.4 | 371 | 348.6 | 126.9 | 431 | 405.0 | 147.4 | 491 | 461.4 | 168.0 | 551 | 517.8 | 188.5 |
| 312 | 293.2 | 106.7 | 372 | 349.6 | 127.2 | 432 | 406.0 | 147.8 | 492 | 462.4 | 168.3 | 552 | 518.7 | 188.8 |
| 313 | 294.1 | 107.1 | 373 | 350.5 | 127.6 | 433 | 406.9 | 148.1 | 493 | 463.3 | 168.6 | 553 | 519.7 | 189.1 |
| 314 | 295.1 | 107.4 | 374 | 351.5 | 127.9 | 434 | 407.8 | 148.4 | 494 | 464.2 | 168.9 | 554 | 520.6 | 189.4 |
| 315 | 296.0 | 107.7 | 375 | 352.4 | 128.3 | 435 | 408.8 | 148.8 | 495 | 465.2 | 169.3 | 555 | 521.5 | 189.8 |
| 316 | 297.0 | 108.1 | 376 | 353.3 | 128.6 | 436 | 409.7 | 149.1 | 496 | 466.1 | 169.6 | 556 | 522.5 | 190.2 |
| 317 | 297.9 | 108.4 | 377 | 354.3 | 129.0 | 437 | 410.7 | 149.5 | 497 | 467.0 | 170.0 | 557 | 523.4 | 190.5 |
| 318 | 298.8 | 108.8 | 378 | 355.2 | 129.3 | 438 | 411.6 | 149.8 | 498 | 468.0 | 170.3 | 558 | 524.4 | 190.8 |
| 319 | 299.8 | 109.1 | 379 | 356.2 | 129.6 | 439 | 412.5 | 150.2 | 499 | 468.9 | 170.7 | 559 | 525.3 | 191.2 |
| 320 | 300.7 | 109.5 | 380 | 357.1 | 130.0 | 440 | 413.5 | 150.5 | 500 | 469.9 | 171.0 | 560 | 526.2 | 191.6 |
| 321 | 301.6 | 109.8 | 381 | 358.0 | 130.3 | 441 | 414.4 | 150.8 | 501 | 470.8 | 171.3 | 561 | 527.2 | 191.9 |
| 322 | 302.6 | 110.1 | 382 | 359.0 | 130.7 | 442 | 415.4 | 151.2 | 502 | 471.7 | 171.7 | 562 | 528.1 | 192.2 |
| 323 | 303.5 | 110.5 | 383 | 359.9 | 131.0 | 443 | 416.3 | 151.5 | 503 | 472.7 | 172.0 | 563 | 529.0 | 192.5 |
| 324 | 304.5 | 110.8 | 384 | 360.8 | 131.3 | 444 | 417.2 | 151.9 | 504 | 473.6 | 172.4 | 564 | 530.0 | 192.9 |
| 325 | 305.4 | 111.2 | 385 | 361.8 | 131.7 | 445 | 418.2 | 152.2 | 505 | 474.5 | 172.7 | 565 | 530.9 | 193.2 |
| 326 | 306.3 | 111.5 | 386 | 362.7 | 132.0 | 446 | 419.1 | 152.5 | 506 | 475.4 | 173.0 | 566 | 531.8 | 193.6 |
| 327 | 307.3 | 111.8 | 387 | 363.7 | 132.4 | 447 | 420.0 | 152.9 | 507 | 476.4 | 173.4 | 567 | 532.8 | 193.9 |
| 328 | 308.2 | 112.2 | 388 | 364.6 | 132.7 | 448 | 421.0 | 153.2 | 508 | 477.3 | 173.7 | 568 | 533.7 | 194.2 |
| 329 | 309.2 | 112.5 | 389 | 365.5 | 133.1 | 449 | 421.9 | 153.6 | 509 | 478.3 | 174.1 | 569 | 534.7 | 194.6 |
| 330 | 310.1 | 112.9 | 390 | 366.5 | 133.4 | 450 | 422.9 | 153.9 | 510 | 479.2 | 174.4 | 570 | 535.6 | 195.0 |
| 331 | 311.0 | 113.2 | 391 | 367.4 | 133.7 | 451 | 423.8 | 154.3 | 511 | 480.2 | 174.8 | 571 | 536.6 | 195.3 |
| 332 | 312.0 | 113.6 | 392 | 368.4 | 134.1 | 452 | 424.7 | 154.6 | 512 | 481.1 | 175.1 | 572 | 537.5 | 195.6 |
| 333 | 312.9 | 113.9 | 393 | 369.3 | 134.4 | 453 | 425.7 | 154.9 | 513 | 482.1 | 175.4 | 573 | 538.5 | 195.9 |
| 334 | 313.9 | 114.2 | 394 | 370.2 | 134.8 | 454 | 426.6 | 155.3 | 514 | 483.0 | 175.8 | 574 | 539.4 | 196.3 |
| 335 | 314.8 | 114.6 | 395 | 371.2 | 135.1 | 455 | 427.6 | 155.6 | 515 | 484.0 | 176.1 | 575 | 540.3 | 196.6 |
| 336 | 315.7 | 114.9 | 396 | 372.1 | 135.4 | 456 | 428.5 | 156.0 | 516 | 484.9 | 176.5 | 576 | 541.3 | 197.0 |
| 337 | 316.7 | 115.3 | 397 | 373.1 | 135.8 | 457 | 429.4 | 156.3 | 517 | 485.8 | 176.8 | 577 | 542.2 | 197.3 |
| 338 | 317.6 | 115.6 | 398 | 374.0 | 136.1 | 458 | 430.4 | 156.7 | 518 | 486.8 | 177.2 | 578 | 543.2 | 197.7 |
| 339 | 318.6 | 116.0 | 399 | 374.9 | 136.5 | 459 | 431.3 | 157.0 | 519 | 487.7 | 177.5 | 579 | 544.1 | 198.0 |
| 340 | 319.5 | 116.3 | 400 | 375.9 | 136.8 | 460 | 432.3 | 157.4 | 520 | 488.7 | 177.9 | 580 | 545.0 | 198.4 |
| 341 | 320.4 | 116.6 | 401 | 376.8 | 137.2 | 461 | 433.2 | 157.7 | 521 | 489.6 | 178.2 | 581 | 546.0 | 198.7 |
| 342 | 321.4 | 117.0 | 402 | 377.8 | 137.5 | 462 | 434.1 | 158.0 | 522 | 490.5 | 178.5 | 582 | 546.9 | 199.0 |
| 343 | 322.3 | 117.3 | 403 | 378.7 | 137.8 | 463 | 435.1 | 158.4 | 523 | 491.5 | 178.9 | 583 | 547.9 | 199.4 |
| 344 | 323.3 | 117.7 | 404 | 379.6 | 138.2 | 464 | 436.0 | 158.7 | 524 | 492.4 | 179.2 | 584 | 548.8 | 199.8 |
| 345 | 324.2 | 118.0 | 405 | 380.6 | 138.5 | 465 | 437.0 | 159.0 | 525 | 493.4 | 179.6 | 585 | 549.8 | 200.1 |
| 346 | 325.1 | 118.4 | 406 | 381.5 | 138.9 | 466 | 437.9 | 159.4 | 526 | 494.3 | 179.9 | 586 | 550.7 | 200.4 |
| 347 | 326.1 | 118.7 | 407 | 382.5 | 139.2 | 467 | 438.8 | 159.7 | 527 | 495.3 | 180.2 | 587 | 551.7 | 200.8 |
| 348 | 327.0 | 119.0 | 408 | 383.4 | 139.6 | 468 | 439.8 | 160.1 | 528 | 496.2 | 180.6 | 588 | 552.6 | 201.2 |
| 349 | 328.0 | 119.4 | 409 | 384.3 | 139.9 | 469 | 440.7 | 160.4 | 529 | 497.1 | 181.0 | 589 | 553.5 | 201.5 |
| 350 | 328.9 | 119.7 | 410 | 385.3 | 140.2 | 470 | 441.7 | 160.8 | 530 | 498.1 | 181.3 | 590 | 554.4 | 201.8 |
| 351 | 329.8 | 120.1 | 411 | 386.2 | 140.6 | 471 | 442.6 | 161.1 | 531 | 499.0 | 181.6 | 591 | 555.4 | 202.1 |
| 352 | 330.8 | 120.4 | 412 | 387.2 | 140.9 | 472 | 443.5 | 161.4 | 532 | 499.9 | 181.9 | 592 | 556.3 | 202.4 |
| 353 | 331.7 | 120.7 | 413 | 388.1 | 141.3 | 473 | 444.5 | 161.8 | 533 | 500.9 | 182.3 | 593 | 557.3 | 202.8 |
| 354 | 332.7 | 121.1 | 414 | 389.0 | 141.6 | 474 | 445.4 | 162.1 | 534 | 501.8 | 182.6 | 594 | 558.2 | 203.2 |
| 355 | 333.6 | 121.4 | 415 | 390.0 | 141.9 | 475 | 446.4 | 162.5 | 535 | 502.7 | 183.0 | 595 | 559.1 | 203.5 |
| 356 | 334.5 | 121.8 | 416 | 390.9 | 142.3 | 476 | 447.3 | 162.8 | 536 | 503.7 | 183.3 | 596 | 560.0 | 203.8 |
| 357 | 335.5 | 122.1 | 417 | 391.9 | 142.6 | 477 | 448.2 | 163.2 | 537 | 504.6 | 183.7 | 597 | 561.0 | 204.2 |
| 358 | 336.4 | 122.5 | 418 | 392.8 | 143.0 | 478 | 449.2 | 163.5 | 538 | 505.5 | 184.0 | 598 | 561.9 | 204.6 |
| 359 | 337.4 | 122.8 | 419 | 393.7 | 143.3 | 479 | 450.1 | 163.8 | 539 | 506.5 | 184.3 | 599 | 562.9 | 204.9 |
| 360 | 338.3 | 123.1 | 420 | 394.7 | 143.7 | 480 | 451.1 | 164.2 | 540 | 507.4 | 184.7 | 600 | 563.8 | 205.2 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

70° 4h 40m

## TRAVERSE TABLE TO DEGREES

21° $1^h\ 24^m$

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.9 | 0.4 | 61 | 56.9 | 21.9 | 121 | 113.0 | 43.4 | 181 | 169.0 | 64.9 | 241 | 225.0 | 86.4 |
| 2 | 1.9 | 0.7 | 62 | 57.9 | 22.2 | 122 | 113.9 | 43.7 | 182 | 169.9 | 65.2 | 242 | 225.9 | 86.7 |
| 3 | 2.8 | 1.1 | 63 | 58.8 | 22.6 | 123 | 114.8 | 44.1 | 183 | 170.8 | 65.6 | 243 | 226.9 | 87.1 |
| 4 | 3.7 | 1.4 | 64 | 59.7 | 22.9 | 124 | 115.8 | 44.4 | 184 | 171.8 | 65.9 | 244 | 227.8 | 87.4 |
| 5 | 4.7 | 1.8 | 65 | 60.7 | 23.3 | 125 | 116.7 | 44.8 | 185 | 172.7 | 66.3 | 245 | 228.7 | 87.8 |
| 6 | 5.6 | 2.2 | 66 | 61.6 | 23.7 | 126 | 117.6 | 45.2 | 186 | 173.6 | 66.7 | 246 | 229.7 | 88.2 |
| 7 | 6.5 | 2.5 | 67 | 62.5 | 24.0 | 127 | 118.6 | 45.5 | 187 | 174.6 | 67.0 | 247 | 230.6 | 88.5 |
| 8 | 7.5 | 2.9 | 68 | 63.5 | 24.4 | 128 | 119.5 | 45.9 | 188 | 175.5 | 67.4 | 248 | 231.5 | 88.9 |
| 9 | 8.4 | 3.2 | 69 | 64.4 | 24.7 | 129 | 120.4 | 46.2 | 189 | 176.4 | 67.7 | 249 | 232.5 | 89.2 |
| 10 | 9.3 | 3.6 | 70 | 65.4 | 25.1 | 130 | 121.4 | 46.6 | 190 | 177.4 | 68.1 | 250 | 233.4 | 89.6 |
| 11 | 10.3 | 3.9 | 71 | 66.3 | 25.4 | 131 | 122.3 | 46.9 | 191 | 178.3 | 68.4 | 251 | 234.3 | 90.0 |
| 12 | 11.2 | 4.3 | 72 | 67.2 | 25.8 | 132 | 123.2 | 47.3 | 192 | 179.2 | 68.8 | 252 | 235.3 | 90.3 |
| 13 | 12.1 | 4.7 | 73 | 68.2 | 26.2 | 133 | 124.2 | 47.7 | 193 | 180.2 | 69.2 | 253 | 236.2 | 90.7 |
| 14 | 13.1 | 5.0 | 74 | 69.1 | 26.5 | 134 | 125.1 | 48.0 | 194 | 181.1 | 69.5 | 254 | 237.1 | 91.0 |
| 15 | 14.0 | 5.4 | 75 | 70.0 | 26.9 | 135 | 126.0 | 48.4 | 195 | 182.0 | 69.9 | 255 | 238.1 | 91.4 |
| 16 | 14.9 | 5.7 | 76 | 71.0 | 27.2 | 136 | 127.0 | 48.7 | 196 | 183.0 | 70.2 | 256 | 239.0 | 91.7 |
| 17 | 15.9 | 6.1 | 77 | 71.9 | 27.6 | 137 | 127.9 | 49.1 | 197 | 183.9 | 70.6 | 257 | 239.9 | 92.1 |
| 18 | 16.8 | 6.5 | 78 | 72.8 | 28.0 | 138 | 128.8 | 49.5 | 198 | 184.8 | 71.0 | 258 | 240.9 | 92.5 |
| 19 | 17.7 | 6.8 | 79 | 73.8 | 28.3 | 139 | 129.8 | 49.8 | 199 | 185.8 | 71.3 | 259 | 241.8 | 92.8 |
| 20 | 18.7 | 7.2 | 80 | 74.7 | 28.7 | 140 | 130.7 | 50.2 | 200 | 186.7 | 71.7 | 260 | 242.7 | 93.2 |
| 21 | 19.6 | 7.5 | 81 | 75.6 | 29.0 | 141 | 131.6 | 50.5 | 201 | 187.6 | 72.0 | 261 | 243.7 | 93.5 |
| 22 | 20.5 | 7.9 | 82 | 76.6 | 29.4 | 142 | 132.6 | 50.9 | 202 | 188.6 | 72.4 | 262 | 244.6 | 93.9 |
| 23 | 21.5 | 8.2 | 83 | 77.5 | 29.7 | 143 | 133.5 | 51.2 | 203 | 189.5 | 72.7 | 263 | 245.5 | 94.3 |
| 24 | 22.4 | 8.6 | 84 | 78.4 | 30.1 | 144 | 134.4 | 51.6 | 204 | 190.5 | 73.1 | 264 | 246.5 | 94.6 |
| 25 | 23.3 | 9.0 | 85 | 79.4 | 30.5 | 145 | 135.4 | 52.0 | 205 | 191.4 | 73.5 | 265 | 247.4 | 95.0 |
| 26 | 24.3 | 9.3 | 86 | 80.3 | 30.8 | 146 | 136.3 | 52.3 | 206 | 192.3 | 73.8 | 266 | 248.3 | 95.3 |
| 27 | 25.2 | 9.7 | 87 | 81.2 | 31.2 | 147 | 137.2 | 52.7 | 207 | 193.3 | 74.2 | 267 | 249.3 | 95.7 |
| 28 | 26.1 | 10.0 | 88 | 82.2 | 31.5 | 148 | 138.2 | 53.0 | 208 | 194.2 | 74.5 | 268 | 250.2 | 96.0 |
| 29 | 27.1 | 10.4 | 89 | 83.1 | 31.9 | 149 | 139.1 | 53.4 | 209 | 195.1 | 74.9 | 269 | 251.1 | 96.4 |
| 30 | 28.0 | 10.8 | 90 | 84.0 | 32.3 | 150 | 140.0 | 53.8 | 210 | 196.1 | 75.3 | 270 | 252.1 | 96.8 |
| 31 | 28.9 | 11.1 | 91 | 85.0 | 32.6 | 151 | 141.0 | 54.1 | 211 | 197.0 | 75.6 | 271 | 253.0 | 97.1 |
| 32 | 29.9 | 11.5 | 92 | 85.9 | 33.0 | 152 | 141.9 | 54.5 | 212 | 197.9 | 76.0 | 272 | 253.9 | 97.5 |
| 33 | 30.8 | 11.8 | 93 | 86.8 | 33.3 | 153 | 142.8 | 54.8 | 213 | 198.9 | 76.3 | 273 | 254.9 | 97.8 |
| 34 | 31.7 | 12.2 | 94 | 87.8 | 33.7 | 154 | 143.8 | 55.2 | 214 | 199.8 | 76.7 | 274 | 255.8 | 98.2 |
| 35 | 32.7 | 12.5 | 95 | 88.7 | 34.0 | 155 | 144.7 | 55.5 | 215 | 200.7 | 77.0 | 275 | 256.7 | 98.6 |
| 36 | 33.6 | 12.9 | 96 | 89.6 | 34.4 | 156 | 145.6 | 55.9 | 216 | 201.7 | 77.4 | 276 | 257.7 | 98.9 |
| 37 | 34.5 | 13.3 | 97 | 90.6 | 34.8 | 157 | 146.6 | 56.3 | 217 | 202.6 | 77.8 | 277 | 258.6 | 99.3 |
| 38 | 35.5 | 13.6 | 98 | 91.5 | 35.1 | 158 | 147.5 | 56.6 | 218 | 203.5 | 78.1 | 278 | 259.5 | 99.6 |
| 39 | 36.4 | 14.0 | 99 | 92.4 | 35.5 | 159 | 148.4 | 57.0 | 219 | 204.5 | 78.5 | 279 | 260.5 | 100.0 |
| 40 | 37.3 | 14.3 | 100 | 93.4 | 35.8 | 160 | 149.4 | 57.3 | 220 | 205.4 | 78.8 | 280 | 261.4 | 100.3 |
| 41 | 38.3 | 14.7 | 101 | 94.3 | 36.2 | 161 | 150.3 | 57.7 | 221 | 206.3 | 79.2 | 281 | 262.3 | 100.7 |
| 42 | 39.2 | 15.1 | 102 | 95.2 | 36.6 | 162 | 151.2 | 58.1 | 222 | 207.3 | 79.6 | 282 | 263.3 | 101.1 |
| 43 | 40.1 | 15.4 | 103 | 96.2 | 36.9 | 163 | 152.2 | 58.4 | 223 | 208.2 | 79.9 | 283 | 264.2 | 101.4 |
| 44 | 41.1 | 15.8 | 104 | 97.1 | 37.3 | 164 | 153.1 | 58.8 | 224 | 209.1 | 80.3 | 284 | 265.1 | 101.8 |
| 45 | 42.0 | 16.1 | 105 | 98.0 | 37.6 | 165 | 154.0 | 59.1 | 225 | 210.1 | 80.6 | 285 | 266.1 | 102.1 |
| 46 | 42.9 | 16.5 | 106 | 99.0 | 38.0 | 166 | 155.0 | 59.5 | 226 | 211.0 | 81.0 | 286 | 267.0 | 102.5 |
| 47 | 43.9 | 16.8 | 107 | 99.9 | 38.3 | 167 | 155.9 | 59.8 | 227 | 211.9 | 81.3 | 287 | 267.9 | 102.9 |
| 48 | 44.8 | 17.2 | 108 | 100.8 | 38.7 | 168 | 156.8 | 60.2 | 228 | 212.9 | 81.7 | 288 | 268.9 | 103.2 |
| 49 | 45.7 | 17.6 | 109 | 101.8 | 39.1 | 169 | 157.8 | 60.6 | 229 | 213.8 | 82.1 | 289 | 269.8 | 103.6 |
| 50 | 46.7 | 17.9 | 110 | 102.7 | 39.4 | 170 | 158.7 | 60.9 | 230 | 214.7 | 82.4 | 290 | 270.7 | 103.9 |
| 51 | 47.6 | 18.3 | 111 | 103.6 | 39.8 | 171 | 159.6 | 61.3 | 231 | 215.7 | 82.8 | 291 | 271.7 | 104.3 |
| 52 | 48.5 | 18.6 | 112 | 104.6 | 40.1 | 172 | 160.6 | 61.6 | 232 | 216.6 | 83.1 | 292 | 272.6 | 104.6 |
| 53 | 49.5 | 19.0 | 113 | 105.5 | 40.5 | 173 | 161.5 | 62.0 | 233 | 217.5 | 83.5 | 293 | 273.5 | 105.0 |
| 54 | 50.4 | 19.4 | 114 | 106.4 | 40.9 | 174 | 162.4 | 62.4 | 234 | 218.5 | 83.9 | 294 | 274.5 | 105.4 |
| 55 | 51.3 | 19.7 | 115 | 107.4 | 41.2 | 175 | 163.4 | 62.7 | 235 | 219.4 | 84.2 | 295 | 275.4 | 105.7 |
| 56 | 52.3 | 20.1 | 116 | 108.3 | 41.6 | 176 | 164.3 | 63.1 | 236 | 220.3 | 84.6 | 296 | 276.3 | 106.1 |
| 57 | 53.2 | 20.4 | 117 | 109.2 | 41.9 | 177 | 165.2 | 63.4 | 237 | 221.3 | 84.9 | 297 | 277.3 | 106.4 |
| 58 | 54.1 | 20.8 | 118 | 110.2 | 42.3 | 178 | 166.2 | 63.8 | 238 | 222.2 | 85.3 | 298 | 278.2 | 106.8 |
| 59 | 55.1 | 21.1 | 119 | 111.1 | 42.6 | 179 | 167.1 | 64.1 | 239 | 223.1 | 85.6 | 299 | 279.1 | 107.2 |
| 60 | 56.0 | 21.5 | 120 | 112.0 | 43.0 | 180 | 168.0 | 64.5 | 240 | 224.1 | 86.0 | 300 | 280.1 | 107.5 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

69° $4^h\ 36^m$

## TRAVERSE TABLE TO DEGREES

21° 1h 24m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 281·0 | 107·9 | 361 | 337·0 | 129·4 | 421 | 393·0 | 150·9 | 481 | 449·0 | 172·4 | 541 | 505·1 | 193·9 |
| 302 | 281·9 | 108·2 | 362 | 337·9 | 129·7 | 422 | 394·0 | 151·2 | 482 | 450·0 | 172·7 | 542 | 506·0 | 194·2 |
| 303 | 282·9 | 108·6 | 363 | 338·9 | 130·1 | 423 | 394·9 | 151·6 | 483 | 450·9 | 173·1 | 543 | 507·0 | 194·6 |
| 304 | 283·8 | 108·9 | 364 | 339·8 | 130·4 | 424 | 395·8 | 152·0 | 484 | 451·8 | 173·5 | 544 | 507·9 | 195·0 |
| 305 | 284·7 | 109·3 | 365 | 340·7 | 130·8 | 425 | 396·8 | 152·3 | 485 | 452·8 | 173·8 | 545 | 508·8 | 195·3 |
| 306 | 285·7 | 109·7 | 366 | 341·7 | 131·2 | 426 | 397·7 | 152·7 | 486 | 453·7 | 174·2 | 546 | 509·8 | 195·7 |
| 307 | 286·6 | 110·0 | 367 | 342·6 | 131·5 | 427 | 398·6 | 153·0 | 487 | 454·6 | 174·5 | 547 | 510·7 | 196·0 |
| 308 | 287·5 | 110·4 | 368 | 343·5 | 131·9 | 428 | 399·6 | 153·4 | 488 | 455·6 | 174·9 | 548 | 511·6 | 196·4 |
| 309 | 288·5 | 110·7 | 369 | 344·5 | 132·2 | 429 | 400·5 | 153·7 | 489 | 456·5 | 175·2 | 549 | 512·6 | 196·8 |
| 310 | 289·4 | 111·1 | 370 | 345·4 | 132·6 | 430 | 401·4 | 154·1 | 490 | 457·4 | 175·6 | 550 | 513·5 | 197·1 |
| 311 | 290·3 | 111·5 | 371 | 346·3 | 133·0 | 431 | 402·4 | 154·5 | 491 | 458·4 | 176·0 | 551 | 514·4 | 197·5 |
| 312 | 291·3 | 111·8 | 372 | 347·3 | 133·3 | 432 | 403·3 | 154·8 | 492 | 459·3 | 176·3 | 552 | 515·4 | 197·8 |
| 313 | 292·2 | 112·2 | 373 | 348·2 | 133·7 | 433 | 404·2 | 155·2 | 493 | 460·2 | 176·7 | 553 | 516·3 | 198·2 |
| 314 | 293·1 | 112·5 | 374 | 349·1 | 134·0 | 434 | 405·2 | 155·5 | 494 | 461·2 | 177·0 | 554 | 517·2 | 198·6 |
| 315 | 294·1 | 112·9 | 375 | 350·1 | 134·4 | 435 | 406·1 | 155·9 | 495 | 462·1 | 177·4 | 555 | 518·2 | 198·9 |
| 316 | 295·0 | 113·2 | 376 | 351·0 | 134·7 | 436 | 407·0 | 156·3 | 496 | 463·0 | 177·8 | 556 | 519·1 | 199·3 |
| 317 | 295·9 | 113·6 | 377 | 351·9 | 135·1 | 437 | 408·0 | 156·6 | 497 | 464·0 | 178·1 | 557 | 520·0 | 199·6 |
| 318 | 296·9 | 114·0 | 378 | 352·9 | 135·5 | 438 | 408·9 | 157·0 | 498 | 464·9 | 178·5 | 558 | 521·0 | 200·0 |
| 319 | 297·8 | 114·3 | 379 | 353·8 | 135·8 | 439 | 409·8 | 157·3 | 499 | 465·8 | 178·8 | 559 | 521·9 | 200·3 |
| 320 | 298·7 | 114·7 | 380 | 354·7 | 136·2 | 440 | 410·8 | 157·7 | 500 | 466·8 | 179·2 | 560 | 522·8 | 200·7 |
| 321 | 299·7 | 115·0 | 381 | 355·7 | 136·5 | 441 | 411·7 | 158·0 | 501 | 467·7 | 179·5 | 561 | 523·8 | 201·0 |
| 322 | 300·6 | 115·4 | 382 | 356·6 | 136·9 | 442 | 412·6 | 158·4 | 502 | 468·6 | 179·9 | 562 | 524·7 | 201·4 |
| 323 | 301·5 | 115·8 | 383 | 357·5 | 137·3 | 443 | 413·6 | 158·8 | 503 | 469·6 | 180·3 | 563 | 525·6 | 201·8 |
| 324 | 302·5 | 116·1 | 384 | 358·5 | 137·6 | 444 | 414·5 | 159·1 | 504 | 470·5 | 180·6 | 564 | 526·6 | 202·1 |
| 325 | 303·4 | 116·5 | 385 | 359·4 | 138·0 | 445 | 415·4 | 159·5 | 505 | 471·5 | 181·0 | 565 | 527·5 | 202·5 |
| 326 | 304·3 | 116·8 | 386 | 360·3 | 138·3 | 446 | 416·4 | 159·8 | 506 | 472·4 | 181·3 | 566 | 528·4 | 202·8 |
| 327 | 305·3 | 117·2 | 387 | 361·3 | 138·7 | 447 | 417·3 | 160·2 | 507 | 473·3 | 181·7 | 567 | 529·4 | 203·2 |
| 328 | 306·2 | 117·5 | 388 | 362·2 | 139·1 | 448 | 418·2 | 160·5 | 508 | 474·3 | 182·0 | 568 | 530·3 | 203·5 |
| 329 | 307·1 | 117·9 | 389 | 363·1 | 139·4 | 449 | 419·2 | 160·9 | 509 | 475·2 | 182·4 | 569 | 531·2 | 203·9 |
| 330 | 308·1 | 118·3 | 390 | 364·1 | 139·8 | 450 | 420·1 | 161·3 | 510 | 476·1 | 182·8 | 570 | 532·2 | 204·3 |
| 331 | 309·0 | 118·6 | 391 | 365·0 | 140·1 | 451 | 421·0 | 161·6 | 511 | 477·1 | 183·1 | 571 | 533·1 | 204·6 |
| 332 | 309·9 | 119·0 | 392 | 365·9 | 140·5 | 452 | 422·0 | 162·0 | 512 | 478·0 | 183·5 | 572 | 534·0 | 205·0 |
| 333 | 310·9 | 119·3 | 393 | 366·9 | 140·8 | 453 | 422·9 | 162·3 | 513 | 478·9 | 183·8 | 573 | 535·0 | 205·4 |
| 334 | 311·8 | 119·7 | 394 | 367·8 | 141·2 | 454 | 423·8 | 162·7 | 514 | 479·9 | 184·2 | 574 | 535·9 | 205·7 |
| 335 | 312·7 | 120·1 | 395 | 368·7 | 141·6 | 455 | 424·8 | 163·1 | 515 | 480·8 | 184·6 | 575 | 536·8 | 206·1 |
| 336 | 313·7 | 120·4 | 396 | 369·7 | 141·9 | 456 | 425·7 | 163·4 | 516 | 481·7 | 184·9 | 576 | 537·8 | 206·4 |
| 337 | 314·6 | 120·8 | 397 | 370·6 | 142·3 | 457 | 426·6 | 163·8 | 517 | 482·7 | 185·3 | 577 | 538·7 | 206·8 |
| 338 | 315·5 | 121·1 | 398 | 371·5 | 142·6 | 458 | 427·6 | 164·1 | 518 | 483·6 | 185·6 | 578 | 539·6 | 207·1 |
| 339 | 316·5 | 121·5 | 399 | 372·5 | 143·0 | 459 | 428·5 | 164·5 | 519 | 484·5 | 186·0 | 579 | 540·6 | 207·5 |
| 340 | 317·4 | 121·8 | 400 | 373·4 | 143·4 | 460 | 429·4 | 164·9 | 520 | 485·5 | 186·4 | 580 | 541·5 | 207·9 |
| 341 | 318·3 | 122·2 | 401 | 374·3 | 143·7 | 461 | 430·4 | 165·2 | 521 | 486·4 | 186·7 | 581 | 542·4 | 208·2 |
| 342 | 319·3 | 122·6 | 402 | 375·3 | 144·1 | 462 | 431·3 | 165·6 | 522 | 487·3 | 187·1 | 582 | 543·4 | 208·6 |
| 343 | 320·2 | 122·9 | 403 | 376·2 | 144·4 | 463 | 432·2 | 165·9 | 523 | 488·3 | 187·4 | 583 | 544·3 | 208·9 |
| 344 | 321·1 | 123·2 | 404 | 377·1 | 144·8 | 464 | 433·2 | 166·3 | 524 | 489·2 | 187·8 | 584 | 545·2 | 209·3 |
| 345 | 322·1 | 123·6 | 405 | 378·1 | 145·1 | 465 | 434·1 | 166·6 | 525 | 490·1 | 188·1 | 585 | 546·2 | 209·6 |
| 346 | 323·0 | 124·0 | 406 | 379·0 | 145·5 | 466 | 435·0 | 167·0 | 526 | 491·1 | 188·5 | 586 | 547·1 | 210·0 |
| 347 | 323·9 | 124·4 | 407 | 379·9 | 145·9 | 467 | 436·0 | 167·4 | 527 | 492·0 | 188·9 | 587 | 548·0 | 210·4 |
| 348 | 324·9 | 124·7 | 408 | 380·9 | 146·2 | 468 | 436·9 | 167·7 | 528 | 492·9 | 189·2 | 588 | 549·0 | 210·7 |
| 349 | 325·8 | 125·1 | 409 | 381·8 | 146·6 | 469 | 437·8 | 168·1 | 529 | 493·9 | 189·6 | 589 | 549·9 | 211·1 |
| 350 | 326·7 | 125·4 | 410 | 382·7 | 146·9 | 470 | 438·8 | 168·4 | 530 | 494·8 | 189·9 | 590 | 550·8 | 211·4 |
| 351 | 327·7 | 125·8 | 411 | 383·7 | 147·3 | 471 | 439·7 | 168·8 | 531 | 495·7 | 190·3 | 591 | 551·8 | 211·8 |
| 352 | 328·6 | 126·1 | 412 | 384·6 | 147·7 | 472 | 440·6 | 169·2 | 532 | 496·7 | 190·7 | 592 | 552·7 | 212·2 |
| 353 | 329·5 | 126·5 | 413 | 385·5 | 148·0 | 473 | 441·6 | 169·5 | 533 | 497·6 | 191·0 | 593 | 553·6 | 212·5 |
| 354 | 330·5 | 126·9 | 414 | 386·5 | 148·4 | 474 | 442·5 | 169·9 | 534 | 498·5 | 191·4 | 594 | 554·6 | 212·9 |
| 355 | 331·4 | 127·2 | 415 | 387·4 | 148·7 | 475 | 443·4 | 170·2 | 535 | 499·5 | 191·7 | 595 | 555·5 | 213·2 |
| 356 | 332·3 | 127·6 | 416 | 388·4 | 149·1 | 476 | 444·4 | 170·6 | 536 | 500·4 | 192·1 | 596 | 556·4 | 213·6 |
| 357 | 333·3 | 127·9 | 417 | 389·3 | 149·4 | 477 | 445·3 | 170·9 | 537 | 501·3 | 192·4 | 597 | 557·4 | 213·9 |
| 358 | 334·2 | 128·3 | 418 | 390·2 | 149·8 | 478 | 446·2 | 171·3 | 538 | 502·3 | 192·8 | 598 | 558·2 | 214·3 |
| 359 | 335·1 | 128·7 | 419 | 391·2 | 150·2 | 479 | 447·2 | 171·7 | 539 | 503·2 | 193·2 | 599 | 559·2 | 214·7 |
| 360 | 336·1 | 129·0 | 420 | 392·1 | 150·5 | 480 | 448·1 | 172·0 | 540 | 504·1 | 193·5 | 600 | 560·1 | 215·0 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

69° 4h 36m

## TRAVERSE TABLE TO DEGREES

22° — 1h 28m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.9 | 0.4 | 61 | 56.6 | 22.9 | 121 | 112.2 | 45.3 | 181 | 167.8 | 67.8 | 241 | 223.5 | 90.3 |
| 2 | 1.9 | 0.7 | 62 | 57.5 | 23.2 | 122 | 113.1 | 45.7 | 182 | 168.7 | 68.2 | 242 | 224.4 | 90.7 |
| 3 | 2.8 | 1.1 | 63 | 58.4 | 23.6 | 123 | 114.0 | 46.1 | 183 | 169.7 | 68.6 | 243 | 225.3 | 91.0 |
| 4 | 3.7 | 1.5 | 64 | 59.3 | 24.0 | 124 | 115.0 | 46.5 | 184 | 170.6 | 68.9 | 244 | 226.2 | 91.4 |
| 5 | 4.6 | 1.9 | 65 | 60.3 | 24.3 | 125 | 115.9 | 46.8 | 185 | 171.5 | 69.3 | 245 | 227.2 | 91.8 |
| 6 | 5.6 | 2.2 | 66 | 61.2 | 24.7 | 126 | 116.8 | 47.2 | 186 | 172.5 | 69.7 | 246 | 228.1 | 92.2 |
| 7 | 6.5 | 2.6 | 67 | 62.1 | 25.1 | 127 | 117.8 | 47.6 | 187 | 173.4 | 70.1 | 247 | 229.0 | 92.5 |
| 8 | 7.4 | 3.0 | 68 | 63.0 | 25.5 | 128 | 118.7 | 47.9 | 188 | 174.3 | 70.4 | 248 | 229.9 | 92.9 |
| 9 | 8.3 | 3.4 | 69 | 64.0 | 25.8 | 129 | 119.6 | 48.3 | 189 | 175.2 | 70.8 | 249 | 230.9 | 93.3 |
| 10 | 9.3 | 3.7 | 70 | 64.9 | 26.2 | 130 | 120.5 | 48.7 | 190 | 176.2 | 71.2 | 250 | 231.8 | 93.7 |
| 11 | 10.2 | 4.1 | 71 | 65.8 | 26.6 | 131 | 121.5 | 49.1 | 191 | 177.1 | 71.5 | 251 | 232.7 | 94.0 |
| 12 | 11.1 | 4.5 | 72 | 66.8 | 27.0 | 132 | 122.4 | 49.4 | 192 | 178.0 | 71.9 | 252 | 233.7 | 94.4 |
| 13 | 12.1 | 4.9 | 73 | 67.7 | 27.3 | 133 | 123.3 | 49.8 | 193 | 178.9 | 72.3 | 253 | 234.6 | 94.8 |
| 14 | 13.0 | 5.2 | 74 | 68.6 | 27.7 | 134 | 124.2 | 50.2 | 194 | 179.9 | 72.7 | 254 | 235.5 | 95.2 |
| 15 | 13.9 | 5.6 | 75 | 69.5 | 28.1 | 135 | 125.2 | 50.6 | 195 | 180.8 | 73.0 | 255 | 236.4 | 95.5 |
| 16 | 14.8 | 6.0 | 76 | 70.5 | 28.5 | 136 | 126.1 | 50.9 | 196 | 181.7 | 73.4 | 256 | 237.4 | 95.9 |
| 17 | 15.8 | 6.4 | 77 | 71.4 | 28.8 | 137 | 127.0 | 51.3 | 197 | 182.7 | 73.8 | 257 | 238.3 | 96.3 |
| 18 | 16.7 | 6.7 | 78 | 72.3 | 29.2 | 138 | 128.0 | 51.7 | 198 | 183.6 | 74.2 | 258 | 239.2 | 96.6 |
| 19 | 17.6 | 7.1 | 79 | 73.2 | 29.6 | 139 | 128.9 | 52.1 | 199 | 184.5 | 74.5 | 259 | 240.1 | 97.0 |
| 20 | 18.5 | 7.5 | 80 | 74.2 | 30.0 | 140 | 129.8 | 52.4 | 200 | 185.4 | 74.9 | 260 | 241.1 | 97.4 |
| 21 | 19.5 | 7.9 | 81 | 75.1 | 30.3 | 141 | 130.7 | 52.8 | 201 | 186.4 | 75.3 | 261 | 242.0 | 97.8 |
| 22 | 20.4 | 8.2 | 82 | 76.0 | 30.7 | 142 | 131.7 | 53.2 | 202 | 187.3 | 75.7 | 262 | 242.9 | 98.1 |
| 23 | 21.3 | 8.6 | 83 | 77.0 | 31.1 | 143 | 132.6 | 53.6 | 203 | 188.2 | 76.0 | 263 | 243.8 | 98.5 |
| 24 | 22.3 | 9.0 | 84 | 77.9 | 31.5 | 144 | 133.5 | 53.9 | 204 | 189.1 | 76.4 | 264 | 244.8 | 98.9 |
| 25 | 23.2 | 9.4 | 85 | 78.8 | 31.8 | 145 | 134.4 | 54.3 | 205 | 190.1 | 76.8 | 265 | 245.7 | 99.3 |
| 26 | 24.1 | 9.7 | 86 | 79.7 | 32.2 | 146 | 135.4 | 54.7 | 206 | 191.0 | 77.2 | 266 | 246.6 | 99.6 |
| 27 | 25.0 | 10.1 | 87 | 80.7 | 32.6 | 147 | 136.3 | 55.1 | 207 | 191.9 | 77.5 | 267 | 247.6 | 100.0 |
| 28 | 26.0 | 10.5 | 88 | 81.6 | 33.0 | 148 | 137.2 | 55.4 | 208 | 192.9 | 77.9 | 268 | 248.5 | 100.4 |
| 29 | 26.9 | 10.9 | 89 | 82.5 | 33.3 | 149 | 138.2 | 55.8 | 209 | 193.8 | 78.3 | 269 | 249.4 | 100.8 |
| 30 | 27.8 | 11.2 | 90 | 83.4 | 33.7 | 150 | 139.1 | 56.2 | 210 | 194.7 | 78.7 | 270 | 250.3 | 101.1 |
| 31 | 28.7 | 11.6 | 91 | 84.4 | 34.1 | 151 | 140.0 | 56.6 | 211 | 195.6 | 79.0 | 271 | 251.3 | 101.5 |
| 32 | 29.7 | 12.0 | 92 | 85.3 | 34.5 | 152 | 140.9 | 56.9 | 212 | 196.6 | 79.4 | 272 | 252.2 | 101.9 |
| 33 | 30.6 | 12.4 | 93 | 86.2 | 34.8 | 153 | 141.9 | 57.3 | 213 | 197.5 | 79.8 | 273 | 253.1 | 102.3 |
| 34 | 31.5 | 12.7 | 94 | 87.2 | 35.2 | 154 | 142.8 | 57.7 | 214 | 198.4 | 80.2 | 274 | 254.0 | 102.6 |
| 35 | 32.5 | 13.1 | 95 | 88.1 | 35.6 | 155 | 143.7 | 58.1 | 215 | 199.3 | 80.5 | 275 | 255.0 | 103.0 |
| 36 | 33.4 | 13.5 | 96 | 89.0 | 36.0 | 156 | 144.6 | 58.4 | 216 | 200.3 | 80.9 | 276 | 255.9 | 103.4 |
| 37 | 34.3 | 13.9 | 97 | 89.9 | 36.3 | 157 | 145.6 | 58.8 | 217 | 201.2 | 81.3 | 277 | 256.8 | 103.8 |
| 38 | 35.2 | 14.2 | 98 | 90.9 | 36.7 | 158 | 146.5 | 59.2 | 218 | 202.1 | 81.7 | 278 | 257.8 | 104.1 |
| 39 | 36.2 | 14.6 | 99 | 91.8 | 37.1 | 159 | 147.4 | 59.6 | 219 | 203.1 | 82.0 | 279 | 258.7 | 104.5 |
| 40 | 37.1 | 15.0 | 100 | 92.7 | 37.5 | 160 | 148.3 | 59.9 | 220 | 204.0 | 82.4 | 280 | 259.6 | 104.9 |
| 41 | 38.0 | 15.4 | 101 | 93.6 | 37.8 | 161 | 149.3 | 60.3 | 221 | 204.9 | 82.8 | 281 | 260.5 | 105.3 |
| 42 | 38.9 | 15.7 | 102 | 94.6 | 38.2 | 162 | 150.2 | 60.7 | 222 | 205.8 | 83.2 | 282 | 261.5 | 105.6 |
| 43 | 39.9 | 16.1 | 103 | 95.5 | 38.6 | 163 | 151.1 | 61.1 | 223 | 206.8 | 83.5 | 283 | 262.4 | 106.0 |
| 44 | 40.8 | 16.5 | 104 | 96.4 | 39.0 | 164 | 152.1 | 61.4 | 224 | 207.7 | 83.9 | 284 | 263.3 | 106.4 |
| 45 | 41.7 | 16.9 | 105 | 97.4 | 39.3 | 165 | 153.0 | 61.8 | 225 | 208.6 | 84.3 | 285 | 264.2 | 106.8 |
| 46 | 42.7 | 17.2 | 106 | 98.3 | 39.7 | 166 | 153.9 | 62.2 | 226 | 209.5 | 84.7 | 286 | 265.2 | 107.1 |
| 47 | 43.6 | 17.6 | 107 | 99.2 | 40.1 | 167 | 154.8 | 62.6 | 227 | 210.5 | 85.0 | 287 | 266.1 | 107.5 |
| 48 | 44.5 | 18.0 | 108 | 100.1 | 40.5 | 168 | 155.8 | 62.9 | 228 | 211.4 | 85.4 | 288 | 267.0 | 107.9 |
| 49 | 45.4 | 18.4 | 109 | 101.1 | 40.8 | 169 | 156.7 | 63.3 | 229 | 212.3 | 85.8 | 289 | 268.0 | 108.3 |
| 50 | 46.4 | 18.7 | 110 | 102.0 | 41.2 | 170 | 157.6 | 63.7 | 230 | 213.3 | 86.2 | 290 | 268.9 | 108.6 |
| 51 | 47.3 | 19.1 | 111 | 102.9 | 41.6 | 171 | 158.5 | 64.1 | 231 | 214.2 | 86.5 | 291 | 269.8 | 109.0 |
| 52 | 48.2 | 19.5 | 112 | 103.8 | 42.0 | 172 | 159.5 | 64.4 | 232 | 215.1 | 86.9 | 292 | 270.7 | 109.4 |
| 53 | 49.1 | 19.9 | 113 | 104.8 | 42.3 | 173 | 160.4 | 64.8 | 233 | 216.0 | 87.3 | 293 | 271.7 | 109.8 |
| 54 | 50.1 | 20.2 | 114 | 105.7 | 42.7 | 174 | 161.3 | 65.2 | 234 | 217.0 | 87.7 | 294 | 272.6 | 110.1 |
| 55 | 51.0 | 20.6 | 115 | 106.6 | 43.1 | 175 | 162.3 | 65.6 | 235 | 217.9 | 88.0 | 295 | 273.5 | 110.5 |
| 56 | 51.9 | 21.0 | 116 | 107.6 | 43.5 | 176 | 163.2 | 65.9 | 236 | 218.8 | 88.4 | 296 | 274.4 | 110.9 |
| 57 | 52.8 | 21.4 | 117 | 108.5 | 43.8 | 177 | 164.1 | 66.3 | 237 | 219.7 | 88.8 | 297 | 275.4 | 111.3 |
| 58 | 53.8 | 21.7 | 118 | 109.4 | 44.2 | 178 | 165.0 | 66.7 | 238 | 220.7 | 89.2 | 298 | 276.3 | 111.6 |
| 59 | 54.7 | 22.1 | 119 | 110.3 | 44.6 | 179 | 166.0 | 67.1 | 239 | 221.6 | 89.5 | 299 | 277.2 | 112.0 |
| 60 | 55.6 | 22.5 | 120 | 111.3 | 45.0 | 180 | 166.9 | 67.4 | 240 | 222.5 | 89.9 | 300 | 278.2 | 112.4 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

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## TRAVERSE TABLE TO DEGREES

22° 1h 28m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 279·1 | 112·7 | 361 | 334·7 | 135·2 | 421 | 390·3 | 157·7 | 481 | 446·0 | 180·2 | 541 | 501·6 | 202·7 |
| 302 | 280·0 | 113·1 | 362 | 335·6 | 135·6 | 422 | 391·3 | 158·1 | 482 | 446·9 | 180·6 | 542 | 502·5 | 203·1 |
| 303 | 280·9 | 113·5 | 363 | 336·6 | 136·0 | 423 | 392·2 | 158·4 | 483 | 447·8 | 180·9 | 543 | 503·4 | 203·5 |
| 304 | 281·9 | 113·9 | 364 | 337·5 | 136·3 | 424 | 393·1 | 158·8 | 484 | 448·8 | 181·3 | 544 | 504·4 | 203·8 |
| 305 | 282·8 | 114·2 | 365 | 338·4 | 136·7 | 425 | 394·1 | 159·2 | 485 | 449·7 | 181·7 | 545 | 505·3 | 204·2 |
| 306 | 283·7 | 114·6 | 366 | 339·3 | 137·1 | 426 | 395·0 | 159·6 | 486 | 450·6 | 182·1 | 546 | 506·2 | 204·6 |
| 307 | 284·6 | 115·0 | 367 | 340·3 | 137·5 | 427 | 395·9 | 159·9 | 487 | 451·6 | 182·4 | 547 | 507·2 | 205·0 |
| 308 | 285·6 | 115·4 | 368 | 341·2 | 137·8 | 428 | 396·8 | 160·3 | 488 | 452·5 | 182·8 | 548 | 508·1 | 205·3 |
| 309 | 286·5 | 115·7 | 369 | 342·1 | 138·2 | 429 | 397·8 | 160·7 | 489 | 453·4 | 183·2 | 549 | 509·0 | 205·7 |
| 310 | 287·4 | 116·1 | 370 | 343·1 | 138·6 | 430 | 398·7 | 161·1 | 490 | 454·3 | 183·6 | 550 | 510·0 | 206·1 |
| 311 | 288·4 | 116·5 | 371 | 344·0 | 139·0 | 431 | 399·6 | 161·4 | 491 | 455·3 | 184·0 | 551 | 510·9 | 206·5 |
| 312 | 289·3 | 116·8 | 372 | 344·9 | 139·3 | 432 | 400·5 | 161·8 | 492 | 456·2 | 184·3 | 552 | 511·8 | 206·8 |
| 313 | 290·2 | 117·2 | 373 | 345·8 | 139·7 | 433 | 401·5 | 162·2 | 493 | 457·1 | 184·7 | 553 | 512·7 | 207·2 |
| 314 | 291·1 | 117·6 | 374 | 346·8 | 140·1 | 434 | 402·4 | 162·6 | 494 | 458·0 | 185·1 | 554 | 513·6 | 207·6 |
| 315 | 292·1 | 118·0 | 375 | 347·7 | 140·5 | 435 | 403·3 | 162·9 | 495 | 459·0 | 185·4 | 555 | 514·6 | 208·0 |
| 316 | 293·0 | 118·3 | 376 | 348·6 | 140·8 | 436 | 404·3 | 163·3 | 496 | 459·9 | 185·8 | 556 | 515·5 | 208·3 |
| 317 | 293·9 | 118·7 | 377 | 349·5 | 141·2 | 437 | 405·2 | 163·7 | 497 | 460·8 | 186·2 | 557 | 516·4 | 208·7 |
| 318 | 294·8 | 119·1 | 378 | 350·5 | 141·6 | 438 | 406·1 | 164·1 | 498 | 461·8 | 186·6 | 558 | 517·4 | 209·1 |
| 319 | 295·8 | 119·5 | 379 | 351·4 | 141·9 | 439 | 407·0 | 164·4 | 499 | 462·7 | 186·9 | 559 | 518·3 | 209·4 |
| 320 | 296·7 | 119·8 | 380 | 352·3 | 142·3 | 440 | 408·0 | 164·8 | 500 | 463·6 | 187·3 | 560 | 519·2 | 209·8 |
| 321 | 297·6 | 120·2 | 381 | 353·3 | 142·7 | 441 | 408·9 | 165·2 | 501 | 464·5 | 187·7 | 561 | 520·1 | 210·2 |
| 322 | 298·6 | 120·6 | 382 | 354·2 | 143·1 | 442 | 409·8 | 165·5 | 502 | 465·4 | 188·0 | 562 | 521·0 | 210·5 |
| 323 | 299·5 | 121·0 | 383 | 355·1 | 143·4 | 443 | 410·7 | 165·9 | 503 | 466·4 | 188·4 | 563 | 522·0 | 210·9 |
| 324 | 300·4 | 121·3 | 384 | 356·0 | 143·8 | 444 | 411·7 | 166·3 | 504 | 467·3 | 188·8 | 564 | 522·9 | 211·3 |
| 325 | 301·3 | 121·7 | 385 | 357·0 | 144·2 | 445 | 412·6 | 166·7 | 505 | 468·2 | 189·2 | 565 | 523·8 | 211·7 |
| 326 | 302·3 | 122·1 | 386 | 357·9 | 144·6 | 446 | 413·5 | 167·0 | 506 | 469·2 | 189·5 | 566 | 524·8 | 212·0 |
| 327 | 303·2 | 122·5 | 387 | 358·8 | 144·9 | 447 | 414·5 | 167·4 | 507 | 470·1 | 189·9 | 567 | 525·7 | 212·4 |
| 328 | 304·1 | 122·8 | 388 | 359·7 | 145·3 | 448 | 415·4 | 167·8 | 508 | 471·0 | 190·3 | 568 | 526·6 | 212·8 |
| 329 | 305·0 | 123·2 | 389 | 360·7 | 145·7 | 449 | 416·3 | 168·2 | 509 | 471·9 | 190·7 | 569 | 527·5 | 213·2 |
| 330 | 306·0 | 123·6 | 390 | 361·6 | 146·1 | 450 | 417·2 | 168·5 | 510 | 472·9 | 191·1 | 570 | 528·5 | 213·5 |
| 331 | 306·9 | 124·0 | 391 | 362·5 | 146·4 | 451 | 418·2 | 168·9 | 511 | 473·8 | 191·4 | 571 | 529·4 | 213·9 |
| 332 | 307·8 | 124·3 | 392 | 363·5 | 146·8 | 452 | 419·1 | 169·3 | 512 | 474·7 | 191·8 | 572 | 530·3 | 214·3 |
| 333 | 308·8 | 124·7 | 393 | 364·4 | 147·2 | 453 | 420·0 | 169·7 | 513 | 475·6 | 192·2 | 573 | 531·2 | 214·7 |
| 334 | 309·7 | 125·1 | 394 | 365·3 | 147·6 | 454 | 420·9 | 170·0 | 514 | 476·6 | 192·5 | 574 | 532·2 | 215·0 |
| 335 | 310·6 | 125·5 | 395 | 366·2 | 147·9 | 455 | 421·9 | 170·4 | 515 | 477·5 | 192·9 | 575 | 533·1 | 215·4 |
| 336 | 311·5 | 125·8 | 396 | 367·2 | 148·3 | 456 | 422·8 | 170·8 | 516 | 478·4 | 193·3 | 576 | 534·0 | 215·8 |
| 337 | 312·5 | 126·2 | 397 | 368·1 | 148·7 | 457 | 423·7 | 171·2 | 517 | 479·3 | 193·7 | 577 | 534·9 | 216·2 |
| 338 | 313·4 | 126·6 | 398 | 369·0 | 149·1 | 458 | 424·6 | 171.5 | 518 | 480·3 | 194·0 | 578 | 535·9 | 216·5 |
| 339 | 314·3 | 127·0 | 399 | 369·9 | 149·4 | 459 | 425·6 | 171·9 | 519 | 481·2 | 194·4 | 579 | 536·8 | 216·9 |
| 340 | 315·2 | 127·3 | 400 | 370·9 | 149·8 | 460 | 426·5 | 172·3 | 520 | 482·1 | 194·8 | 580 | 537·7 | 217·3 |
| 341 | 316·2 | 127·7 | 401 | 371·8 | 150·2 | 461 | 427·4 | 172·7 | 521 | 483·0 | 195·2 | 581 | 538·6 | 217·7 |
| 342 | 317·1 | 128·1 | 402 | 372·7 | 150·6 | 462 | 428·4 | 173·0 | 522 | 484·0 | 195·5 | 582 | 539·6 | 218·0 |
| 343 | 318·0 | 128·5 | 403 | 373·7 | 150·9 | 463 | 429·3 | 173·4 | 523 | 484·9 | 195·9 | 583 | 540·5 | 218·4 |
| 344 | 319·0 | 128·8 | 404 | 374·6 | 151·3 | 464 | 430·2 | 173·8 | 524 | 485·8 | 196·3 | 584 | 541·4 | 218·8 |
| 345 | 319·9 | 129·2 | 405 | 375·5 | 151·7 | 465 | 431·1 | 174·2 | 525 | 486·7 | 196·7 | 585 | 542·4 | 219·2 |
| 346 | 320·8 | 129·6 | 406 | 376·4 | 152·1 | 466 | 432·1 | 174·5 | 526 | 487·7 | 197·0 | 586 | 543·3 | 219·5 |
| 347 | 321·7 | 130·0 | 407 | 377·4 | 152·4 | 467 | 433·0 | 174·9 | 527 | 488·6 | 197·4 | 587 | 544·2 | 219·9 |
| 348 | 322·7 | 130·3 | 408 | 378·3 | 152·8 | 468 | 433·9 | 175·3 | 528 | 489·5 | 197·8 | 588 | 545·1 | 220·3 |
| 349 | 323·6 | 130·7 | 409 | 379·2 | 153·2 | 469 | 434·8 | 175·7 | 529 | 490·4 | 198·2 | 589 | 546·1 | 220·7 |
| 350 | 324·5 | 131·1 | 410 | 380·1 | 153·6 | 470 | 435·8 | 176·0 | 530 | 491·4 | 198·5 | 590 | 547·0 | 221·0 |
| 351 | 325·4 | 131·5 | 411 | 381·1 | 153·9 | 471 | 436·7 | 176·4 | 531 | 492·3 | 198·9 | 591 | 547·9 | 221·4 |
| 352 | 326·4 | 131·8 | 412 | 382·0 | 154·3 | 472 | 437·6 | 176·8 | 532 | 493·2 | 199·3 | 592 | 548·9 | 221·8 |
| 353 | 327·3 | 132·2 | 413 | 382·9 | 154·7 | 473 | 438·6 | 177·2 | 533 | 494·2 | 199·7 | 593 | 549·8 | 222·2 |
| 354 | 328·2 | 132·6 | 414 | 383·9 | 155·1 | 474 | 439·5 | 177·5 | 534 | 495·1 | 200·0 | 594 | 550·7 | 222·5 |
| 355 | 329·2 | 133·0 | 415 | 384·8 | 155·4 | 475 | 440·4 | 177·9 | 535 | 496·0 | 200·4 | 595 | 551·7 | 222·9 |
| 356 | 330·1 | 133·3 | 416 | 385·7 | 155·8 | 476 | 441·3 | 178·3 | 536 | 496·9 | 200·8 | 596 | 552·6 | 223·3 |
| 357 | 331·0 | 133·7 | 417 | 386·6 | 156·2 | 477 | 442·3 | 178·7 | 537 | 497·9 | 201·2 | 597 | 553·5 | 223·7 |
| 358 | 332·0 | 134·1 | 418 | 387·6 | 156·6 | 478 | 443·2 | 179·0 | 538 | 498·8 | 201·5 | 598 | 554·4 | 224·0 |
| 359 | 332·9 | 134·5 | 419 | 388·5 | 156·9 | 479 | 444·1 | 179·4 | 539 | 499·7 | 201·9 | 599 | 555·4 | 224·4 |
| 360 | 333·8 | 134·8 | 420 | 389·4 | 157·3 | 480 | 445·0 | 179·8 | 540 | 500·7 | 202·3 | 600 | 556·3 | 224·8 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

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## TRAVERSE TABLE TO DEGREES

23° $1^h\ 32^m$

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.9 | 0.4 | 61 | 56.2 | 23.8 | 121 | 111.4 | 47.3 | 181 | 166.6 | 70.7 | 241 | 221.8 | 94.2 |
| 2 | 1.8 | 0.8 | 62 | 57.1 | 24.2 | 122 | 112.3 | 47.7 | 182 | 167.5 | 71.1 | 242 | 222.8 | 94.6 |
| 3 | 2.8 | 1.2 | 63 | 58.0 | 24.6 | 123 | 113.2 | 48.1 | 183 | 168.5 | 71.5 | 243 | 223.7 | 94.9 |
| 4 | 3.7 | 1.6 | 64 | 58.9 | 25.0 | 124 | 114.1 | 48.5 | 184 | 169.4 | 71.9 | 244 | 224.6 | 95.3 |
| 5 | 4.6 | 2.0 | 65 | 59.8 | 25.4 | 125 | 115.1 | 48.8 | 185 | 170.3 | 72.3 | 245 | 225.5 | 95.7 |
| 6 | 5.5 | 2.3 | 66 | 60.8 | 25.8 | 126 | 116.0 | 49.2 | 186 | 171.2 | 72.7 | 246 | 226.4 | 96.1 |
| 7 | 6.4 | 2.7 | 67 | 61.7 | 26.2 | 127 | 116.9 | 49.6 | 187 | 172.1 | 73.1 | 247 | 227.4 | 96.5 |
| 8 | 7.4 | 3.1 | 68 | 62.6 | 26.6 | 128 | 117.8 | 50.0 | 188 | 173.1 | 73.5 | 248 | 228.3 | 96.9 |
| 9 | 8.3 | 3.5 | 69 | 63.5 | 27.0 | 129 | 118.7 | 50.4 | 189 | 174.0 | 73.8 | 249 | 229.2 | 97.3 |
| 10 | 9.2 | 3.9 | 70 | 64.4 | 27.4 | 130 | 119.7 | 50.8 | 190 | 174.9 | 74.2 | 250 | 230.1 | 97.7 |
| 11 | 10.1 | 4.3 | 71 | 65.4 | 27.7 | 131 | 120.6 | 51.2 | 191 | 175.8 | 74.6 | 251 | 231.0 | 98.1 |
| 12 | 11.0 | 4.7 | 72 | 66.3 | 28.1 | 132 | 121.5 | 51.6 | 192 | 176.7 | 75.0 | 252 | 232.0 | 98.5 |
| 13 | 12.0 | 5.1 | 73 | 67.2 | 28.5 | 133 | 122.4 | 52.0 | 193 | 177.7 | 75.4 | 253 | 232.9 | 98.9 |
| 14 | 12.9 | 5.5 | 74 | 68.1 | 28.9 | 134 | 123.3 | 52.4 | 194 | 178.6 | 75.8 | 254 | 233.8 | 99.2 |
| 15 | 13.8 | 5.9 | 75 | 69.0 | 29.3 | 135 | 124.3 | 52.7 | 195 | 179.5 | 76.2 | 255 | 234.7 | 99.6 |
| 16 | 14.7 | 6.3 | 76 | 70.0 | 29.7 | 136 | 125.2 | 53.1 | 196 | 180.4 | 76.6 | 256 | 235.6 | 100.0 |
| 17 | 15.6 | 6.6 | 77 | 70.9 | 30.1 | 137 | 126.1 | 53.5 | 197 | 181.3 | 77.0 | 257 | 236.6 | 100.4 |
| 18 | 16.6 | 7.0 | 78 | 71.8 | 30.5 | 138 | 127.0 | 53.9 | 198 | 182.3 | 77.4 | 258 | 237.5 | 100.8 |
| 19 | 17.5 | 7.4 | 79 | 72.7 | 30.9 | 139 | 128.0 | 54.3 | 199 | 183.2 | 77.8 | 259 | 238.4 | 101.2 |
| 20 | 18.4 | 7.8 | 80 | 73.6 | 31.3 | 140 | 128.9 | 54.7 | 200 | 184.1 | 78.1 | 260 | 239.3 | 101.6 |
| 21 | 19.3 | 8.2 | 81 | 74.6 | 31.6 | 141 | 129.8 | 55.1 | 201 | 185.0 | 78.5 | 261 | 240.3 | 102.0 |
| 22 | 20.3 | 8.6 | 82 | 75.5 | 32.0 | 142 | 130.7 | 55.5 | 202 | 185.9 | 78.9 | 262 | 241.2 | 102.4 |
| 23 | 21.2 | 9.0 | 83 | 76.4 | 32.4 | 143 | 131.6 | 55.9 | 203 | 186.9 | 79.3 | 263 | 242.1 | 102.8 |
| 24 | 22.1 | 9.4 | 84 | 77.3 | 32.8 | 144 | 132.6 | 56.3 | 204 | 187.8 | 79.7 | 264 | 243.0 | 103.2 |
| 25 | 23.0 | 9.8 | 85 | 78.2 | 33.2 | 145 | 133.5 | 56.7 | 205 | 188.7 | 80.1 | 265 | 243.9 | 103.5 |
| 26 | 23.9 | 10.2 | 86 | 79.2 | 33.6 | 146 | 134.4 | 57.0 | 206 | 189.6 | 80.5 | 266 | 244.9 | 103.9 |
| 27 | 24.9 | 10.5 | 87 | 80.1 | 34.0 | 147 | 135.3 | 57.4 | 207 | 190.5 | 80.9 | 267 | 245.8 | 104.3 |
| 28 | 25.8 | 10.9 | 88 | 81.0 | 34.4 | 148 | 136.2 | 57.8 | 208 | 191.5 | 81.3 | 268 | 246.7 | 104.7 |
| 29 | 26.7 | 11.3 | 89 | 81.9 | 34.8 | 149 | 137.2 | 58.2 | 209 | 192.4 | 81.7 | 269 | 247.6 | 105.1 |
| 30 | 27.6 | 11.7 | 90 | 82.8 | 35.2 | 150 | 138.1 | 58.6 | 210 | 193.3 | 82.1 | 270 | 248.5 | 105.5 |
| 31 | 28.5 | 12.1 | 91 | 83.8 | 35.6 | 151 | 139.0 | 59.0 | 211 | 194.2 | 82.4 | 271 | 249.5 | 105.9 |
| 32 | 29.5 | 12.5 | 92 | 84.7 | 35.9 | 152 | 139.9 | 59.4 | 212 | 195.1 | 82.8 | 272 | 250.4 | 106.3 |
| 33 | 30.4 | 12.9 | 93 | 85.6 | 36.3 | 153 | 140.8 | 59.8 | 213 | 196.1 | 83.2 | 273 | 251.3 | 106.7 |
| 34 | 31.3 | 13.3 | 94 | 86.5 | 36.7 | 154 | 141.8 | 60.2 | 214 | 197.0 | 83.6 | 274 | 252.2 | 107.1 |
| 35 | 32.2 | 13.7 | 95 | 87.4 | 37.1 | 155 | 142.7 | 60.6 | 215 | 197.9 | 84.0 | 275 | 253.1 | 107.5 |
| 36 | 33.1 | 14.1 | 96 | 88.4 | 37.5 | 156 | 143.6 | 61.0 | 216 | 198.8 | 84.4 | 276 | 254.1 | 107.8 |
| 37 | 34.1 | 14.5 | 97 | 89.3 | 37.9 | 157 | 144.5 | 61.3 | 217 | 199.7 | 84.8 | 277 | 255.0 | 108.2 |
| 38 | 35.0 | 14.8 | 98 | 90.2 | 38.3 | 158 | 145.4 | 61.7 | 218 | 200.7 | 85.2 | 278 | 255.9 | 108.6 |
| 39 | 35.9 | 15.2 | 99 | 91.1 | 38.7 | 159 | 146.4 | 62.1 | 219 | 201.6 | 85.6 | 279 | 256.8 | 109.0 |
| 40 | 36.8 | 15.6 | 100 | 92.1 | 39.1 | 160 | 147.3 | 62.5 | 220 | 202.5 | 86.0 | 280 | 257.7 | 109.4 |
| 41 | 37.7 | 16.0 | 101 | 93.0 | 39.5 | 161 | 148.2 | 62.9 | 221 | 203.4 | 86.4 | 281 | 258.7 | 109.8 |
| 42 | 38.7 | 16.4 | 102 | 93.9 | 39.9 | 162 | 149.1 | 63.3 | 222 | 204.4 | 86.7 | 282 | 259.6 | 110.2 |
| 43 | 39.6 | 16.8 | 103 | 94.8 | 40.2 | 163 | 150.0 | 63.7 | 223 | 205.3 | 87.1 | 283 | 260.5 | 110.6 |
| 44 | 40.5 | 17.2 | 104 | 95.7 | 40.6 | 164 | 151.0 | 64.1 | 224 | 206.2 | 87.5 | 284 | 261.4 | 111.0 |
| 45 | 41.4 | 17.6 | 105 | 96.7 | 41.0 | 165 | 151.9 | 64.5 | 225 | 207.1 | 87.9 | 285 | 262.3 | 111.4 |
| 46 | 42.3 | 18.0 | 106 | 97.6 | 41.4 | 166 | 152.8 | 64.9 | 226 | 208.0 | 88.3 | 286 | 263.3 | 111.7 |
| 47 | 43.3 | 18.4 | 107 | 98.5 | 41.8 | 167 | 153.7 | 65.3 | 227 | 209.0 | 88.7 | 287 | 264.2 | 112.1 |
| 48 | 44.2 | 18.8 | 108 | 99.4 | 42.2 | 168 | 154.6 | 65.6 | 228 | 209.9 | 89.1 | 288 | 265.1 | 112.5 |
| 49 | 45.1 | 19.1 | 109 | 100.3 | 42.6 | 169 | 155.6 | 66.0 | 229 | 210.8 | 89.5 | 289 | 266.0 | 112.9 |
| 50 | 46.0 | 19.5 | 110 | 101.3 | 43.0 | 170 | 156.5 | 66.4 | 230 | 211.7 | 89.9 | 290 | 266.9 | 113.3 |
| 51 | 46.9 | 19.9 | 111 | 102.2 | 43.4 | 171 | 157.4 | 66.8 | 231 | 212.6 | 90.3 | 291 | 267.9 | 113.7 |
| 52 | 47.9 | 20.3 | 112 | 103.1 | 43.8 | 172 | 158.3 | 67.2 | 232 | 213.6 | 90.6 | 292 | 268.8 | 114.1 |
| 53 | 48.8 | 20.7 | 113 | 104.0 | 44.2 | 173 | 159.2 | 67.6 | 233 | 214.5 | 91.0 | 293 | 269.7 | 114.5 |
| 54 | 49.7 | 21.1 | 114 | 104.9 | 44.5 | 174 | 160.2 | 68.0 | 234 | 215.4 | 91.4 | 294 | 270.6 | 114.9 |
| 55 | 50.6 | 21.5 | 115 | 105.9 | 44.9 | 175 | 161.1 | 68.4 | 235 | 216.3 | 91.8 | 295 | 271.5 | 115.3 |
| 56 | 51.5 | 21.9 | 116 | 106.8 | 45.3 | 176 | 162.0 | 68.8 | 236 | 217.2 | 92.2 | 296 | 272.5 | 115.7 |
| 57 | 52.5 | 22.3 | 117 | 107.7 | 45.7 | 177 | 162.9 | 69.2 | 237 | 218.2 | 92.6 | 297 | 273.4 | 116.0 |
| 58 | 53.4 | 22.7 | 118 | 108.6 | 46.1 | 178 | 163.8 | 69.6 | 238 | 219.1 | 93.0 | 298 | 274.3 | 116.4 |
| 59 | 54.3 | 23.1 | 119 | 109.5 | 46.5 | 179 | 164.8 | 69.9 | 239 | 220.0 | 93.4 | 299 | 275.2 | 116.8 |
| 60 | 55.2 | 23.4 | 120 | 110.5 | 46.9 | 180 | 165.7 | 70.3 | 240 | 220.9 | 93.8 | 300 | 276.2 | 117.2 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

67° $4^h\ 28^m$

## TRAVERSE TABLE TO DEGREES

23° 1h 32m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 277·1 | 117·6 | 361 | 332·3 | 141·1 | 421 | 387·5 | 164·5 | 481 | 442·7 | 188·0 | 541 | 498·0 | 211·4 |
| 302 | 278·0 | 118·0 | 362 | 333·2 | 141·5 | 422 | 388·5 | 164·9 | 482 | 443·7 | 188·4 | 542 | 498·9 | 211·8 |
| 303 | 278·9 | 118·4 | 363 | 334·1 | 141·8 | 423 | 389·4 | 165·3 | 483 | 444·6 | 188·8 | 543 | 499·8 | 212·2 |
| 304 | 279·8 | 118·8 | 364 | 335·1 | 142·2 | 424 | 390·3 | 165·7 | 484 | 445·5 | 189·2 | 544 | 500·7 | 212·6 |
| 305 | 280·8 | 119·2 | 365 | 336·0 | 142·6 | 425 | 391·2 | 166·1 | 485 | 446·4 | 189·5 | 545 | 501·7 | 213·0 |
| 306 | 281·7 | 119·6 | 366 | 336·9 | 143·0 | 426 | 392·1 | 166·5 | 486 | 447·3 | 189·9 | 546 | 502·6 | 213·4 |
| 307 | 282·6 | 120·0 | 367 | 337·8 | 143·4 | 427 | 393·1 | 166·8 | 487 | 448·3 | 190·2 | 547 | 503·5 | 213·8 |
| 308 | 283·5 | 120·4 | 368 | 338·7 | 143·8 | 428 | 394·0 | 167·2 | 488 | 449·2 | 190·6 | 548 | 504·4 | 214·2 |
| 309 | 284·4 | 120·8 | 369 | 339·7 | 144·2 | 429 | 394·9 | 167·6 | 489 | 450·1 | 191·0 | 549 | 505·3 | 214·6 |
| 310 | 285·4 | 121·2 | 370 | 340·6 | 144·6 | 430 | 395·8 | 168·0 | 490 | 451·0 | 191·4 | 550 | 506·3 | 215·0 |
| 311 | 286·3 | 121·6 | 371 | 341·5 | 145·0 | 431 | 396·7 | 168·4 | 491 | 451·9 | 191·8 | 551 | 507·2 | 215·3 |
| 312 | 287·2 | 121·9 | 372 | 342·4 | 145·4 | 432 | 397·7 | 168·8 | 492 | 452·9 | 192·2 | 552 | 508·1 | 215·6 |
| 313 | 288·1 | 122·3 | 373 | 343·4 | 145·7 | 433 | 398·6 | 169·2 | 493 | 453·8 | 192·6 | 553 | 509·0 | 216·0 |
| 314 | 289·0 | 122·7 | 374 | 344·3 | 146·1 | 434 | 399·5 | 169·6 | 494 | 454·7 | 193·0 | 554 | 509·9 | 216·4 |
| 315 | 290·0 | 123·1 | 375 | 345·2 | 146·5 | 435 | 400·4 | 170·0 | 495 | 455·6 | 193·4 | 555 | 510·9 | 216·8 |
| 316 | 290·9 | 123·5 | 376 | 346·1 | 146·9 | 436 | 401·3 | 170·4 | 496 | 456·6 | 193·8 | 556 | 511·8 | 217·2 |
| 317 | 291·8 | 123·9 | 377 | 347·0 | 147·3 | 437 | 402·3 | 170·8 | 497 | 457·5 | 194·2 | 557 | 512·7 | 217·6 |
| 318 | 292·7 | 124·3 | 378 | 348·0 | 147·7 | 438 | 403·2 | 171·1 | 498 | 458·4 | 194·6 | 558 | 513·6 | 218·0 |
| 319 | 293·6 | 124·6 | 379 | 348·9 | 148·1 | 439 | 404·1 | 171·5 | 499 | 459·3 | 195·0 | 559 | 514·5 | 218·4 |
| 320 | 294·6 | 125·0 | 380 | 349·8 | 148·5 | 440 | 405·0 | 171·9 | 500 | 460·2 | 195·4 | 560 | 515·5 | 218·8 |
| 321 | 295·5 | 125·4 | 381 | 350·7 | 148·9 | 441 | 405·9 | 172·3 | 501 | 461·2 | 195·8 | 561 | 516·4 | 219·2 |
| 322 | 296·4 | 125·8 | 382 | 351·6 | 149·3 | 442 | 406·9 | 172·7 | 502 | 462·1 | 196·2 | 562 | 517·3 | 219·6 |
| 323 | 297·3 | 126·2 | 383 | 352·6 | 149·7 | 443 | 407·8 | 173·1 | 503 | 463·0 | 196·6 | 563 | 518·2 | 220·0 |
| 324 | 298·2 | 126·6 | 384 | 353·5 | 150·0 | 444 | 408·7 | 173·5 | 504 | 463·9 | 197·0 | 564 | 519·2 | 220·4 |
| 325 | 299·2 | 127·0 | 385 | 354·4 | 150·4 | 445 | 409·6 | 173·9 | 505 | 464·9 | 197·4 | 565 | 520·1 | 220·8 |
| 326 | 300·1 | 127·4 | 386 | 355·3 | 150·8 | 446 | 410·5 | 174·3 | 506 | 465·8 | 197·8 | 566 | 521·0 | 221·2 |
| 327 | 301·0 | 127·8 | 387 | 356·2 | 151·2 | 447 | 411·5 | 174·7 | 507 | 466·7 | 198·1 | 567 | 521·9 | 221·6 |
| 328 | 301·9 | 128·2 | 388 | 357·2 | 151·6 | 448 | 412·4 | 175·1 | 508 | 467·6 | 198·5 | 568 | 522·8 | 222·0 |
| 329 | 302·8 | 128·6 | 389 | 358·1 | 152·0 | 449 | 413·3 | 175·4 | 509 | 468·5 | 198·8 | 569 | 523·8 | 222·3 |
| 330 | 303·8 | 128·9 | 390 | 359·0 | 152·4 | 450 | 414·2 | 175·8 | 510 | 469·5 | 199·3 | 570 | 524·7 | 222·7 |
| 331 | 304·7 | 129·3 | 391 | 359·9 | 152·8 | 451 | 415·2 | 176·2 | 511 | 470·4 | 199·7 | 571 | 525·6 | 223·1 |
| 332 | 305·6 | 129·7 | 392 | 360·8 | 153·2 | 452 | 416·1 | 176·6 | 512 | 471·3 | 200·0 | 572 | 526·5 | 223·4 |
| 333 | 306·5 | 130·1 | 393 | 361·8 | 153·6 | 453 | 417·0 | 177·0 | 513 | 472·2 | 200·4 | 573 | 527·4 | 223·8 |
| 334 | 307·5 | 130·5 | 394 | 362·7 | 154·0 | 454 | 417·9 | 177·4 | 514 | 473·1 | 200·8 | 574 | 528·4 | 224·2 |
| 335 | 308·4 | 130·9 | 395 | 363·6 | 154·3 | 455 | 418·8 | 177·8 | 515 | 474·0 | 201·2 | 575 | 529·3 | 224·6 |
| 336 | 309·3 | 131·3 | 396 | 364·5 | 154·7 | 456 | 419·8 | 178·2 | 516 | 475·0 | 201·6 | 576 | 530·2 | 225·0 |
| 337 | 310·2 | 131·7 | 397 | 365·4 | 155·1 | 457 | 420·7 | 178·6 | 517 | 475·9 | 202·0 | 577 | 531·1 | 225·4 |
| 338 | 311·1 | 132·1 | 398 | 366·4 | 155·5 | 458 | 421·6 | 179·0 | 518 | 476·8 | 202·4 | 578 | 532·0 | 225·8 |
| 339 | 312·1 | 132·5 | 399 | 367·3 | 155·9 | 459 | 422·5 | 179·4 | 519 | 477·7 | 202·8 | 579 | 533·0 | 226·2 |
| 340 | 313·0 | 132·9 | 400 | 368·2 | 156·3 | 460 | 423·4 | 179·7 | 520 | 478·6 | 203·2 | 580 | 533·9 | 226·6 |
| 341 | 313·9 | 133·2 | 401 | 369·1 | 156·7 | 461 | 424·4 | 180·1 | 521 | 479·6 | 203·6 | 581 | 534·8 | 227·0 |
| 342 | 314·8 | 133·6 | 402 | 370·0 | 157·1 | 462 | 425·3 | 180.5 | 522 | 480·5 | 204·0 | 582 | 535·7 | 227·4 |
| 343 | 315·7 | 134·0 | 403 | 371·0 | 157·5 | 463 | 426·2 | 180·9 | 523 | 481·4 | 204·4 | 583 | 536·6 | 227·8 |
| 344 | 316·7 | 134·4 | 404 | 371·9 | 157·9 | 464 | 427·1 | 181·3 | 524 | 482·3 | 204·8 | 584 | 537·6 | 228·2 |
| 345 | 317·6 | 134·8 | 405 | 372·8 | 158·3 | 465 | 428·0 | 181·7 | 525 | 483·2 | 205·2 | 585 | 538·5 | 228·6 |
| 346 | 318·5 | 135·2 | 406 | 373·7 | 158·6 | 466 | 429·0 | 182·1 | 526 | 484·2 | 205·5 | 586 | 539·4 | 229·0 |
| 347 | 319·4 | 135·6 | 407 | 374·6 | 159·0 | 467 | 429·9 | 182·5 | 527 | 485·1 | 205·9 | 587 | 540·3 | 229·4 |
| 348 | 320·3 | 136·0 | 408 | 375·6 | 159·4 | 468 | 430·8 | 182·9 | 528 | 486·0 | 206·3 | 588 | 541·2 | 229·8 |
| 349 | 321·3 | 136·4 | 409 | 376·5 | 159·8 | 469 | 431·7 | 183·3 | 529 | 486·9 | 206·7 | 589 | 542·2 | 230·2 |
| 350 | 322·2 | 136·8 | 410 | 377·4 | 160·2 | 470 | 432·6 | 183·7 | 530 | 487·8 | 207·1 | 590 | 543·1 | 230·6 |
| 351 | 323·1 | 137·2 | 411 | 378·3 | 160·6 | 471 | 433·6 | 184·0 | 531 | 488·8 | 207·4 | 591 | 544·0 | 231·0 |
| 352 | 324·0 | 137·5 | 412 | 379·3 | 161·0 | 472 | 434·5 | 184·4 | 532 | 489·7 | 207·8 | 592 | 544·9 | 231·3 |
| 353 | 324·9 | 137·9 | 413 | 380·2 | 161·4 | 473 | 435·4 | 184·8 | 533 | 490·6 | 208·2 | 593 | 545·8 | 231·7 |
| 354 | 325·9 | 138·3 | 414 | 381·1 | 161·8 | 474 | 436·3 | 185·2 | 534 | 491·5 | 208·6 | 594 | 546·8 | 232·0 |
| 355 | 326·8 | 138·7 | 415 | 382·0 | 162·2 | 475 | 437·2 | 185·6 | 535 | 492·5 | 209·0 | 595 | 547·7 | 232·4 |
| 356 | 327·7 | 139·1 | 416 | 382·9 | 162·5 | 476 | 438·2 | 186·0 | 536 | 493·4 | 209·4 | 596 | 548·6 | 232·8 |
| 357 | 328·6 | 139·5 | 417 | 383·9 | 162·9 | 477 | 439·1 | 186·4 | 537 | 494·3 | 209·8 | 597 | 549·5 | 233·2 |
| 358 | 329·5 | 139·9 | 418 | 384·8 | 163·3 | 478 | 440·0 | 186·8 | 538 | 495·2 | 210·2 | 598 | 550·4 | 233·6 |
| 359 | 330·5 | 140·3 | 419 | 385·7 | 163·7 | 479 | 440·9 | 187·2 | 539 | 496·1 | 210·6 | 599 | 551·3 | 234·0 |
| 360 | 331·4 | 140·7 | 420 | 386·6 | 164·1 | 480 | 441·8 | 187·6 | 540 | 497·1 | 211·0 | 600 | 552·3 | 234·4 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

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## TRAVERSE TABLE TO DEGREES

24° $1^h\ 36^m$

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0·9 | 0·4 | 61 | 55·7 | 24·8 | 121 | 110·5 | 49·2 | 181 | 165·4 | 73·6 | 241 | 220·2 | 98·0 |
| 2 | 1·8 | 0·8 | 62 | 56·6 | 25·2 | 122 | 111·5 | 49·6 | 182 | 166·3 | 74·0 | 242 | 221·1 | 98·4 |
| 3 | 2·7 | 1·2 | 63 | 57·6 | 25·6 | 123 | 112·4 | 50·0 | 183 | 167·2 | 74·4 | 243 | 222·0 | 98·8 |
| 4 | 3·7 | 1·6 | 64 | 58·5 | 26·0 | 124 | 113·3 | 50·4 | 184 | 168·1 | 74·8 | 244 | 222·9 | 99·2 |
| 5 | 4·6 | 2·0 | 65 | 59·4 | 26·4 | 125 | 114·2 | 50·8 | 185 | 169·0 | 75·2 | 245 | 223·8 | 99·7 |
| 6 | 5·5 | 2·4 | 66 | 60·3 | 26·8 | 126 | 115·1 | 51·2 | 186 | 169·9 | 75·7 | 246 | 224·7 | 100·1 |
| 7 | 6·4 | 2·8 | 67 | 61·2 | 27·3 | 127 | 116·0 | 51·7 | 187 | 170·8 | 76·1 | 247 | 225·6 | 100·5 |
| 8 | 7·3 | 3·3 | 68 | 62·1 | 27·7 | 128 | 116·9 | 52·1 | 188 | 171·7 | 76·5 | 248 | 226·6 | 100·9 |
| 9 | 8·2 | 3·7 | 69 | 63·0 | 28·1 | 129 | 117·8 | 52·5 | 189 | 172·7 | 76·9 | 249 | 227·5 | 101·3 |
| 10 | 9·1 | 4·1 | 70 | 63·9 | 28·5 | 130 | 118·8 | 52·9 | 190 | 173·6 | 77·3 | 250 | 228·4 | 101·7 |
| 11 | 10·0 | 4·5 | 71 | 64·9 | 28·9 | 131 | 119·7 | 53·3 | 191 | 174·5 | 77·7 | 251 | 229·3 | 102·1 |
| 12 | 11·0 | 4·9 | 72 | 65·8 | 29·3 | 132 | 120·6 | 53·7 | 192 | 175·4 | 78·1 | 252 | 230·2 | 102·5 |
| 13 | 11·9 | 5·3 | 73 | 66·7 | 29·7 | 133 | 121·5 | 54·1 | 193 | 176·3 | 78·5 | 253 | 231·1 | 102·9 |
| 14 | 12·8 | 5·7 | 74 | 67·6 | 30·1 | 134 | 122·4 | 54·5 | 194 | 177·2 | 78·9 | 254 | 232·0 | 103·3 |
| 15 | 13·7 | 6·1 | 75 | 68·5 | 30·5 | 135 | 123·3 | 54·9 | 195 | 178·1 | 79·3 | 255 | 233·0 | 103·7 |
| 16 | 14·6 | 6·5 | 76 | 69·4 | 30·9 | 136 | 124·2 | 55·3 | 196 | 179·1 | 79·7 | 256 | 233·9 | 104·1 |
| 17 | 15·5 | 6·9 | 77 | 70·3 | 31·3 | 137 | 125·2 | 55·7 | 197 | 180·0 | 80·1 | 257 | 234·8 | 104·5 |
| 18 | 16·4 | 7·3 | 78 | 71·3 | 31·7 | 138 | 126·1 | 56·1 | 198 | 180·9 | 80·5 | 258 | 235·7 | 104·9 |
| 19 | 17·4 | 7·7 | 79 | 72·2 | 32·1 | 139 | 127·0 | 56·5 | 199 | 181·8 | 80·9 | 259 | 236·6 | 105·3 |
| 20 | 18·3 | 8·1 | 80 | 73·1 | 32·5 | 140 | 127·9 | 56·9 | 200 | 182·7 | 81·3 | 260 | 237·5 | 105·8 |
| 21 | 19·2 | 8·5 | 81 | 74·0 | 32·9 | 141 | 128·8 | 57·3 | 201 | 183·6 | 81·8 | 261 | 238·4 | 106·2 |
| 22 | 20·1 | 8·9 | 82 | 74·9 | 33·4 | 142 | 129·7 | 57·8 | 202 | 184·5 | 82·2 | 262 | 239·3 | 106·6 |
| 23 | 21·0 | 9·4 | 83 | 75·8 | 33·8 | 143 | 130·6 | 58·2 | 203 | 185·4 | 82·6 | 263 | 240·3 | 107·0 |
| 24 | 21·9 | 9·8 | 84 | 76·7 | 34·2 | 144 | 131·6 | 58·6 | 204 | 186·4 | 83·0 | 264 | 241·2 | 107·4 |
| 25 | 22·8 | 10·2 | 85 | 77·7 | 34·6 | 145 | 132·5 | 59·0 | 205 | 187·3 | 83·4 | 265 | 242·1 | 107·8 |
| 26 | 23·8 | 10·6 | 86 | 78·6 | 35·0 | 146 | 133·4 | 59·4 | 206 | 188·2 | 83·8 | 266 | 243·0 | 108·2 |
| 27 | 24·7 | 11·0 | 87 | 79·5 | 35·4 | 147 | 134·3 | 59·8 | 207 | 189·1 | 84·2 | 267 | 243·9 | 108·6 |
| 28 | 25·6 | 11·4 | 88 | 80·4 | 35·8 | 148 | 135·2 | 60·2 | 208 | 190·0 | 84·6 | 268 | 244·8 | 109·0 |
| 29 | 26·5 | 11·8 | 89 | 81·3 | 36·2 | 149 | 136·1 | 60·6 | 209 | 190·9 | 85·0 | 269 | 245·7 | 109·4 |
| 30 | 27·4 | 12·2 | 90 | 82·2 | 36·6 | 150 | 137·0 | 61·0 | 210 | 191·8 | 85·4 | 270 | 246·7 | 109·8 |
| 31 | 28·3 | 12·6 | 91 | 83·1 | 37·0 | 151 | 137·9 | 61·4 | 211 | 192·8 | 85·8 | 271 | 247·6 | 110·2 |
| 32 | 29·2 | 13·0 | 92 | 84·0 | 37·4 | 152 | 138·9 | 61·8 | 212 | 193·7 | 86·2 | 272 | 248·5 | 110·6 |
| 33 | 30·1 | 13·4 | 93 | 85·0 | 37·8 | 153 | 139·8 | 62·2 | 213 | 194·6 | 86·6 | 273 | 249·4 | 111·0 |
| 34 | 31·1 | 13·8 | 94 | 85·9 | 38·2 | 154 | 140·7 | 62·6 | 214 | 195·5 | 87·0 | 274 | 250·3 | 111·4 |
| 35 | 32·0 | 14·2 | 95 | 86·8 | 38·6 | 155 | 141·6 | 63·0 | 215 | 196·4 | 87·4 | 275 | 251·2 | 111·9 |
| 36 | 32·9 | 14·6 | 96 | 87·7 | 39·0 | 156 | 142·5 | 63·5 | 216 | 197·3 | 87·9 | 276 | 252·1 | 112·3 |
| 37 | 33·8 | 15·0 | 97 | 88·6 | 39·5 | 157 | 143·4 | 63·9 | 217 | 198·2 | 88·3 | 277 | 253·1 | 112·7 |
| 38 | 34·7 | 15·5 | 98 | 89·5 | 39·9 | 158 | 144·3 | 64·3 | 218 | 199·2 | 88·7 | 278 | 254·0 | 113·1 |
| 39 | 35·6 | 15·9 | 99 | 90·4 | 40·3 | 159 | 145·3 | 64·7 | 219 | 200·1 | 89·1 | 279 | 254·9 | 113·5 |
| 40 | 36·5 | 16·3 | 100 | 91·4 | 40·7 | 160 | 146·2 | 65·1 | 220 | 201·0 | 89·5 | 280 | 255·8 | 113·9 |
| 41 | 37·5 | 16·7 | 101 | 92·3 | 41·1 | 161 | 147·1 | 65·5 | 221 | 201·9 | 89·9 | 281 | 256·7 | 114·3 |
| 42 | 38·4 | 17·1 | 102 | 93·2 | 41·5 | 162 | 148·0 | 65·9 | 222 | 202·8 | 90·3 | 282 | 257·6 | 114·7 |
| 43 | 39·3 | 17·5 | 103 | 94·1 | 41·9 | 163 | 148·9 | 66·3 | 223 | 203·7 | 90·7 | 283 | 258·5 | 115·1 |
| 44 | 40·2 | 17·9 | 104 | 95·0 | 42·3 | 164 | 149·8 | 66·7 | 224 | 204·6 | 91·1 | 284 | 259·4 | 115·5 |
| 45 | 41·1 | 18·3 | 105 | 95·9 | 42·7 | 165 | 150·7 | 67·1 | 225 | 205·5 | 91·5 | 285 | 260·4 | 115·9 |
| 46 | 42·0 | 18·7 | 106 | 96·8 | 43·1 | 166 | 151·6 | 67·5 | 226 | 206·5 | 91·9 | 286 | 261·3 | 116·3 |
| 47 | 42·9 | 19·1 | 107 | 97·7 | 43·5 | 167 | 152·6 | 67·9 | 227 | 207·4 | 92·3 | 287 | 262·2 | 116·7 |
| 48 | 43·9 | 19·5 | 108 | 98·7 | 43·9 | 168 | 153·5 | 68·3 | 228 | 208·3 | 92·7 | 288 | 263·1 | 117·1 |
| 49 | 44·8 | 19·9 | 109 | 99·6 | 44·3 | 169 | 154·4 | 68·7 | 229 | 209·2 | 93·1 | 289 | 264·0 | 117·5 |
| 50 | 45·7 | 20·3 | 110 | 100·5 | 44·7 | 170 | 155·3 | 69·1 | 230 | 210·1 | 93·5 | 290 | 264·9 | 118·0 |
| 51 | 46·6 | 20·7 | 111 | 101·4 | 45·1 | 171 | 156·2 | 69·6 | 231 | 211·0 | 94·0 | 291 | 265·8 | 118·4 |
| 52 | 47·5 | 21·2 | 112 | 102·3 | 45·6 | 172 | 157·1 | 70·0 | 232 | 211·9 | 94·4 | 292 | 266·8 | 118·8 |
| 53 | 48·4 | 21·6 | 113 | 103·2 | 46·0 | 173 | 158·0 | 70·4 | 233 | 212·9 | 94·8 | 293 | 267·7 | 119·2 |
| 54 | 49·3 | 22·0 | 114 | 104·1 | 46·4 | 174 | 159·0 | 70·8 | 234 | 213·8 | 95·2 | 294 | 268·6 | 119·6 |
| 55 | 50·2 | 22·4 | 115 | 105·1 | 46·8 | 175 | 159·9 | 71·2 | 235 | 214·7 | 95·6 | 295 | 269·5 | 120·0 |
| 56 | 51·2 | 22·8 | 116 | 106·0 | 47·2 | 176 | 160·8 | 71·6 | 236 | 215·6 | 96·0 | 296 | 270·4 | 120·4 |
| 57 | 52·1 | 23·2 | 117 | 106·9 | 47·6 | 177 | 161·7 | 72·0 | 237 | 216·5 | 96·4 | 297 | 271·3 | 120·8 |
| 58 | 53·0 | 23·6 | 118 | 107·8 | 48·0 | 178 | 162·6 | 72·4 | 238 | 217·4 | 96·8 | 298 | 272·2 | 121·2 |
| 59 | 53·9 | 24·0 | 119 | 108·7 | 48·4 | 179 | 163·5 | 72·8 | 239 | 218·3 | 97·2 | 299 | 273·2 | 121·6 |
| 60 | 54·8 | 24·4 | 120 | 109·6 | 48·8 | 180 | 164·4 | 73·2 | 240 | 219·3 | 97·6 | 300 | 274·1 | 122·0 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

66° $4^h\ 24^m$

## TRAVERSE TABLE TO DEGREES

24° 1h 36m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 275.0 | 122.4 | 361 | 329.8 | 146.8 | 421 | 384.6 | 171.2 | 481 | 439.4 | 195.6 | 541 | 494.2 | 220.0 |
| 302 | 275.9 | 122.8 | 362 | 330.7 | 147.2 | 422 | 385.5 | 171.6 | 482 | 440.3 | 196.0 | 542 | 495.1 | 220.4 |
| 303 | 276.8 | 123.2 | 363 | 331.6 | 147.6 | 423 | 386.4 | 172.1 | 483 | 441.2 | 196.5 | 543 | 496.0 | 220.9 |
| 304 | 277.7 | 123.7 | 364 | 332.5 | 148.1 | 424 | 387.3 | 172.5 | 484 | 442.1 | 196.9 | 544 | 496.9 | 221.3 |
| 305 | 278.6 | 124.1 | 365 | 333.4 | 148.5 | 425 | 388.2 | 172.9 | 485 | 443.0 | 197.3 | 545 | 497.8 | 221.7 |
| 306 | 279.5 | 124.5 | 366 | 334.3 | 148.9 | 426 | 389.2 | 173.3 | 486 | 444.0 | 197.7 | 546 | 498.8 | 222.1 |
| 307 | 280.4 | 124.9 | 367 | 335.3 | 149.3 | 427 | 390.1 | 173.7 | 487 | 444.9 | 198.1 | 547 | 499.7 | 222.5 |
| 308 | 281.4 | 125.3 | 368 | 336.2 | 149.7 | 428 | 391.0 | 174.1 | 488 | 445.8 | 198.5 | 548 | 500.6 | 222.9 |
| 309 | 282.3 | 125.7 | 369 | 337.1 | 150.1 | 429 | 391.9 | 174.5 | 489 | 446.7 | 198.9 | 549 | 501.5 | 223.3 |
| 310 | 283.2 | 126.1 | 370 | 338.0 | 150.5 | 430 | 392.8 | 174.9 | 490 | 447.6 | 199.3 | 550 | 502.4 | 223.7 |
| 311 | 284.1 | 126.5 | 371 | 338.9 | 150.9 | 431 | 393.7 | 175.3 | 491 | 448.6 | 199.7 | 551 | 503.4 | 224.1 |
| 312 | 285.0 | 126.9 | 272 | 339.8 | 151.3 | 432 | 394.6 | 175.7 | 492 | 449.5 | 200.1 | 552 | 504.3 | 224.5 |
| 313 | 285.9 | 127.3 | 373 | 340.7 | 151.7 | 433 | 395.6 | 176.1 | 493 | 450.4 | 200.5 | 553 | 505.2 | 224.9 |
| 314 | 286.8 | 127.7 | 374 | 341.7 | 152.1 | 434 | 396.5 | 176.5 | 494 | 451.3 | 200.9 | 554 | 506.1 | 225.3 |
| 315 | 287.8 | 128.1 | 375 | 342.6 | 152.5 | 435 | 397.4 | 176.9 | 495 | 452.2 | 201.3 | 555 | 507.0 | 225.7 |
| 316 | 288.7 | 128.5 | 376 | 343.5 | 152.9 | 436 | 398.3 | 177.3 | 496 | 453.1 | 201.7 | 556 | 507.9 | 226.1 |
| 317 | 289.6 | 128.9 | 377 | 344.4 | 153.3 | 437 | 399.2 | 177.7 | 497 | 454.0 | 202.2 | 557 | 508.8 | 226.6 |
| 318 | 290.5 | 129.3 | 378 | 345.3 | 153.7 | 438 | 400.1 | 178.2 | 498 | 454.9 | 202.6 | 558 | 509.7 | 227.0 |
| 319 | 291.4 | 129.8 | 379 | 346.2 | 154.2 | 439 | 401.0 | 178.6 | 499 | 455.8 | 203.0 | 559 | 510.6 | 227.4 |
| 320 | 292.3 | 130.2 | 380 | 347.1 | 154.6 | 440 | 402.0 | 179.0 | 500 | 456.8 | 203.4 | 560 | 511.6 | 227.8 |
| 321 | 293.2 | 130.6 | 381 | 348.1 | 155.0 | 441 | 402.9 | 179.4 | 501 | 457.7 | 203.8 | 561 | 512.5 | 228.2 |
| 322 | 294.2 | 131.0 | 382 | 349.0 | 155.4 | 442 | 403.8 | 179.8 | 502 | 458.6 | 204.2 | 562 | 513.4 | 228.6 |
| 323 | 295.1 | 131.4 | 383 | 349.9 | 155.8 | 443 | 404.7 | 180.2 | 503 | 459.5 | 204.6 | 563 | 514.3 | 229.0 |
| 324 | 296.0 | 131.8 | 384 | 350.8 | 156.2 | 444 | 405.6 | 180.6 | 504 | 460.4 | 205.0 | 564 | 515.2 | 229.4 |
| 325 | 296.9 | 132.2 | 385 | 351.7 | 156.6 | 445 | 406.5 | 181.0 | 505 | 461.3 | 205.4 | 565 | 516.1 | 229.8 |
| 326 | 297.8 | 132.6 | 386 | 352.6 | 157.0 | 446 | 407.4 | 181.4 | 506 | 462.2 | 205.8 | 566 | 517.0 | 230.2 |
| 327 | 298.7 | 133.0 | 387 | 353.5 | 157.4 | 447 | 408.3 | 181.8 | 507 | 463.2 | 206.2 | 567 | 518.0 | 230.6 |
| 328 | 299.6 | 133.4 | 388 | 354.4 | 157.8 | 448 | 409.3 | 182.2 | 508 | 464.1 | 206.6 | 568 | 518.9 | 231.0 |
| 329 | 300.5 | 133.8 | 389 | 355.4 | 158.2 | 449 | 410.2 | 182.6 | 509 | 465.0 | 207.0 | 569 | 519.8 | 231.4 |
| 330 | 301.5 | 134.2 | 390 | 356.3 | 158.6 | 450 | 411.1 | 183.0 | 510 | 465.9 | 207.4 | 570 | 520.7 | 231.8 |
| 331 | 302.4 | 134.6 | 391 | 357.2 | 159.0 | 451 | 412.0 | 183.4 | 511 | 466.8 | 207.8 | 571 | 521.6 | 232.2 |
| 332 | 303.3 | 135.0 | 392 | 358.1 | 159.4 | 452 | 412.9 | 183.8 | 512 | 467.7 | 208.2 | 572 | 522.5 | 232.7 |
| 333 | 304.2 | 135.4 | 393 | 359.0 | 159.8 | 453 | 413.8 | 184.3 | 513 | 468.6 | 208.7 | 573 | 523.4 | 233.1 |
| 334 | 305.1 | 135.9 | 394 | 359.9 | 160.3 | 454 | 414.7 | 184.7 | 514 | 469.5 | 209.1 | 574 | 524.3 | 233.5 |
| 335 | 306.0 | 136.3 | 395 | 360.8 | 160.7 | 455 | 415.7 | 185.1 | 515 | 470.5 | 209.5 | 575 | 525.3 | 233.9 |
| 336 | 306.9 | 136.7 | 396 | 361.8 | 161.1 | 456 | 416.6 | 185.5 | 516 | 471.4 | 209.9 | 576 | 526.2 | 234.3 |
| 337 | 307.9 | 137.1 | 397 | 362.7 | 161.5 | 457 | 417.5 | 185.9 | 517 | 472.3 | 210.3 | 577 | 527.1 | 234.7 |
| 338 | 308.8 | 137.5 | 398 | 363.6 | 161.9 | 458 | 418.4 | 186.3 | 518 | 473.2 | 210.7 | 578 | 528.0 | 235.1 |
| 339 | 309.7 | 137.9 | 399 | 364.5 | 162.3 | 459 | 419.3 | 186.7 | 519 | 474.1 | 211.1 | 579 | 528.9 | 235.5 |
| 340 | 310.6 | 138.3 | 400 | 365.4 | 162.7 | 460 | 420.2 | 187.1 | 520 | 475.0 | 211.5 | 580 | 529.8 | 235.9 |
| 341 | 311.5 | 138.7 | 401 | 366.3 | 163.1 | 461 | 421.1 | 187.5 | 521 | 475.9 | 211.9 | 581 | 530.8 | 236.3 |
| 342 | 312.4 | 139.1 | 402 | 367.2 | 163.5 | 462 | 422.0 | 187.9 | 522 | 476.8 | 212.3 | 582 | 531.7 | 236.7 |
| 343 | 313.3 | 139.5 | 403 | 368.2 | 163.9 | 463 | 423.0 | 188.3 | 523 | 477.8 | 212.7 | 583 | 532.6 | 237.1 |
| 344 | 314.3 | 139.9 | 404 | 369.1 | 164.3 | 464 | 423.9 | 188.7 | 524 | 478.7 | 213.1 | 584 | 533.5 | 237.5 |
| 345 | 315.2 | 140.3 | 405 | 370.0 | 164.7 | 465 | 424.8 | 189.1 | 525 | 479.6 | 213.5 | 585 | 534.4 | 237.9 |
| 346 | 316.1 | 140.7 | 406 | 370.9 | 165.1 | 466 | 425.7 | 189.5 | 526 | 480.5 | 213.9 | 586 | 535.3 | 238.3 |
| 347 | 317.0 | 141.1 | 407 | 371.8 | 165.5 | 467 | 426.6 | 189.9 | 527 | 481.4 | 214.4 | 587 | 536.2 | 238.8 |
| 348 | 317.9 | 141.5 | 408 | 372.7 | 165.9 | 468 | 427.5 | 190.4 | 528 | 482.3 | 214.8 | 588 | 537.1 | 239.2 |
| 349 | 318.8 | 142.0 | 409 | 373.6 | 166.4 | 469 | 428.4 | 190.8 | 529 | 483.2 | 215.2 | 589 | 538.0 | 239.6 |
| 350 | 319.7 | 142.4 | 410 | 374.5 | 166.8 | 470 | 429.4 | 191.2 | 530 | 484.2 | 215.6 | 590 | 539.0 | 240.0 |
| 351 | 320.6 | 142.8 | 411 | 375.5 | 167.2 | 471 | 430.3 | 191.6 | 531 | 485.1 | 216.0 | 591 | 539.9 | 240.4 |
| 352 | 321.6 | 143.2 | 412 | 376.4 | 167.6 | 472 | 431.2 | 192.0 | 532 | 486.0 | 216.4 | 592 | 540.8 | 240.8 |
| 353 | 322.5 | 143.6 | 413 | 377.3 | 168.0 | 473 | 432.1 | 192.4 | 533 | 486.9 | 216.8 | 593 | 541.7 | 241.2 |
| 354 | 323.4 | 144.0 | 414 | 378.2 | 168.4 | 474 | 433.0 | 192.8 | 534 | 487.8 | 217.2 | 594 | 542.6 | 241.6 |
| 355 | 324.3 | 144.4 | 415 | 379.1 | 168.8 | 475 | 433.9 | 193.2 | 535 | 488.7 | 217.6 | 595 | 543.5 | 242.0 |
| 356 | 325.2 | 144.8 | 416 | 380.0 | 169.2 | 476 | 434.8 | 193.6 | 536 | 489.6 | 218.0 | 596 | 544.4 | 242.4 |
| 357 | 326.1 | 145.2 | 417 | 380.9 | 169.6 | 477 | 435.8 | 194.0 | 537 | 490.6 | 218.4 | 597 | 545.4 | 242.8 |
| 358 | 327.0 | 145.6 | 418 | 381.9 | 170.0 | 478 | 436.7 | 194.4 | 538 | 491.5 | 218.8 | 598 | 546.3 | 243.2 |
| 359 | 328.0 | 146.0 | 419 | 382.8 | 170.4 | 479 | 437.6 | 194.8 | 539 | 492.4 | 219.2 | 599 | 547.2 | 243.6 |
| 360 | 328.9 | 146.4 | 420 | 383.7 | 170.8 | 480 | 438.5 | 195.2 | 540 | 493.3 | 219.6 | 600 | 548.1 | 244.0 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

66° 4h 24m

## TRAVERSE TABLE TO DEGREES

25° 1ʰ 40ᵐ

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0·9 | 0·4 | 61 | 55·3 | 25·8 | 121 | 109·7 | 51·1 | 181 | 164·0 | 76·5 | 241 | 218·4 | 101·9 |
| 2 | 1·8 | 0·8 | 62 | 56·2 | 26·2 | 122 | 110·6 | 51·6 | 182 | 164·9 | 76·9 | 242 | 219·3 | 102·3 |
| 3 | 2·7 | 1·3 | 63 | 57·1 | 26·6 | 123 | 111·5 | 52·0 | 183 | 165·9 | 77·3 | 243 | 220·2 | 102·7 |
| 4 | 3·6 | 1·7 | 64 | 58·0 | 27·0 | 124 | 112·4 | 52·4 | 184 | 166·8 | 77·8 | 244 | 221·1 | 103·1 |
| 5 | 4·5 | 2·1 | 65 | 58·9 | 27·5 | 125 | 113·3 | 52·8 | 185 | 167·7 | 78·2 | 245 | 222·0 | 103·5 |
| 6 | 5·4 | 2·5 | 66 | 59·8 | 27·9 | 126 | 114·2 | 53·2 | 186 | 168·6 | 78·6 | 246 | 223·0 | 104·0 |
| 7 | 6·3 | 3·0 | 67 | 60·7 | 28·3 | 127 | 115·1 | 53·7 | 187 | 169·5 | 79·0 | 247 | 223·9 | 104·4 |
| 8 | 7·3 | 3·4 | 68 | 61·6 | 28·7 | 128 | 116·0 | 54·1 | 188 | 170·4 | 79·5 | 248 | 224·8 | 104·8 |
| 9 | 8·2 | 3·8 | 69 | 62·5 | 29·2 | 129 | 116·9 | 54·5 | 189 | 171·3 | 79·9 | 249 | 225·7 | 105·2 |
| 10 | 9·1 | 4·2 | 70 | 63·4 | 29·6 | 130 | 117·8 | 54·9 | 190 | 172·2 | 80·3 | 250 | 226·6 | 105·7 |
| 11 | 10·0 | 4·6 | 71 | 64·3 | 30·0 | 131 | 118·7 | 55·4 | 191 | 173·1 | 80·7 | 251 | 227·5 | 106·1 |
| 12 | 10·9 | 5·1 | 72 | 65·3 | 30·4 | 132 | 119·6 | 55·8 | 192 | 174·0 | 81·1 | 252 | 228·4 | 106·5 |
| 13 | 11·8 | 5·5 | 73 | 66·2 | 30·9 | 133 | 120·5 | 56·2 | 193 | 174·9 | 81·6 | 253 | 229·3 | 106·9 |
| 14 | 12·7 | 5·9 | 74 | 67·1 | 31·3 | 134 | 121·4 | 56·6 | 194 | 175·8 | 82·0 | 254 | 230·2 | 107·3 |
| 15 | 13·6 | 6·3 | 75 | 68·0 | 31·7 | 135 | 122·4 | 57·1 | 195 | 176·7 | 82·4 | 255 | 231·1 | 107·8 |
| 16 | 14·5 | 6·8 | 76 | 68·9 | 32·1 | 136 | 123·3 | 57·5 | 196 | 177·6 | 82·8 | 256 | 232·0 | 108·2 |
| 17 | 15·4 | 7·2 | 77 | 69·8 | 32·5 | 137 | 124·2 | 57·9 | 197 | 178·5 | 83·3 | 257 | 232·9 | 108·6 |
| 18 | 16·3 | 7·6 | 78 | 70·7 | 33·0 | 138 | 125·1 | 58·3 | 198 | 179·4 | 83·7 | 258 | 233·8 | 109·0 |
| 19 | 17·2 | 8·0 | 79 | 71·6 | 33·4 | 139 | 126·0 | 58·7 | 199 | 180·4 | 84·1 | 259 | 234·7 | 109·5 |
| 20 | 18·1 | 8·5 | 80 | 72·5 | 33·8 | 140 | 126·9 | 59·2 | 200 | 181·3 | 84·5 | 260 | 235·6 | 109·9 |
| 21 | 19·0 | 8·9 | 81 | 73·4 | 34·2 | 141 | 127·8 | 59·6 | 201 | 182·2 | 84·9 | 261 | 236·5 | 110·3 |
| 22 | 19·9 | 9·3 | 82 | 74·3 | 34·7 | 142 | 128·7 | 60·0 | 202 | 183·1 | 85·4 | 262 | 237·5 | 110·7 |
| 23 | 20·8 | 9·7 | 83 | 75·2 | 35·1 | 143 | 129·6 | 60·4 | 203 | 184·0 | 85·8 | 263 | 238·4 | 111·1 |
| 24 | 21·8 | 10·1 | 84 | 76·1 | 35·5 | 144 | 130·5 | 60·9 | 204 | 184·9 | 86·2 | 264 | 239·3 | 111·6 |
| 25 | 22·7 | 10·6 | 85 | 77·0 | 35·9 | 145 | 131·4 | 61·3 | 205 | 185·8 | 86·6 | 265 | 240·2 | 112·0 |
| 26 | 23·6 | 11·0 | 86 | 77·9 | 36·3 | 146 | 132·3 | 61·7 | 206 | 186·7 | 87·1 | 266 | 241·1 | 112·4 |
| 27 | 24·5 | 11·4 | 87 | 78·8 | 36·8 | 147 | 133·2 | 62·1 | 207 | 187·6 | 87·5 | 267 | 242·0 | 112·8 |
| 28 | 25·4 | 11·8 | 88 | 79·8 | 37·2 | 148 | 134·1 | 62·5 | 208 | 188·5 | 87·9 | 268 | 242·9 | 113·3 |
| 29 | 26·3 | 12·3 | 89 | 80·7 | 37·6 | 149 | 135·0 | 63·0 | 209 | 189·4 | 88·3 | 269 | 243·8 | 113·7 |
| 30 | 27·2 | 12·7 | 90 | 81·6 | 38·0 | 150 | 135·9 | 63·4 | 210 | 190·3 | 88·7 | 270 | 244·7 | 114·1 |
| 31 | 28·1 | 13·1 | 91 | 82·5 | 38·5 | 151 | 136·9 | 63·8 | 211 | 191·2 | 89·2 | 271 | 245·6 | 114·5 |
| 32 | 29·0 | 13·5 | 92 | 83·4 | 38·9 | 152 | 137·8 | 64·2 | 212 | 192·1 | 89·6 | 272 | 246·5 | 115·0 |
| 33 | 29·9 | 13·9 | 93 | 84·3 | 39·3 | 153 | 138·7 | 64·7 | 213 | 193·0 | 90·0 | 273 | 247·4 | 115·4 |
| 34 | 30·8 | 14·4 | 94 | 85·2 | 39·7 | 154 | 139·6 | 65·1 | 214 | 193·9 | 90·4 | 274 | 248·3 | 115·8 |
| 35 | 31·7 | 14·8 | 95 | 86·1 | 40·1 | 155 | 140·5 | 65·5 | 215 | 194·9 | 90·9 | 275 | 249·2 | 116·2 |
| 36 | 32·6 | 15·2 | 96 | 87·0 | 40·6 | 156 | 141·4 | 65·9 | 216 | 195·8 | 91·3 | 276 | 250·1 | 116·6 |
| 37 | 33·5 | 15·6 | 97 | 87·9 | 41·0 | 157 | 142·3 | 66·4 | 217 | 196·7 | 91·7 | 277 | 251·0 | 117·1 |
| 38 | 34·4 | 16·1 | 98 | 88·8 | 41·4 | 158 | 143·2 | 66·8 | 218 | 197·6 | 92·1 | 278 | 252·0 | 117·5 |
| 39 | 35·3 | 16·5 | 99 | 89·7 | 41·8 | 159 | 144·1 | 67·2 | 219 | 198·5 | 92·6 | 279 | 252·9 | 117·9 |
| 40 | 36·3 | 16·9 | 100 | 90·6 | 42·3 | 160 | 145·0 | 67·6 | 220 | 199·4 | 93·0 | 280 | 253·8 | 118·3 |
| 41 | 37·2 | 17·3 | 101 | 91·5 | 42·7 | 161 | 145·9 | 68·0 | 221 | 200·3 | 93·4 | 281 | 254·7 | 118·8 |
| 42 | 38·1 | 17·7 | 102 | 92·4 | 43·1 | 162 | 146·8 | 68·5 | 222 | 201·2 | 93·8 | 282 | 255·6 | 119·2 |
| 43 | 39·0 | 18·2 | 103 | 93·3 | 43·5 | 163 | 147·7 | 68·9 | 223 | 202·1 | 94·2 | 283 | 256·5 | 119·6 |
| 44 | 39·9 | 18·6 | 104 | 94·3 | 44·0 | 164 | 148·6 | 69·3 | 224 | 203·0 | 94·7 | 284 | 257·4 | 120·0 |
| 45 | 40·8 | 19·0 | 105 | 95·2 | 44·4 | 165 | 149·5 | 69·7 | 225 | 203·9 | 95·1 | 285 | 258·3 | 120·4 |
| 46 | 41·7 | 19·4 | 106 | 96·1 | 44·8 | 166 | 150·4 | 70·2 | 226 | 204·8 | 95·5 | 286 | 259·2 | 120·9 |
| 47 | 42·6 | 19·9 | 107 | 97·0 | 45·2 | 167 | 151·4 | 70·6 | 227 | 205·7 | 95·9 | 287 | 260·1 | 121·3 |
| 48 | 43·5 | 20·3 | 108 | 97·9 | 45·6 | 168 | 152·3 | 71·0 | 228 | 206·6 | 96·4 | 288 | 261·0 | 121·7 |
| 49 | 44·4 | 20·7 | 109 | 98·8 | 46·1 | 169 | 153·2 | 71·4 | 229 | 207·5 | 96·8 | 289 | 261·9 | 122·1 |
| 50 | 45·3 | 21·1 | 110 | 99·7 | 46·5 | 170 | 154·1 | 71·8 | 230 | 208·5 | 97·2 | 290 | 262·8 | 122·6 |
| 51 | 46·2 | 21·6 | 111 | 100·6 | 46·9 | 171 | 155·0 | 72·3 | 231 | 209·4 | 97·6 | 291 | 263·7 | 123·0 |
| 52 | 47·1 | 22·0 | 112 | 101·5 | 47·3 | 172 | 155·9 | 72·7 | 232 | 210·3 | 98·0 | 292 | 264·6 | 123·4 |
| 53 | 48·0 | 22·4 | 113 | 102·4 | 47·8 | 173 | 156·8 | 73·1 | 233 | 211·2 | 98·5 | 293 | 265·5 | 123·8 |
| 54 | 48·9 | 22·8 | 114 | 103·3 | 48·2 | 174 | 157·7 | 73·5 | 234 | 212·1 | 98·9 | 294 | 266·5 | 124·2 |
| 55 | 49·8 | 23·2 | 115 | 104·2 | 48·6 | 175 | 158·6 | 74·0 | 235 | 213·0 | 99·3 | 295 | 267·4 | 124·7 |
| 56 | 50·8 | 23·7 | 116 | 105·1 | 49·0 | 176 | 159·5 | 74·4 | 236 | 213·9 | 99·7 | 296 | 268·3 | 125·1 |
| 57 | 51·7 | 24·1 | 117 | 106·0 | 49·4 | 177 | 160·4 | 74·8 | 237 | 214·8 | 100·2 | 297 | 269·2 | 125·5 |
| 58 | 52·6 | 24·5 | 118 | 106·9 | 49·9 | 178 | 161·3 | 75·2 | 238 | 215·7 | 100·6 | 298 | 270·1 | 125·9 |
| 59 | 53·5 | 24·9 | 119 | 107·9 | 50·3 | 179 | 162·2 | 75·6 | 239 | 216·6 | 101·0 | 299 | 271·0 | 126·4 |
| 60 | 54·4 | 25·4 | 120 | 108·8 | 50·7 | 180 | 163·1 | 76·1 | 240 | 217·5 | 101·4 | 300 | 271·9 | 126·8 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

65° 4ʰ 20ᵐ

## TRAVERSE TABLE TO DEGREES

25° 1h 40m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 272·8 | 127·2 | 361 | 327·1 | 152·5 | 421 | 381·5 | 177·9 | 481 | 435·9 | 203·3 | 541 | 490·3 | 228·6 |
| 302 | 273·7 | 127·6 | 362 | 328·0 | 153·0 | 422 | 382·4 | 178·3 | 482 | 436·8 | 203·7 | 542 | 491·2 | 229·0 |
| 303 | 274·6 | 128·0 | 363 | 329·0 | 153·4 | 423 | 383·3 | 178·7 | 483 | 437·7 | 204·1 | 543 | 492·1 | 229·4 |
| 304 | 275·5 | 128·4 | 364 | 329·9 | 153·8 | 424 | 384·2 | 179·2 | 484 | 438·6 | 204·5 | 544 | 493·0 | 229·9 |
| 305 | 276·4 | 128·9 | 365 | 330·8 | 154·2 | 425 | 385·1 | 179·6 | 485 | 439·5 | 204·9 | 545 | 493·9 | 230·3 |
| 306 | 277·3 | 129·3 | 366 | 331·7 | 154·6 | 426 | 386·0 | 180·0 | 486 | 440·4 | 205·4 | 546 | 494·8 | 230·7 |
| 307 | 278·2 | 129·7 | 367 | 332·6 | 155·1 | 427 | 387·0 | 180·4 | 487 | 441·3 | 205·8 | 547 | 495·7 | 231·1 |
| 308 | 279·1 | 130·1 | 368 | 333·5 | 155·5 | 428 | 387·9 | 180·9 | 488 | 442·2 | 206·2 | 548 | 496·6 | 231·6 |
| 309 | 280·0 | 130·6 | 369 | 334·4 | 155·9 | 429 | 388·8 | 181·3 | 489 | 443·1 | 206·6 | 549 | 497·5 | 232·0 |
| 310 | 280·9 | 131·0 | 370 | 335·3 | 156·3 | 430 | 389·7 | 181·7 | 490 | 444·0 | 207·1 | 550 | 498·4 | 232·4 |
| 311 | 281·8 | 131·4 | 371 | 336·2 | 156·8 | 431 | 390·6 | 182·1 | 491 | 444·9 | 207·5 | 551 | 499·3 | 232·8 |
| 312 | 282·7 | 131·8 | 372 | 337·1 | 157·2 | 432 | 391·5 | 182·5 | 492 | 445·9 | 207·9 | 552 | 500·2 | 233·2 |
| 313 | 283·6 | 132·2 | 373 | 338·0 | 157·6 | 433 | 392·4 | 183·0 | 493 | 446·8 | 208·3 | 553 | 501·1 | 233·7 |
| 314 | 284·5 | 132·7 | 374 | 338·9 | 158·0 | 434 | 393·3 | 183·4 | 494 | 447·7 | 208·7 | 554 | 502·0 | 234·1 |
| 315 | 285·4 | 133·1 | 375 | 339·8 | 158·5 | 435 | 394·2 | 183·8 | 495 | 448·6 | 209·1 | 555 | 503·0 | 234·5 |
| 316 | 286·4 | 133·5 | 376 | 340·7 | 158·9 | 436 | 395·1 | 184·2 | 496 | 449·5 | 209·6 | 556 | 503·9 | 235·0 |
| 317 | 287·3 | 133·9 | 377 | 341·6 | 159·3 | 437 | 396·0 | 184·7 | 497 | 450·4 | 210·0 | 557 | 504·8 | 235·4 |
| 318 | 288·2 | 134·4 | 378 | 342·5 | 159·7 | 438 | 396·9 | 185·1 | 498 | 451·3 | 210·4 | 558 | 505·7 | 235·8 |
| 319 | 289·1 | 134·8 | 379 | 343·5 | 160·1 | 439 | 397·8 | 185·5 | 499 | 452·2 | 210·9 | 559 | 506·6 | 236·2 |
| 320 | 290·0 | 135·2 | 380 | 344·4 | 160·6 | 440 | 398·7 | 185·9 | 500 | 453·1 | 211·3 | 560 | 507·5 | 236·6 |
| 321 | 290·9 | 135·6 | 381 | 345·3 | 161·0 | 441 | 399·6 | 186·3 | 501 | 454·0 | 211·7 | 561 | 508·4 | 237·1 |
| 322 | 291·8 | 136·1 | 382 | 346·2 | 161·4 | 442 | 400·6 | 186·8 | 502 | 454·9 | 212·1 | 562 | 509·3 | 237·5 |
| 323 | 292·7 | 136·5 | 383 | 347·1 | 161·8 | 443 | 401·5 | 187·2 | 503 | 455·8 | 212·5 | 563 | 510·2 | 237·9 |
| 324 | 293·6 | 136·9 | 384 | 348·0 | 162·3 | 444 | 402·4 | 187·6 | 504 | 456·7 | 213·0 | 564 | 511·1 | 238·3 |
| 325 | 294·5 | 137·3 | 385 | 348·9 | 162·7 | 445 | 403·3 | 188·0 | 505 | 457·7 | 213·4 | 565 | 512·0 | 238·7 |
| 326 | 295·4 | 137·7 | 386 | 349·8 | 163·1 | 446 | 404·2 | 188·5 | 506 | 458·6 | 213·8 | 566 | 512·9 | 239·2 |
| 327 | 296·3 | 138·2 | 387 | 350·7 | 163·5 | 447 | 405·1 | 188·9 | 507 | 459·5 | 214·2 | 567 | 513·8 | 239·6 |
| 328 | 297·2 | 138·6 | 388 | 351·6 | 163·9 | 448 | 406·0 | 189·3 | 508 | 460·4 | 214·7 | 568 | 514·8 | 240·1 |
| 329 | 298·1 | 139·0 | 389 | 352·5 | 164·4 | 449 | 406·9 | 189·7 | 509 | 461·3 | 215·1 | 569 | 515·7 | 240·5 |
| 330 | 299·0 | 139·4 | 390 | 353·4 | 164·8 | 450 | 407·8 | 190·1 | 510 | 462·2 | 215·5 | 570 | 516·6 | 240·9 |
| 331 | 300·0 | 139·9 | 391 | 354·3 | 165·2 | 451 | 408·7 | 190·6 | 511 | 463·1 | 215·9 | 571 | 517·5 | 241·3 |
| 332 | 300·9 | 140·3 | 392 | 355·2 | 165·6 | 452 | 409·6 | 191·0 | 512 | 464·0 | 216·4 | 572 | 518·4 | 241·7 |
| 333 | 301·8 | 140·7 | 393 | 356·1 | 166·1 | 453 | 410·5 | 191·4 | 513 | 464·9 | 216·8 | 573 | 519·3 | 242·1 |
| 334 | 302·7 | 141·1 | 394 | 357·0 | 166·5 | 454 | 411·4 | 191·8 | 514 | 465·8 | 217·2 | 574 | 520·2 | 242·6 |
| 335 | 303·6 | 141·5 | 395 | 358·0 | 166·9 | 455 | 412·3 | 192·3 | 515 | 466·7 | 217·7 | 575 | 521·1 | 243·0 |
| 336 | 304·5 | 142·0 | 396 | 358·9 | 167·3 | 456 | 413·2 | 192·7 | 516 | 467·6 | 218·1 | 576 | 522·0 | 243·4 |
| 337 | 305·4 | 142·4 | 397 | 359·8 | 167·7 | 457 | 414·1 | 193·1 | 517 | 468·5 | 218·5 | 577 | 522·9 | 243·8 |
| 338 | 306·3 | 142·8 | 398 | 360·7 | 168·2 | 458 | 415·1 | 193·5 | 518 | 469·4 | 218·9 | 578 | 523·8 | 244·3 |
| 339 | 307·2 | 143·2 | 399 | 361·6 | 168·6 | 459 | 416·0 | 194·0 | 519 | 470·3 | 219·3 | 579 | 524·7 | 244·7 |
| 340 | 308·1 | 143·7 | 400 | 362·5 | 169·0 | 460 | 416·9 | 194·4 | 520 | 471·2 | 219·8 | 580 | 525·6 | 245·1 |
| 341 | 309·0 | 144·1 | 401 | 363·4 | 169·4 | 461 | 417·8 | 194·8 | 521 | 472·2 | 220·2 | 581 | 526·5 | 245·5 |
| 342 | 309·9 | 144·5 | 402 | 364·3 | 169·9 | 462 | 418·7 | 195·2 | 522 | 473·1 | 220·6 | 582 | 527·4 | 246·0 |
| 343 | 310·8 | 144·9 | 403 | 365·2 | 170·3 | 463 | 419·6 | 195·6 | 523 | 474·0 | 221·0 | 583 | 528·3 | 246·4 |
| 344 | 311·7 | 145·4 | 404 | 366·1 | 170·7 | 464 | 420·5 | 196·1 | 524 | 474·9 | 221·4 | 584 | 529·3 | 246·8 |
| 345 | 312·6 | 145·8 | 405 | 367·0 | 171·1 | 465 | 421·4 | 196·5 | 525 | 475·8 | 221·9 | 585 | 530·2 | 247·2 |
| 346 | 313·5 | 146·2 | 406 | 367·9 | 171·6 | 466 | 422·3 | 196·9 | 526 | 476·7 | 222·3 | 586 | 531·1 | 247·7 |
| 347 | 314·5 | 146·6 | 407 | 368·8 | 172·0 | 467 | 423·2 | 197·3 | 527 | 477·6 | 222·7 | 587 | 532·0 | 248·1 |
| 348 | 315·4 | 147·0 | 408 | 369·7 | 172·4 | 468 | 424·1 | 197·8 | 528 | 478·5 | 223·2 | 588 | 532·9 | 248·5 |
| 349 | 316·3 | 147·5 | 409 | 370·6 | 172·8 | 469 | 425·0 | 198·2 | 529 | 479·4 | 223·6 | 589 | 533·8 | 248·9 |
| 350 | 317·2 | 147·9 | 410 | 371·5 | 173·2 | 470 | 425·9 | 198·6 | 530 | 480·3 | 224·0 | 590 | 534·7 | 249·4 |
| 351 | 318·1 | 148·3 | 411 | 372·5 | 173·7 | 471 | 426·8 | 199·0 | 531 | 481·2 | 224·4 | 591 | 535·6 | 249·8 |
| 352 | 319·0 | 148·7 | 412 | 373·4 | 174·1 | 472 | 427·7 | 199·4 | 532 | 482·1 | 224·8 | 592 | 536·5 | 250·2 |
| 353 | 319·9 | 149·2 | 413 | 374·3 | 174·5 | 473 | 428·6 | 199·9 | 533 | 483·0 | 225·3 | 593 | 537·4 | 250·6 |
| 354 | 320·8 | 149·6 | 414 | 375·2 | 174·9 | 474 | 429·6 | 200·3 | 534 | 483·9 | 225·7 | 594 | 538·3 | 251·1 |
| 355 | 321·7 | 150·0 | 415 | 376·1 | 175·4 | 475 | 430·5 | 200·7 | 535 | 484·8 | 226·1 | 595 | 539·2 | 251·5 |
| 356 | 322·6 | 150·4 | 416 | 377·0 | 175·8 | 476 | 431·4 | 201·1 | 536 | 485·7 | 226·5 | 596 | 540·1 | 251·9 |
| 357 | 323·5 | 150·8 | 417 | 377·9 | 176·2 | 477 | 432·3 | 201·6 | 537 | 486·7 | 226·9 | 597 | 541·0 | 252·3 |
| 358 | 324·4 | 151·3 | 418 | 378·8 | 176·6 | 478 | 433·2 | 202·0 | 538 | 487·6 | 227·4 | 598 | 541·9 | 252·7 |
| 359 | 325·3 | 151·7 | 419 | 379·7 | 177·0 | 479 | 434·1 | 202·4 | 539 | 488·5 | 227·8 | 599 | 542·8 | 253·1 |
| 360 | 326·2 | 152·1 | 420 | 380·6 | 177·5 | 480 | 435·0 | 202·8 | 540 | 489·4 | 228·2 | 600 | 543·8 | 253·6 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

65° 4h 20m

## TRAVERSE TABLE TO DEGREES

26° $1^h\ 44^m$

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0·9 | 0·4 | 61 | 54·8 | 26·7 | 121 | 108·8 | 53·0 | 181 | 162·7 | 79·3 | 241 | 216·6 | 105·6 |
| 2 | 1·8 | 0·9 | 62 | 55·7 | 27·2 | 122 | 109·7 | 53·5 | 182 | 163·6 | 79·8 | 242 | 217·5 | 106·1 |
| 3 | 2·7 | 1·3 | 63 | 56·6 | 27·6 | 123 | 110·6 | 53·9 | 183 | 164·5 | 80·2 | 243 | 218·4 | 106·5 |
| 4 | 3·6 | 1·8 | 64 | 57·5 | 28·1 | 124 | 111·5 | 54·4 | 184 | 165·4 | 80·7 | 244 | 219·3 | 107·0 |
| 5 | 4·5 | 2·2 | 65 | 58·4 | 28·5 | 125 | 112·3 | 54·8 | 185 | 166·3 | 81·1 | 245 | 220·2 | 107·4 |
| 6 | 5·4 | 2·6 | 66 | 59·3 | 28·9 | 126 | 113·2 | 55·2 | 186 | 167·2 | 81·5 | 246 | 221·1 | 107·8 |
| 7 | 6·3 | 3·1 | 67 | 60·2 | 29·4 | 127 | 114·1 | 55·7 | 187 | 168·1 | 82·0 | 247 | 222·0 | 108·3 |
| 8 | 7·2 | 3·5 | 68 | 61·1 | 29·8 | 128 | 115·0 | 56·1 | 188 | 169·0 | 82·4 | 248 | 222·9 | 108·7 |
| 9 | 8·1 | 3·9 | 69 | 62·0 | 30·2 | 129 | 115·9 | 56·5 | 189 | 169·9 | 82·9 | 249 | 223·8 | 109·2 |
| 10 | 9·0 | 4·4 | 70 | 62·9 | 30·7 | 130 | 116·8 | 57·0 | 190 | 170·8 | 83·3 | 250 | 224·7 | 109·6 |
| 11 | 9·9 | 4·8 | 71 | 63·8 | 31·1 | 131 | 117·7 | 57·4 | 191 | 171·7 | 83·7 | 251 | 225·6 | 110·0 |
| 12 | 10·8 | 5·3 | 72 | 64·7 | 31·6 | 132 | 118·6 | 57·9 | 192 | 172·6 | 84·2 | 252 | 226·5 | 110·5 |
| 13 | 11·7 | 5·7 | 73 | 65·6 | 32·0 | 133 | 119·5 | 58·3 | 193 | 173·5 | 84·6 | 253 | 227·4 | 110·9 |
| 14 | 12·6 | 6·1 | 74 | 66·5 | 32·4 | 134 | 120·4 | 58·7 | 194 | 174·4 | 85·0 | 254 | 228·3 | 111·3 |
| 15 | 13·5 | 6·6 | 75 | 67·4 | 32·9 | 135 | 121·3 | 59·2 | 195 | 175·3 | 85·5 | 255 | 229·2 | 111·8 |
| 16 | 14·4 | 7·0 | 76 | 68·3 | 33·3 | 136 | 122·2 | 59·6 | 196 | 176·2 | 85·9 | 256 | 230·1 | 112·2 |
| 17 | 15·3 | 7·5 | 77 | 69·2 | 33·8 | 137 | 123·1 | 60·1 | 197 | 177·1 | 86·4 | 257 | 231·0 | 112·7 |
| 18 | 16·2 | 7·9 | 78 | 70·1 | 34·2 | 138 | 124·0 | 60·5 | 198 | 178·0 | 86·8 | 258 | 231·9 | 113·1 |
| 19 | 17·1 | 8·3 | 79 | 71·0 | 34·6 | 139 | 124·9 | 60·9 | 199 | 178·9 | 87·2 | 259 | 232·8 | 113·5 |
| 20 | 18·0 | 8·8 | 80 | 71·9 | 35·1 | 140 | 125·8 | 61·4 | 200 | 179·8 | 87·7 | 260 | 233·7 | 114·0 |
| 21 | 18·9 | 9·2 | 81 | 72·8 | 35·5 | 141 | 126·7 | 61·8 | 201 | 180·7 | 88·1 | 261 | 234·6 | 114·4 |
| 22 | 19·8 | 9·6 | 82 | 73·7 | 35·9 | 142 | 127·6 | 62·2 | 202 | 181·6 | 88·6 | 262 | 235·5 | 114·9 |
| 23 | 20·7 | 10·1 | 83 | 74·6 | 36·4 | 143 | 128·5 | 62·7 | 203 | 182·5 | 89·0 | 263 | 236·4 | 115·3 |
| 24 | 21·6 | 10·5 | 84 | 75·5 | 36·8 | 144 | 129·4 | 63·1 | 204 | 183·4 | 89·4 | 264 | 237·3 | 115·7 |
| 25 | 22·5 | 11·0 | 85 | 76·4 | 37·3 | 145 | 130·3 | 63·6 | 205 | 184·3 | 89·9 | 265 | 238·2 | 116·2 |
| 26 | 23·4 | 11·4 | 86 | 77·3 | 37·7 | 146 | 131·2 | 64·0 | 206 | 185·2 | 90·3 | 266 | 239·1 | 116·6 |
| 27 | 24·3 | 11·8 | 87 | 78·2 | 38·1 | 147 | 132·1 | 64·4 | 207 | 186·1 | 90·7 | 267 | 240·0 | 117·0 |
| 28 | 25·2 | 12·3 | 88 | 79·1 | 38·6 | 148 | 133·0 | 64·9 | 208 | 186·9 | 91·2 | 268 | 240·9 | 117·5 |
| 29 | 26·1 | 12·7 | 89 | 80·0 | 39·0 | 149 | 133·9 | 65·3 | 209 | 187·8 | 91·6 | 269 | 241·8 | 117·9 |
| 30 | 27·0 | 13·2 | 90 | 80·9 | 39·5 | 150 | 134·8 | 65·8 | 210 | 188·7 | 92·1 | 270 | 242·7 | 118·4 |
| 31 | 27·9 | 13·6 | 91 | 81·8 | 39·9 | 151 | 135·7 | 66·2 | 211 | 189·6 | 92·5 | 271 | 243·6 | 118·8 |
| 32 | 28·8 | 14·0 | 92 | 82·7 | 40·3 | 152 | 136·6 | 66·6 | 212 | 190·5 | 92·9 | 272 | 244·5 | 119·2 |
| 33 | 29·7 | 14·5 | 93 | 83·6 | 40·8 | 153 | 137·5 | 67·1 | 213 | 191·4 | 93·4 | 273 | 245·4 | 119·7 |
| 34 | 30·6 | 14·9 | 94 | 84·5 | 41·2 | 154 | 138·4 | 67·5 | 214 | 192·3 | 93·8 | 274 | 246·3 | 120·1 |
| 35 | 31·5 | 15·3 | 95 | 85·4 | 41·6 | 155 | 139·3 | 67·9 | 215 | 193·2 | 94·2 | 275 | 247·2 | 120·6 |
| 36 | 32·4 | 15·8 | 96 | 86·3 | 42·1 | 156 | 140·2 | 68·4 | 216 | 194·1 | 94·7 | 276 | 248·1 | 121·0 |
| 37 | 33·3 | 16·2 | 97 | 87·2 | 42·5 | 157 | 141·1 | 68·8 | 217 | 195·0 | 95·1 | 277 | 249·0 | 121·4 |
| 38 | 34·2 | 16·7 | 98 | 88·1 | 43·0 | 158 | 142·0 | 69·3 | 218 | 195·9 | 95·6 | 278 | 249·9 | 121·9 |
| 39 | 35·1 | 17·1 | 99 | 89·0 | 43·4 | 159 | 142·9 | 69·7 | 219 | 196·8 | 96·0 | 279 | 250·8 | 122·3 |
| 40 | 36·0 | 17·5 | 100 | 89·9 | 43·8 | 160 | 143·8 | 70·1 | 220 | 197·7 | 96·4 | 280 | 251·7 | 122·7 |
| 41 | 36·9 | 18·0 | 101 | 90·8 | 44·3 | 161 | 144·7 | 70·6 | 221 | 198·6 | 96·9 | 281 | 252·6 | 123·2 |
| 42 | 37·7 | 18·4 | 102 | 91·7 | 44·7 | 162 | 145·6 | 71·0 | 222 | 199·5 | 97·3 | 282 | 253·5 | 123·6 |
| 43 | 38·6 | 18·8 | 103 | 92·6 | 45·2 | 163 | 146·5 | 71·5 | 223 | 200·4 | 97·8 | 283 | 254·4 | 124·1 |
| 44 | 39·5 | 19·3 | 104 | 93·5 | 45·6 | 164 | 147·4 | 71·9 | 224 | 201·3 | 98·2 | 284 | 255·3 | 124·5 |
| 45 | 40·4 | 19·7 | 105 | 94·4 | 46·0 | 165 | 148·3 | 72·3 | 225 | 202·2 | 98·6 | 285 | 256·2 | 124·9 |
| 46 | 41·3 | 20·2 | 106 | 95·3 | 46·5 | 166 | 149·2 | 72·8 | 226 | 203·1 | 99·1 | 286 | 257·1 | 125·4 |
| 47 | 42·2 | 20·6 | 107 | 96·2 | 46·9 | 167 | 150·1 | 73·2 | 227 | 204·0 | 99·5 | 287 | 258·0 | 125·8 |
| 48 | 43·1 | 21·0 | 108 | 97·1 | 47·3 | 168 | 151·0 | 73·6 | 228 | 204·9 | 99·9 | 288 | 258·9 | 126·3 |
| 49 | 44·0 | 21·5 | 109 | 98·0 | 47·8 | 169 | 151·9 | 74·1 | 229 | 205·8 | 100·4 | 289 | 259·8 | 126·7 |
| 50 | 44·9 | 21·9 | 110 | 98·9 | 48·2 | 170 | 152·8 | 74·5 | 230 | 206·7 | 100·8 | 290 | 260·7 | 127·1 |
| 51 | 45·8 | 22·4 | 111 | 99·8 | 48·7 | 171 | 153·7 | 75·0 | 231 | 207·6 | 101·3 | 291 | 261·5 | 127·6 |
| 52 | 46·7 | 22·8 | 112 | 100·7 | 49·1 | 172 | 154·6 | 75·4 | 232 | 208·5 | 101·7 | 292 | 262·4 | 128·0 |
| 53 | 47·6 | 23·2 | 113 | 101·6 | 49·5 | 173 | 155·5 | 75·8 | 233 | 209·4 | 102·1 | 293 | 263·3 | 128·4 |
| 54 | 48·5 | 23·7 | 114 | 102·5 | 50·0 | 174 | 156·4 | 76·3 | 234 | 210·3 | 102·6 | 294 | 264·2 | 128·9 |
| 55 | 49·4 | 24·1 | 115 | 103·4 | 50·4 | 175 | 157·3 | 76·7 | 235 | 211·2 | 103·0 | 295 | 265·1 | 129·3 |
| 56 | 50·3 | 24·5 | 116 | 104·3 | 50·9 | 176 | 158·2 | 77·2 | 236 | 212·1 | 103·5 | 296 | 266·0 | 129·8 |
| 57 | 51·2 | 25·0 | 117 | 105·2 | 51·3 | 177 | 159·1 | 77·6 | 237 | 213·0 | 103·9 | 297 | 266·9 | 130·2 |
| 58 | 52·1 | 25·4 | 118 | 106·1 | 51·7 | 178 | 160·0 | 78·0 | 238 | 213·9 | 104·3 | 298 | 267·8 | 130·6 |
| 59 | 53·0 | 25·9 | 119 | 107·0 | 52·2 | 179 | 160·9 | 78·5 | 239 | 214·8 | 104·8 | 299 | 268·7 | 131·1 |
| 60 | 53·9 | 26·3 | 120 | 107·9 | 52·6 | 180 | 161·8 | 78·9 | 240 | 215·7 | 105·2 | 300 | 269·6 | 131·5 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

64° $4^h\ 16^m$

## TRAVERSE TABLE TO DEGREES

26° 1h 44m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 270·5 | 132·0 | 361 | 324·5 | 158·3 | 421 | 378·4 | 184·6 | 481 | 432·3 | 210·9 | 541 | 486·2 | 237·2 |
| 302 | 271·4 | 132·4 | 362 | 325·4 | 158·7 | 422 | 379·3 | 185·0 | 482 | 433·2 | 211·3 | 542 | 487·1 | 237·6 |
| 303 | 272·3 | 132·8 | 363 | 326·3 | 159·1 | 423 | 380·2 | 185·4 | 483 | 434·1 | 211·7 | 543 | 488·0 | 238·0 |
| 304 | 273·2 | 133·3 | 364 | 327·2 | 159·6 | 424 | 381·1 | 185·9 | 484 | 435·0 | 212·2 | 544 | 488·9 | 238·5 |
| 305 | 274·1 | 133·7 | 365 | 328·1 | 160·0 | 425 | 382·0 | 186·3 | 485 | 435·9 | 212·6 | 545 | 489·8 | 238·9 |
| 306 | 275·0 | 134·1 | 366 | 329·0 | 160·4 | 426 | 382·9 | 186·7 | 486 | 436·8 | 213·0 | 546 | 490·7 | 239·3 |
| 307 | 275·9 | 134·6 | 367 | 329·9 | 160·9 | 427 | 383·8 | 187·2 | 487 | 437·7 | 213·5 | 547 | 491·6 | 239·8 |
| 308 | 276·8 | 135·0 | 368 | 330·8 | 161·3 | 428 | 384·7 | 187·6 | 488 | 438·6 | 213·9 | 548 | 492·5 | 240·2 |
| 309 | 277·7 | 135·5 | 369 | 331·7 | 161·8 | 429 | 385·6 | 188·1 | 489 | 439·5 | 214·4 | 549 | 493·4 | 240·7 |
| 310 | 278·6 | 135·9 | 370 | 332·6 | 162·2 | 430 | 386·5 | 188·5 | 490 | 440·4 | 214·8 | 550 | 494·3 | 241·1 |
| 311 | 279·5 | 136·3 | 371 | 333·5 | 162·6 | 431 | 387·4 | 188·9 | 491 | 441·3 | 215·2 | 551 | 495·2 | 241·5 |
| 312 | 280·4 | 136·8 | 372 | 334·4 | 163·1 | 432 | 388·3 | 189·4 | 492 | 442·2 | 215·7 | 552 | 496·1 | 242·0 |
| 313 | 281·3 | 137·2 | 373 | 335·3 | 163·5 | 433 | 389·2 | 189·8 | 493 | 443·1 | 216·1 | 553 | 497·0 | 242·4 |
| 314 | 282·2 | 137·7 | 374 | 336·2 | 164·0 | 434 | 390·1 | 190·3 | 494 | 444·0 | 216·6 | 554 | 497·9 | 242·9 |
| 315 | 283·1 | 138·1 | 375 | 337·1 | 164·4 | 435 | 391·0 | 190·7 | 495 | 444·9 | 217·0 | 555 | 498·8 | 243·3 |
| 316 | 284·0 | 138·5 | 376 | 338·0 | 164·8 | 436 | 391·9 | 191·1 | 496 | 445·8 | 217·4 | 556 | 499·7 | 243·7 |
| 317 | 284·9 | 139·0 | 377 | 338·9 | 165·3 | 437 | 392·8 | 191·6 | 497 | 446·7 | 217·9 | 557 | 500·6 | 244·2 |
| 318 | 285·8 | 139·4 | 378 | 339·8 | 165·7 | 438 | 393·7 | 192·0 | 498 | 447·6 | 218·3 | 558 | 501·5 | 244·6 |
| 319 | 286·7 | 139·8 | 379 | 340·7 | 166·2 | 439 | 394·6 | 192·4 | 499 | 448·5 | 218·7 | 559 | 502·4 | 245·0 |
| 320 | 287·6 | 140·3 | 380 | 341·5 | 166·6 | 440 | 395·5 | 192·9 | 500 | 449·4 | 219·2 | 560 | 503·3 | 245·5 |
| 321 | 288·5 | 140·7 | 381 | 342·4 | 167·0 | 441 | 396·4 | 193·3 | 501 | 450·3 | 219·6 | 561 | 504·2 | 245·9 |
| 322 | 289·4 | 141·2 | 382 | 343·3 | 167·5 | 442 | 397·3 | 193·8 | 502 | 451·2 | 220·1 | 562 | 505·1 | 246·4 |
| 323 | 290·3 | 141·6 | 383 | 344·2 | 167·9 | 443 | 398·2 | 194·2 | 503 | 452·1 | 220·5 | 563 | 506·0 | 246·8 |
| 324 | 291·2 | 142·0 | 384 | 345·1 | 168·3 | 444 | 399·1 | 194·7 | 504 | 453·0 | 221·0 | 564 | 506·9 | 247·3 |
| 325 | 292·1 | 142·5 | 385 | 346·0 | 168·8 | 445 | 400·0 | 195·1 | 505 | 453·9 | 221·4 | 565 | 507·8 | 247·7 |
| 326 | 293·0 | 142·9 | 386 | 346·9 | 169·2 | 446 | 400·9 | 195·5 | 506 | 454·8 | 221·8 | 566 | 508·7 | 248·1 |
| 327 | 293·9 | 143·4 | 387 | 347·8 | 169·7 | 447 | 401·8 | 196·0 | 507 | 455·7 | 222·3 | 567 | 509·6 | 248·6 |
| 328 | 294·8 | 143·8 | 388 | 348·7 | 170·1 | 448 | 402·7 | 196·4 | 508 | 456·6 | 222·7 | 568 | 510·5 | 249·0 |
| 329 | 295·7 | 144·2 | 389 | 349·6 | 170·5 | 449 | 403·6 | 196·8 | 509 | 457·5 | 223·1 | 569 | 511·4 | 249·4 |
| 330 | 296·6 | 144·7 | 390 | 350·5 | 171·0 | 450 | 404·5 | 197·3 | 510 | 458·4 | 223·6 | 570 | 512·3 | 249·9 |
| 331 | 297·5 | 145·1 | 391 | 351·4 | 171·4 | 451 | 405·4 | 197·7 | 511 | 459·3 | 224·0 | 571 | 513·2 | 250·3 |
| 332 | 298·4 | 145·6 | 392 | 352·3 | 171·8 | 452 | 406·3 | 198·1 | 512 | 460·2 | 224·4 | 572 | 514·1 | 250·8 |
| 333 | 299·3 | 146·0 | 393 | 353·2 | 172·3 | 453 | 407·2 | 198·6 | 513 | 461·1 | 224·9 | 573 | 515·0 | 251·2 |
| 334 | 300·2 | 146·4 | 394 | 354·1 | 172·7 | 454 | 408·1 | 199·0 | 514 | 462·0 | 225·3 | 574 | 515·9 | 251·6 |
| 335 | 301·1 | 146·9 | 395 | 355·0 | 173·2 | 455 | 409·0 | 199·5 | 515 | 462·9 | 225·8 | 575 | 516·8 | 252·1 |
| 336 | 302·0 | 147·3 | 396 | 355·9 | 173·6 | 456 | 409·9 | 199·9 | 516 | 463·8 | 226·2 | 576 | 517·7 | 252·5 |
| 337 | 302·9 | 147·7 | 397 | 356·8 | 174·0 | 457 | 410·8 | 200·3 | 517 | 464·7 | 226·6 | 577 | 518·6 | 252·9 |
| 338 | 303·8 | 148·2 | 398 | 357·7 | 174·5 | 458 | 411·7 | 200·8 | 518 | 465·6 | 227·1 | 578 | 519·5 | 253·4 |
| 339 | 304·7 | 148·6 | 399 | 358·6 | 174·9 | 459 | 412·6 | 201·2 | 519 | 466·5 | 227·5 | 579 | 520·4 | 253·8 |
| 340 | 305·6 | 149·0 | 400 | 359·5 | 175·4 | 460 | 413·5 | 201·7 | 520 | 467·4 | 228·0 | 580 | 521·3 | 254·3 |
| 341 | 306·5 | 149·5 | 401 | 360·4 | 175·8 | 461 | 414·4 | 202·1 | 521 | 468·3 | 228·4 | 581 | 522·2 | 254·7 |
| 342 | 307·4 | 149·9 | 402 | 361·3 | 176·2 | 462 | 415·2 | 202·5 | 522 | 469·2 | 228·8 | 582 | 523·1 | 255·1 |
| 343 | 308·3 | 150·4 | 403 | 362·2 | 176·7 | 463 | 416·1 | 203·0 | 523 | 470·1 | 229·3 | 583 | 524·0 | 255·6 |
| 344 | 309·2 | 150·8 | 404 | 363·1 | 177·1 | 464 | 417·0 | 203·4 | 524 | 471·0 | 229·7 | 584 | 524·9 | 256·0 |
| 345 | 310·1 | 151·2 | 405 | 364·0 | 177·5 | 465 | 417·9 | 203·8 | 525 | 471·9 | 230·1 | 585 | 525·8 | 256·4 |
| 346 | 311·0 | 151·7 | 406 | 364·9 | 178·0 | 466 | 418·8 | 204·3 | 526 | 472·8 | 230·6 | 586 | 526·7 | 256·9 |
| 347 | 311·9 | 152·1 | 407 | 365·8 | 178·4 | 467 | 419·7 | 204·7 | 527 | 473·7 | 231·0 | 587 | 527·6 | 257·3 |
| 348 | 312·8 | 152·6 | 408 | 366·7 | 178·9 | 468 | 420·6 | 205·2 | 528 | 474·6 | 231·5 | 588 | 528·5 | 257·8 |
| 349 | 313·7 | 153·0 | 409 | 367·6 | 179·3 | 469 | 421·5 | 205·6 | 529 | 475·5 | 231·9 | 589 | 529·4 | 258·2 |
| 350 | 314·6 | 153·4 | 410 | 368·5 | 179·7 | 470 | 422·4 | 206·0 | 530 | 476·4 | 232·3 | 590 | 530·3 | 258·6 |
| 351 | 315·5 | 153·9 | 411 | 369·4 | 180·2 | 471 | 423·3 | 206·5 | 531 | 477·3 | 232·8 | 591 | 531·2 | 259·1 |
| 352 | 316·4 | 154·3 | 412 | 370·3 | 180·6 | 472 | 424·2 | 206·9 | 532 | 478·2 | 233·2 | 592 | 532·1 | 259·5 |
| 353 | 317·3 | 154·7 | 413 | 371·2 | 181·1 | 473 | 425·1 | 207·3 | 533 | 479·1 | 233·6 | 593 | 533·0 | 259·9 |
| 354 | 318·2 | 155·2 | 414 | 372·1 | 181·5 | 474 | 426·0 | 207·8 | 534 | 480·0 | 234·1 | 594 | 533·9 | 260·4 |
| 355 | 319·1 | 155·6 | 415 | 373·0 | 181·9 | 475 | 426·9 | 208·2 | 535 | 480·9 | 234·5 | 595 | 534·8 | 260·8 |
| 356 | 320·0 | 156·1 | 416 | 373·9 | 182·4 | 476 | 427·8 | 208·7 | 536 | 481·8 | 235·0 | 596 | 535·7 | 261·3 |
| 357 | 320·9 | 156·5 | 417 | 374·8 | 182·8 | 477 | 428·7 | 209·1 | 537 | 482·7 | 235·4 | 597 | 536·6 | 261·7 |
| 358 | 321·8 | 156·9 | 418 | 375·7 | 183·2 | 478 | 429·6 | 209·5 | 538 | 483·6 | 235·8 | 598 | 537·5 | 262·1 |
| 359 | 322·7 | 157·4 | 419 | 376·6 | 183·7 | 479 | 430·5 | 210·0 | 539 | 484·5 | 236·3 | 599 | 538·4 | 262·6 |
| 360 | 323·6 | 157·8 | 420 | 377·5 | 184·1 | 480 | 431·4 | 210·4 | 540 | 485·3 | 236·7 | 600 | 539·3 | 263·0 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

64° 4h 16m

## TRAVERSE TABLE TO DEGREES

27° 1h 48m

| Dist. | D.Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0·9 | 0·5 | 61 | 54·4 | 27·7 | 121 | 107·8 | 54·9 | 181 | 161·3 | 82·2 | 241 | 214·7 | 109·4 |
| 2 | 1·8 | 0·9 | 62 | 55·2 | 28·1 | 122 | 108·7 | 55·4 | 182 | 162·2 | 82·6 | 242 | 215·6 | 109·9 |
| 3 | 2·7 | 1·4 | 63 | 56·1 | 28·6 | 123 | 109·6 | 55·8 | 183 | 163·1 | 83·1 | 243 | 216·5 | 110·3 |
| 4 | 3·6 | 1·8 | 64 | 57·0 | 29·1 | 124 | 110·5 | 56·3 | 184 | 163·9 | 83·5 | 244 | 217·4 | 110·8 |
| 5 | 4·5 | 2·3 | 65 | 57·9 | 29·5 | 125 | 111·4 | 56·7 | 185 | 164·8 | 84·0 | 245 | 218·3 | 111·2 |
| 6 | 5·3 | 2·7 | 66 | 58·8 | 30·0 | 126 | 112·3 | 57·2 | 186 | 165·7 | 84·4 | 246 | 219·2 | 111·7 |
| 7 | 6·2 | 3·2 | 67 | 59·7 | 30·4 | 127 | 113·2 | 57·7 | 187 | 166·6 | 84·9 | 247 | 220·1 | 112·1 |
| 8 | 7·1 | 3·6 | 68 | 60·6 | 30·9 | 128 | 114·0 | 58·1 | 188 | 167·5 | 85·4 | 248 | 221·0 | 112·6 |
| 9 | 8·0 | 4·1 | 69 | 61·5 | 31·3 | 129 | 114·9 | 58·6 | 189 | 168·4 | 85·8 | 249 | 221·9 | 113·0 |
| 10 | 8·9 | 4·5 | 70 | 62·4 | 31·8 | 130 | 115·8 | 59·0 | 190 | 169·3 | 86·3 | 250 | 222·8 | 113·5 |
| 11 | 9·8 | 5·0 | 71 | 63·3 | 32·2 | 131 | 116·7 | 59·5 | 191 | 170·2 | 86·7 | 251 | 223·6 | 114·0 |
| 12 | 10·7 | 5·4 | 72 | 64·2 | 32·7 | 132 | 117·6 | 59·9 | 192 | 171·1 | 87·2 | 252 | 224·5 | 114·4 |
| 13 | 11·6 | 5·9 | 73 | 65·0 | 33·1 | 133 | 118·5 | 60·4 | 193 | 172·0 | 87·6 | 253 | 225·4 | 114·9 |
| 14 | 12·5 | 6·4 | 74 | 65·9 | 33·6 | 134 | 119·4 | 60·8 | 194 | 172·9 | 88·1 | 254 | 226·3 | 115·3 |
| 15 | 13·4 | 6·8 | 75 | 66·8 | 34·0 | 135 | 120·3 | 61·3 | 195 | 173·7 | 88·5 | 255 | 227·2 | 115·8 |
| 16 | 14·3 | 7·3 | 76 | 67·7 | 34·5 | 136 | 121·2 | 61·7 | 196 | 174·6 | 89·0 | 256 | 228·1 | 116·2 |
| 17 | 15·1 | 7·7 | 77 | 68·6 | 35·0 | 137 | 122·1 | 62·2 | 197 | 175·5 | 89·4 | 257 | 229·0 | 116·7 |
| 18 | 16·0 | 8·2 | 78 | 69·5 | 35·4 | 138 | 123·0 | 62·7 | 198 | 176·4 | 89·9 | 258 | 229·9 | 117·1 |
| 19 | 16·9 | 8·6 | 79 | 70·4 | 35·9 | 139 | 123·8 | 63·1 | 199 | 177·3 | 90·3 | 259 | 230·8 | 117·6 |
| 20 | 17·8 | 9·1 | 80 | 71·3 | 36·3 | 140 | 124·7 | 63·6 | 200 | 178·2 | 90·8 | 260 | 231·7 | 118·0 |
| 21 | 18·7 | 9·5 | 81 | 72·2 | 36·8 | 141 | 125·6 | 64·0 | 201 | 179·1 | 91·3 | 261 | 232·6 | 118·5 |
| 22 | 19·6 | 10·0 | 82 | 73·1 | 37·2 | 142 | 126·5 | 64·5 | 202 | 180·0 | 91·7 | 262 | 233·4 | 118·9 |
| 23 | 20·5 | 10·4 | 83 | 74·0 | 37·7 | 143 | 127·4 | 64·9 | 203 | 180·9 | 92·2 | 263 | 234·3 | 119·4 |
| 24 | 21·4 | 10·9 | 84 | 74·8 | 38·1 | 144 | 128·3 | 65·4 | 204 | 181·8 | 92·6 | 264 | 235·2 | 119·9 |
| 25 | 22·3 | 11·3 | 85 | 75·7 | 38·6 | 145 | 129·2 | 65·8 | 205 | 182·7 | 93·1 | 265 | 236·1 | 120·3 |
| 26 | 23·2 | 11·8 | 86 | 76·6 | 39·0 | 146 | 130·1 | 66·3 | 206 | 183·5 | 93·5 | 266 | 237·0 | 120·8 |
| 27 | 24·1 | 12·3 | 87 | 77·5 | 39·5 | 147 | 131·0 | 66·7 | 207 | 184·4 | 94·0 | 267 | 237·9 | 121·2 |
| 28 | 24·9 | 12·7 | 88 | 78·4 | 40·0 | 148 | 131·9 | 67·2 | 208 | 185·3 | 94·4 | 268 | 238·8 | 121·7 |
| 29 | 25·8 | 13·2 | 89 | 79·3 | 40·4 | 149 | 132·8 | 67·6 | 209 | 186·2 | 94·9 | 269 | 239·7 | 122·1 |
| 30 | 26·7 | 13·6 | 90 | 80·2 | 40·9 | 150 | 133·7 | 68·1 | 210 | 187·1 | 95·3 | 270 | 240 6 | 122·6 |
| 31 | 27·6 | 14·1 | 91 | 81·1 | 41·3 | 151 | 134·5 | 68·6 | 211 | 188·0 | 95·8 | 271 | 241·5 | 123·0 |
| 32 | 28·5 | 14·5 | 92 | 82·0 | 41·8 | 152 | 135·4 | 69·0 | 212 | 188·9 | 96·2 | 272 | 242·4 | 123·5 |
| 33 | 29·4 | 15·0 | 93 | 82·9 | 42·2 | 153 | 136·3 | 69·5 | 213 | 189·8 | 96·7 | 273 | 243·2 | 123·9 |
| 34 | 30·3 | 15·4 | 94 | 83·8 | 42·7 | 154 | 137·2 | 69·9 | 214 | 190·7 | 97·2 | 274 | 244·1 | 124·4 |
| 35 | 31·2 | 15·9 | 95 | 84·6 | 43·1 | 155 | 138·1 | 70·4 | 215 | 191·6 | 97·6 | 275 | 245·0 | 124·8 |
| 36 | 32·1 | 16·3 | 96 | 85·5 | 43·6 | 156 | 139·0 | 70·8 | 216 | 192·5 | 98·1 | 276 | 245·9 | 125·3 |
| 37 | 33·0 | 16·8 | 97 | 86·4 | 44·0 | 157 | 139·9 | 71·3 | 217 | 193·3 | 98·5 | 277 | 246·8 | 125·8 |
| 38 | 33·9 | 17·3 | 98 | 87·3 | 44·5 | 158 | 140·8 | 71·7 | 218 | 194·2 | 99·0 | 278 | 247·7 | 126·2 |
| 39 | 34·7 | 17·7 | 99 | 88·2 | 44·9 | 159 | 141·7 | 72·2 | 219 | 195·1 | 99·4 | 279 | 248·6 | 126·7 |
| 40 | 35·6 | 18·2 | 100 | 89·1 | 45·4 | 160 | 142·6 | 72·6 | 220 | 196·0 | 99·9 | 280 | 249·5 | 127·1 |
| 41 | 36·5 | 18·6 | 101 | 90·0 | 45·9 | 161 | 143·5 | 73·1 | 221 | 196·9 | 100·3 | 281 | 250·4 | 127·6 |
| 42 | 37·4 | 19·1 | 102 | 90·9 | 46·3 | 162 | 144·3 | 73·5 | 222 | 197·8 | 100·8 | 282 | 251·3 | 128·0 |
| 43 | 38·3 | 19·5 | 103 | 91·8 | 46·8 | 163 | 145·2 | 74·0 | 223 | 198·7 | 101·2 | 283 | 252·2 | 128·5 |
| 44 | 39·2 | 20·0 | 104 | 92·7 | 47·2 | 164 | 146·1 | 74·5 | 224 | 199·6 | 101·7 | 284 | 253·0 | 128·9 |
| 45 | 40·1 | 20·4 | 105 | 93·6 | 47·7 | 165 | 147·0 | 74·9 | 225 | 200·5 | 102·1 | 285 | 253·9 | 129·4 |
| 46 | 41·0 | 20·9 | 106 | 94·4 | 48·1 | 166 | 147·9 | 75·4 | 226 | 201·4 | 102·6 | 286 | 254·8 | 129·8 |
| 47 | 41·9 | 21·3 | 107 | 95·3 | 48·6 | 167 | 148·8 | 75·8 | 227 | 202·3 | 103·1 | 287 | 255·7 | 130·3 |
| 48 | 42·8 | 21·8 | 108 | 96·2 | 49·0 | 168 | 149·7 | 76·3 | 228 | 203·1 | 103·5 | 288 | 256·6 | 130·7 |
| 49 | 43·7 | 22·2 | 109 | 97·1 | 49·5 | 169 | 150·6 | 76·7 | 229 | 204·0 | 104·0 | 289 | 257·5 | 131·2 |
| 50 | 44·6 | 22·7 | 110 | 98·0 | 49·9 | 170 | 151·5 | 77·2 | 230 | 204·9 | 104·4 | 290 | 258·4 | 131·7 |
| 51 | 45·4 | 23·2 | 111 | 98·9 | 50·4 | 171 | 152·4 | 77·6 | 231 | 205·8 | 104·9 | 291 | 259·3 | 132·1 |
| 52 | 46·3 | 23·6 | 112 | 99·8 | 50·8 | 172 | 153·3 | 78·1 | 232 | 206·7 | 105·3 | 292 | 260·2 | 132·6 |
| 53 | 47·2 | 24·1 | 113 | 100·7 | 51·3 | 173 | 154·1 | 78·5 | 233 | 207·6 | 105·8 | 293 | 261·1 | 133·0 |
| 54 | 48·1 | 24·5 | 114 | 101·6 | 51·8 | 174 | 155·0 | 79·0 | 234 | 208·5 | 106·2 | 294 | 262·0 | 133·5 |
| 55 | 49·0 | 25·0 | 115 | 102·5 | 52·2 | 175 | 155·9 | 79·4 | 235 | 209·4 | 106·7 | 295 | 262·8 | 133·9 |
| 56 | 49·9 | 25·4 | 116 | 103 4 | 52·7 | 176 | 156·8 | 79·9 | 236 | 210·3 | 107·1 | 296 | 263·7 | 134·4 |
| 57 | 50·8 | 25·9 | 117 | 104·2 | 53·1 | 177 | 157·7 | 80·4 | 237 | 211·2 | 107·6 | 297 | 264·6 | 134·8 |
| 58 | 51·7 | 26·3 | 118 | 105·1 | 53·6 | 178 | 158·6 | 80·8 | 238 | 212·1 | 108·0 | 298 | 265·5 | 135·3 |
| 59 | 52·6 | 26·8 | 119 | 106·0 | 54·0 | 179 | 159·5 | 81·3 | 239 | 213·0 | 108·5 | 299 | 266·4 | 135·7 |
| 60 | 53·5 | 27·2 | 120 | 106·9 | 54·5 | 180 | 160·4 | 81·7 | 240 | 213·8 | 109·0 | 300 | 267·3 | 136·2 |
| Dist. | Dep. | D.Lat. | Dist. | Dep. | D.Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

63° 4h 12m

## TRAVERSE TABLE TO DEGREES

27° — 1h 48m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 268·2 | 136·7 | 361 | 321·7 | 163·9 | 421 | 375·1 | 191·1 | 481 | 428·6 | 218·3 | 541 | 482·0 | 245·6 |
| 302 | 269·1 | 137·1 | 362 | 322·5 | 164·4 | 422 | 376·0 | 191·6 | 482 | 429·4 | 218·8 | 542 | 482·9 | 246·1 |
| 303 | 270·0 | 137·6 | 363 | 323·4 | 164·8 | 423 | 376·9 | 192·0 | 483 | 430·3 | 219·2 | 543 | 483·8 | 246·5 |
| 304 | 270·9 | 138·0 | 364 | 324·3 | 165·3 | 424 | 377·8 | 192·5 | 484 | 431·2 | 219·7 | 544 | 484·7 | 247·0 |
| 305 | 271·8 | 138·5 | 365 | 325·2 | 165·7 | 425 | 378·7 | 193·0 | 485 | 432·1 | 220·1 | 545 | 485·6 | 247·4 |
| 306 | 272·7 | 138·9 | 366 | 326·1 | 166·2 | 426 | 379·6 | 193·4 | 486 | 433·0 | 220·6 | 546 | 486·4 | 247·9 |
| 307 | 273·5 | 139·4 | 367 | 327·0 | 166·6 | 427 | 380·5 | 193·9 | 487 | 433·9 | 221·1 | 547 | 487·3 | 248·4 |
| 308 | 274·4 | 139·8 | 368 | 327·9 | 167·1 | 428 | 381·4 | 194·3 | 488 | 434·8 | 221·5 | 548 | 488·2 | 248·8 |
| 309 | 275·3 | 140·3 | 369 | 328·8 | 167·5 | 429 | 382·2 | 194·8 | 489 | 435·7 | 222·0 | 549 | 489·1 | 249·2 |
| 310 | 276·2 | 140·7 | 370 | 329·7 | 168·0 | 430 | 383·1 | 195·2 | 490 | 436·6 | 222·4 | 550 | 490·0 | 249·7 |
| 311 | 277·1 | 141·2 | 371 | 330·6 | 168·4 | 431 | 384·0 | 195·7 | 491 | 437·5 | 222·9 | 551 | 490·9 | 250·1 |
| 312 | 278·0 | 141·7 | 372 | 331·5 | 168·9 | 432 | 384·9 | 196·1 | 492 | 438·3 | 223·3 | 552 | 491·8 | 250·6 |
| 313 | 278·9 | 142·1 | 373 | 332·3 | 169·3 | 433 | 385·8 | 196·6 | 493 | 439·2 | 223·8 | 553 | 492·7 | 251·0 |
| 314 | 279·8 | 142·6 | 374 | 333·2 | 169·8 | 434 | 386·7 | 197·0 | 494 | 440·1 | 224·2 | 554 | 493·6 | 251·5 |
| 315 | 280·7 | 143·0 | 375 | 334·1 | 170·3 | 435 | 387·6 | 197·5 | 495 | 441·0 | 224·7 | 555 | 494·5 | 252·0 |
| 316 | 281·6 | 143·5 | 376 | 335·0 | 170·7 | 436 | 388·5 | 197·9 | 496 | 441·9 | 225·2 | 556 | 495·4 | 252·4 |
| 317 | 282·5 | 143·9 | 377 | 335·9 | 171·2 | 437 | 389·4 | 198·4 | 497 | 442·8 | 225·6 | 557 | 496·3 | 252·9 |
| 318 | 283·3 | 144·4 | 378 | 336·8 | 171·6 | 438 | 390·3 | 198·9 | 498 | 443·7 | 226·1 | 558 | 497·2 | 253·3 |
| 319 | 284·2 | 144·8 | 379 | 337·7 | 172·1 | 439 | 391·2 | 199·3 | 499 | 444·6 | 226·5 | 559 | 498·1 | 253·8 |
| 320 | 285·1 | 145·3 | 380 | 338·6 | 172·5 | 440 | 392·0 | 199·8 | 500 | 445·5 | 227·0 | 560 | 499·0 | 254·2 |
| 321 | 286·0 | 145·7 | 381 | 339·5 | 173·0 | 441 | 392·9 | 200·2 | 501 | 446·4 | 227·5 | 561 | 499·8 | 254·7 |
| 322 | 286·9 | 146·2 | 382 | 340·4 | 173·4 | 442 | 393·8 | 200·7 | 502 | 447·3 | 227·9 | 562 | 500·7 | 255·1 |
| 323 | 287·8 | 146·6 | 383 | 341·3 | 173·9 | 443 | 394·7 | 201·1 | 503 | 448·2 | 228·4 | 563 | 501·6 | 255·6 |
| 324 | 288·7 | 147·1 | 384 | 342·1 | 174·3 | 444 | 395·6 | 201·6 | 504 | 449·0 | 228·8 | 564 | 502·5 | 256·0 |
| 325 | 289·6 | 147·6 | 385 | 343·0 | 174·8 | 445 | 396·5 | 202·0 | 505 | 449·9 | 229·3 | 565 | 503·4 | 256·5 |
| 326 | 290·5 | 148·0 | 386 | 343·9 | 175·2 | 446 | 397·4 | 202·5 | 506 | 450·8 | 229·8 | 566 | 504·3 | 257·0 |
| 327 | 291·4 | 148·5 | 387 | 344·8 | 175·7 | 447 | 398·3 | 202·9 | 507 | 451·7 | 230·2 | 567 | 505·2 | 257·4 |
| 328 | 292·3 | 148·9 | 388 | 345·7 | 176·2 | 448 | 399·2 | 203·4 | 508 | 452·6 | 230·6 | 568 | 506·1 | 257·9 |
| 329 | 293·2 | 149·4 | 389 | 346·6 | 176·6 | 449 | 400·1 | 203·8 | 509 | 453·5 | 231·0 | 569 | 507·0 | 258·3 |
| 330 | 294·0 | 149·8 | 390 | 347·5 | 177·1 | 450 | 401·0 | 204·3 | 510 | 454·4 | 231·5 | 570 | 507·9 | 258·8 |
| 331 | 294·9 | 150·3 | 391 | 348·4 | 177·5 | 451 | 401·8 | 204·7 | 511 | 455·3 | 231·9 | 571 | 508·7 | 259·2 |
| 332 | 295·8 | 150·7 | 392 | 349·3 | 178·0 | 452 | 402·7 | 205·2 | 512 | 456·2 | 232·4 | 572 | 509·6 | 259·7 |
| 333 | 296·7 | 151·2 | 393 | 350·2 | 178·4 | 453 | 403·6 | 205·7 | 513 | 457·1 | 232·9 | 573 | 510·5 | 260·1 |
| 334 | 297·6 | 151·6 | 394 | 351·1 | 178·9 | 454 | 404·5 | 206·1 | 514 | 458·0 | 233·3 | 574 | 511·4 | 260·6 |
| 335 | 298·5 | 152·1 | 395 | 352·0 | 179·3 | 455 | 405·4 | 206·6 | 515 | 458·8 | 233·8 | 575 | 512·3 | 261·1 |
| 336 | 299·4 | 152·5 | 396 | 352·8 | 179·8 | 456 | 406·3 | 207·0 | 516 | 459·7 | 234·2 | 576 | 513·2 | 261·5 |
| 337 | 300·3 | 153·0 | 397 | 353·7 | 180·2 | 457 | 407·2 | 207·5 | 517 | 460·6 | 234·7 | 577 | 514·1 | 262·0 |
| 338 | 301·2 | 153·5 | 398 | 354·6 | 180·7 | 458 | 408·1 | 207·9 | 518 | 461·5 | 235·2 | 578 | 515·0 | 262·4 |
| 339 | 302·1 | 153·9 | 399 | 355·5 | 181·2 | 459 | 409·0 | 208·4 | 519 | 462·4 | 235·7 | 579 | 515·9 | 262·9 |
| 340 | 302·9 | 154·4 | 400 | 356·4 | 181·6 | 460 | 409·9 | 208·8 | 520 | 463·3 | 236·1 | 580 | 516·8 | 263·4 |
| 341 | 303·8 | 154·8 | 401 | 357·3 | 182·1 | 461 | 410·8 | 209·3 | 521 | 464·2 | 236·6 | 581 | 517·7 | 263·8 |
| 342 | 304·7 | 155·3 | 402 | 358·2 | 182·5 | 462 | 411·6 | 209·8 | 522 | 465·1 | 237·0 | 582 | 518·5 | 264·3 |
| 343 | 305·6 | 155·7 | 403 | 359·1 | 183·0 | 463 | 412·5 | 210·2 | 523 | 466·0 | 237·5 | 583 | 519·4 | 264·7 |
| 344 | 306·5 | 156·2 | 404 | 360·0 | 183·4 | 464 | 413·4 | 210·7 | 524 | 466·9 | 237·9 | 584 | 520·3 | 265·2 |
| 345 | 307·4 | 156·6 | 405 | 360·9 | 183·9 | 465 | 414·3 | 211·1 | 525 | 467·8 | 238·4 | 585 | 521·2 | 265·6 |
| 346 | 308·3 | 157·1 | 406 | 361·8 | 184·3 | 466 | 415·2 | 211·6 | 526 | 468·7 | 238·8 | 586 | 522·1 | 266·0 |
| 347 | 309·2 | 157·5 | 407 | 362·6 | 184·8 | 467 | 416·1 | 212·0 | 527 | 469·5 | 239·3 | 587 | 523·0 | 266·5 |
| 348 | 310·1 | 158·0 | 408 | 363·5 | 185·2 | 468 | 417·0 | 212·5 | 528 | 470·4 | 239·7 | 588 | 523·9 | 267·0 |
| 349 | 311·0 | 158·5 | 409 | 364·4 | 185·7 | 469 | 417·9 | 212·9 | 529 | 471·3 | 240·2 | 589 | 524·8 | 267·4 |
| 350 | 311·9 | 158·9 | 410 | 365·3 | 186·1 | 470 | 418·8 | 213·4 | 530 | 472·2 | 240·6 | 590 | 525·7 | 267·9 |
| 351 | 312·7 | 159·4 | 411 | 366·2 | 186·6 | 471 | 419·7 | 213·8 | 531 | 473·1 | 241·1 | 591 | 526·6 | 268·3 |
| 352 | 313·6 | 159·8 | 412 | 367·1 | 187·1 | 472 | 420·6 | 214·3 | 532 | 474·0 | 241·5 | 592 | 527·5 | 268·8 |
| 353 | 314·5 | 160·3 | 413 | 368·0 | 187·5 | 473 | 421·4 | 214·7 | 533 | 474·9 | 242·0 | 593 | 528·4 | 269·2 |
| 354 | 315·4 | 160·7 | 414 | 368·9 | 188·0 | 474 | 422·3 | 215·2 | 534 | 475·8 | 242·4 | 594 | 529·3 | 269·7 |
| 355 | 316·3 | 161·2 | 415 | 369·8 | 188·4 | 475 | 423·2 | 215·7 | 535 | 476·7 | 242·9 | 595 | 530·1 | 270·1 |
| 356 | 317·2 | 161·6 | 416 | 370·7 | 188·9 | 476 | 424·1 | 216·1 | 536 | 477·6 | 243·4 | 596 | 531·0 | 270·6 |
| 357 | 318·1 | 162·1 | 417 | 371·6 | 189·3 | 477 | 425·0 | 216·6 | 537 | 478·4 | 243·8 | 597 | 531·9 | 271·1 |
| 358 | 319·0 | 162·5 | 418 | 372·4 | 189·8 | 478 | 425·9 | 217·0 | 538 | 479·3 | 244·3 | 598 | 532·8 | 271·5 |
| 359 | 319·9 | 163·0 | 419 | 373·3 | 190·2 | 479 | 426·8 | 217·5 | 539 | 480·2 | 244·7 | 599 | 533·7 | 272·0 |
| 360 | 320·8 | 163·4 | 420 | 374·2 | 190·7 | 480 | 427·7 | 217·9 | 540 | 481·1 | 245·2 | 600 | 534·6 | 272·4 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

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## TRAVERSE TABLE TO DEGREES

28° 1h 52m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0·9 | 0·5 | 61 | 53·9 | 28·6 | 121 | 106·8 | 56·8 | 181 | 159·8 | 85·0 | 241 | 212·8 | 113·1 |
| 2 | 1·8 | 0·9 | 62 | 54·7 | 29·1 | 122 | 107·7 | 57·3 | 182 | 160·7 | 85·4 | 242 | 213·7 | 113·6 |
| 3 | 2·6 | 1·4 | 63 | 55·6 | 29·6 | 123 | 108·6 | 57·7 | 183 | 161·6 | 85·9 | 243 | 214·6 | 114·1 |
| 4 | 3·5 | 1·9 | 64 | 56·5 | 30·0 | 124 | 109·5 | 58·2 | 184 | 162·5 | 86·4 | 244 | 215·4 | 114·6 |
| 5 | 4·4 | 2·3 | 65 | 57·4 | 30·5 | 125 | 110·4 | 58·7 | 185 | 163·3 | 86·9 | 245 | 216·3 | 115·0 |
| 6 | 5·3 | 2·8 | 66 | 58·3 | 31·0 | 126 | 111·3 | 59·2 | 186 | 164·2 | 87·3 | 246 | 217·2 | 115·5 |
| 7 | 6·2 | 3·3 | 67 | 59·2 | 31·5 | 127 | 112·1 | 59·6 | 187 | 165·1 | 87·8 | 247 | 218·1 | 116·0 |
| 8 | 7·1 | 3·8 | 68 | 60·0 | 31·9 | 128 | 113·0 | 60·1 | 188 | 166·0 | 88·3 | 248 | 219·0 | 116·4 |
| 9 | 7·9 | 4·2 | 69 | 60·9 | 32·4 | 129 | 113·9 | 60·6 | 189 | 166·9 | 88·7 | 249 | 219·9 | 116·9 |
| 10 | 8·8 | 4·7 | 70 | 61·8 | 32·9 | 130 | 114·8 | 61·0 | 190 | 167·8 | 89·2 | 250 | 220·7 | 117·4 |
| 11 | 9·7 | 5·2 | 71 | 62·7 | 33·3 | 131 | 115·7 | 61·5 | 191 | 168·6 | 89·7 | 251 | 221·6 | 117·8 |
| 12 | 10·6 | 5·6 | 72 | 63·6 | 33·8 | 132 | 116·5 | 62·0 | 192 | 169·5 | 90·1 | 252 | 222·5 | 118·3 |
| 13 | 11·5 | 6·1 | 73 | 64·5 | 34·3 | 133 | 117·4 | 62·4 | 193 | 170·4 | 90·6 | 253 | 223·4 | 118·8 |
| 14 | 12·4 | 6·6 | 74 | 65·3 | 34·7 | 134 | 118·3 | 62·9 | 194 | 171·3 | 91·1 | 254 | 224·3 | 119·2 |
| 15 | 13·2 | 7·0 | 75 | 66·2 | 35·2 | 135 | 119·2 | 63·4 | 195 | 172·2 | 91·5 | 255 | 225·2 | 119·7 |
| 16 | 14·1 | 7·5 | 76 | 67·1 | 35·7 | 136 | 120·1 | 63·8 | 196 | 173·1 | 92·0 | 256 | 226·0 | 120·2 |
| 17 | 15·0 | 8·0 | 77 | 68·0 | 36·1 | 137 | 121·0 | 64·3 | 197 | 173·9 | 92·5 | 257 | 226·9 | 120·7 |
| 18 | 15·9 | 8·5 | 78 | 68·9 | 36·6 | 138 | 121·8 | 64·8 | 198 | 174·8 | 93·0 | 258 | 227·8 | 121·1 |
| 19 | 16·8 | 8·9 | 79 | 69·8 | 37·1 | 139 | 122·7 | 65·3 | 199 | 175·7 | 93·4 | 259 | 228·7 | 121·6 |
| 20 | 17·7 | 9·4 | 80 | 70·6 | 37·6 | 140 | 123·6 | 65·7 | 200 | 176·6 | 93·9 | 260 | 229·6 | 122·1 |
| 21 | 18·5 | 9·9 | 81 | 71·5 | 38·0 | 141 | 124·5 | 66·2 | 201 | 177·5 | 94·4 | 261 | 230·4 | 122·5 |
| 22 | 19·4 | 10·3 | 82 | 72·4 | 38·5 | 142 | 125·4 | 66·7 | 202 | 178·4 | 94·8 | 262 | 231·3 | 123·0 |
| 23 | 20·3 | 10·8 | 83 | 73·3 | 39·0 | 143 | 126·3 | 67·1 | 203 | 179·2 | 95·3 | 263 | 232·2 | 123·5 |
| 24 | 21·2 | 11·3 | 84 | 74·2 | 39·4 | 144 | 127·1 | 67·6 | 204 | 180·1 | 95·8 | 264 | 233·1 | 123·9 |
| 25 | 22·1 | 11·7 | 85 | 75·1 | 39·9 | 145 | 128·0 | 68·1 | 205 | 181·0 | 96·2 | 265 | 234·0 | 124·4 |
| 26 | 23·0 | 12·2 | 86 | 75·9 | 40·4 | 146 | 128·9 | 68·5 | 206 | 181·9 | 96·7 | 266 | 234·9 | 124·9 |
| 27 | 23·8 | 12·7 | 87 | 76·8 | 40·8 | 147 | 129·8 | 69·0 | 207 | 182·8 | 97·2 | 267 | 235·7 | 125·3 |
| 28 | 24·7 | 13·1 | 88 | 77·7 | 41·3 | 148 | 130·7 | 69·5 | 208 | 183·7 | 97·7 | 268 | 236·6 | 125·8 |
| 29 | 25·6 | 13·6 | 89 | 78·6 | 41·8 | 149 | 131·6 | 70·0 | 209 | 184·5 | 98·1 | 269 | 237·5 | 126·3 |
| 30 | 26·5 | 14·1 | 90 | 79·5 | 42·3 | 150 | 132·4 | 70·4 | 210 | 185·4 | 98·6 | 270 | 238·4 | 126·8 |
| 31 | 27·4 | 14·6 | 91 | 80·3 | 42·7 | 151 | 133·3 | 70·9 | 211 | 186·3 | 99·1 | 271 | 239·3 | 127·2 |
| 32 | 28·3 | 15·0 | 92 | 81·2 | 43·2 | 152 | 134·2 | 71·4 | 212 | 187·2 | 99·5 | 272 | 240·2 | 127·7 |
| 33 | 29·1 | 15·5 | 93 | 82·1 | 43·7 | 153 | 135·1 | 71·8 | 213 | 188·1 | 100·0 | 273 | 241·0 | 128·2 |
| 34 | 30·0 | 16·0 | 94 | 83·0 | 44·1 | 154 | 136·0 | 72·3 | 214 | 189·0 | 100·5 | 274 | 241·9 | 128·6 |
| 35 | 30·9 | 16·4 | 95 | 83·9 | 44·6 | 155 | 136·9 | 72·8 | 215 | 189·8 | 100·9 | 275 | 242·8 | 129·1 |
| 36 | 31·8 | 16·9 | 96 | 84·8 | 45·1 | 156 | 137·7 | 73·2 | 216 | 190·7 | 101·4 | 276 | 243·7 | 129·6 |
| 37 | 32·7 | 17·4 | 97 | 85·6 | 45·5 | 157 | 138·6 | 73·7 | 217 | 191·6 | 101·9 | 277 | 244·6 | 130·0 |
| 38 | 33·6 | 17·8 | 98 | 86·5 | 46·0 | 158 | 139·5 | 74·2 | 218 | 192·5 | 102·3 | 278 | 245·5 | 130·5 |
| 39 | 34·4 | 18·3 | 99 | 87·4 | 46·5 | 159 | 140·4 | 74·6 | 219 | 193·4 | 102·8 | 279 | 246·3 | 131·0 |
| 40 | 35·3 | 18·8 | 100 | 88·3 | 46·9 | 160 | 141·3 | 75·1 | 220 | 194·2 | 103·3 | 280 | 247·2 | 131·5 |
| 41 | 36·2 | 19·2 | 101 | 89·2 | 47·4 | 161 | 142·2 | 75·6 | 221 | 195·1 | 103·8 | 281 | 248·1 | 131·9 |
| 42 | 37·1 | 19·7 | 102 | 90·1 | 47·9 | 162 | 143·0 | 76·1 | 222 | 196·0 | 104·2 | 282 | 249·0 | 132·4 |
| 43 | 38·0 | 20·2 | 103 | 90·9 | 48·4 | 163 | 143·9 | 76·5 | 223 | 196·9 | 104·7 | 283 | 249·9 | 132·9 |
| 44 | 38·8 | 20·7 | 104 | 91·8 | 48·8 | 164 | 144·8 | 77·0 | 224 | 197·8 | 105·2 | 284 | 250·8 | 133·3 |
| 45 | 39·7 | 21·1 | 105 | 92·7 | 49·3 | 165 | 145·7 | 77·5 | 225 | 198·7 | 105·6 | 285 | 251·6 | 133·8 |
| 46 | 40·6 | 21·6 | 106 | 93·6 | 49·8 | 166 | 146·6 | 77·9 | 226 | 199·5 | 106·1 | 286 | 252·5 | 134·3 |
| 47 | 41·5 | 22·1 | 107 | 94·5 | 50·2 | 167 | 147·5 | 78·4 | 227 | 200·4 | 106·6 | 287 | 253·4 | 134·7 |
| 48 | 42·4 | 22·5 | 108 | 95·4 | 50·7 | 168 | 148·3 | 78·9 | 228 | 201·3 | 107·0 | 288 | 254·3 | 135·2 |
| 49 | 43·3 | 23·0 | 109 | 96·2 | 51·2 | 169 | 149·2 | 79·3 | 229 | 202·2 | 107·5 | 289 | 255·2 | 135·7 |
| 50 | 44·1 | 23·5 | 110 | 97·1 | 51·6 | 170 | 150·1 | 79·8 | 230 | 203·1 | 108·0 | 290 | 256·1 | 136·1 |
| 51 | 45·0 | 23·9 | 111 | 98·0 | 52·1 | 171 | 151·0 | 80·3 | 231 | 204·0 | 108·4 | 291 | 256·9 | 136·6 |
| 52 | 45·9 | 24·4 | 112 | 98·9 | 52·6 | 172 | 151·9 | 80·7 | 232 | 204·8 | 108·9 | 292 | 257·8 | 137·1 |
| 53 | 46·8 | 24·9 | 113 | 99·8 | 53·1 | 173 | 152·7 | 81·2 | 233 | 205·7 | 109·4 | 293 | 258·7 | 137·6 |
| 54 | 47·7 | 25·4 | 114 | 100·7 | 53·5 | 174 | 153·6 | 81·7 | 234 | 206·6 | 109·9 | 294 | 259·6 | 138·0 |
| 55 | 48·6 | 25·8 | 115 | 101·5 | 54·0 | 175 | 154·5 | 82·2 | 235 | 207·5 | 110·3 | 295 | 260·5 | 138·5 |
| 56 | 49·4 | 26·3 | 116 | 102·4 | 54·5 | 176 | 155·4 | 82·6 | 236 | 208·4 | 110·8 | 296 | 261·3 | 139·0 |
| 57 | 50·3 | 26·8 | 117 | 103·3 | 54·9 | 177 | 156·3 | 83·1 | 237 | 209·3 | 111·3 | 297 | 262·2 | 139·4 |
| 58 | 51·2 | 27·2 | 118 | 104·2 | 55·4 | 178 | 157·2 | 83·6 | 238 | 210·1 | 111·7 | 298 | 263·1 | 139·9 |
| 59 | 52·1 | 27·7 | 119 | 105·1 | 55·9 | 179 | 158·0 | 84·0 | 239 | 211·0 | 112·2 | 299 | 264·0 | 140·4 |
| 60 | 53·0 | 28·2 | 120 | 106·0 | 56·3 | 180 | 158·9 | 84·5 | 240 | 211·9 | 112·7 | 300 | 264·9 | 140·8 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

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## TRAVERSE TABLE TO DEGREES

28° $1^h\ 52^m$

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 265.7 | 141.3 | 361 | 318.7 | 169.5 | 421 | 371.7 | 197.7 | 481 | 424.7 | 225.8 | 541 | 477.7 | 254.0 |
| 302 | 266.6 | 141.8 | 362 | 319.6 | 170.0 | 422 | 372.6 | 198.1 | 482 | 425.6 | 226.3 | 542 | 478.6 | 254.5 |
| 303 | 267.5 | 142.3 | 363 | 320.5 | 170.4 | 423 | 373.5 | 198.6 | 483 | 426.5 | 226.8 | 543 | 479.4 | 255.0 |
| 304 | 268.4 | 142.7 | 364 | 321.4 | 170.9 | 424 | 374.3 | 199.1 | 484 | 427.4 | 227.3 | 544 | 480.3 | 255.5 |
| 305 | 269.3 | 143.2 | 365 | 322.2 | 171.4 | 425 | 375.2 | 199.5 | 485 | 428.3 | 227.7 | 545 | 481.1 | 255.9 |
| 306 | 270.2 | 143.7 | 366 | 323.1 | 171.8 | 426 | 376.1 | 200.0 | 486 | 429.2 | 228.2 | 546 | 482.0 | 256.4 |
| 307 | 271.0 | 144.1 | 367 | 324.0 | 172.3 | 427 | 377.0 | 200.5 | 487 | 430.1 | 228.6 | 547 | 482.9 | 256.9 |
| 308 | 271.9 | 144.6 | 368 | 324.9 | 172.8 | 428 | 377.9 | 200.9 | 488 | 430.9 | 229.1 | 548 | 483.8 | 257.3 |
| 309 | 272.8 | 145.1 | 369 | 325.8 | 173.2 | 429 | 378.8 | 201.4 | 489 | 431.8 | 229.6 | 549 | 484.7 | 257.8 |
| 310 | 273.7 | 145.5 | 370 | 326.7 | 173.7 | 430 | 379.6 | 201.9 | 490 | 432.6 | 230.0 | 550 | 485.6 | 258.2 |
| 311 | 274.6 | 146.0 | 371 | 327.5 | 174.2 | 431 | 380.5 | 202.3 | 491 | 433.5 | 230.5 | 551 | 486.5 | 258.7 |
| 312 | 275.5 | 146.5 | 372 | 328.4 | 174.6 | 432 | 381.4 | 202.8 | 492 | 434.4 | 231.0 | 552 | 487.4 | 259.1 |
| 313 | 276.3 | 146.9 | 373 | 329.3 | 175.1 | 433 | 382.3 | 203.3 | 493 | 435.3 | 231.4 | 553 | 488.3 | 259.6 |
| 314 | 277.2 | 147.4 | 374 | 330.2 | 175.6 | 434 | 383.2 | 203.8 | 494 | 436.2 | 231.9 | 554 | 489.2 | 260.1 |
| 315 | 278.1 | 147.9 | 375 | 331.1 | 176.1 | 435 | 384.1 | 204.2 | 495 | 437.1 | 232.4 | 555 | 490.1 | 260.6 |
| 316 | 279.0 | 148.4 | 376 | 332.0 | 176.5 | 436 | 384.9 | 204.7 | 496 | 437.9 | 232.9 | 556 | 490.9 | 261.0 |
| 317 | 279.9 | 148.8 | 377 | 332.8 | 177.0 | 437 | 385.8 | 205.2 | 497 | 438.8 | 233.4 | 557 | 491.8 | 261.5 |
| 318 | 280.7 | 149.3 | 378 | 333.7 | 177.5 | 438 | 386.7 | 205.6 | 498 | 439.7 | 233.8 | 558 | 492.7 | 262.0 |
| 319 | 281.6 | 149.8 | 379 | 334.6 | 177.9 | 439 | 387.6 | 206.1 | 499 | 440.6 | 234.3 | 559 | 493.5 | 262.5 |
| 320 | 282.5 | 150.2 | 380 | 335.5 | 178.4 | 440 | 388.5 | 206.6 | 500 | 441.5 | 234.7 | 560 | 494.4 | 262.9 |
| 321 | 283.4 | 150.7 | 381 | 336.4 | 178.9 | 441 | 389.4 | 207.0 | 501 | 442.3 | 235.2 | 561 | 495.3 | 263.4 |
| 322 | 284.3 | 151.2 | 382 | 337.3 | 179.3 | 442 | 390.2 | 207.5 | 502 | 443.2 | 235.6 | 562 | 496.2 | 263.8 |
| 323 | 285.2 | 151.6 | 383 | 338.1 | 179.8 | 443 | 391.1 | 208.0 | 503 | 444.1 | 236.1 | 563 | 497.1 | 264.3 |
| 324 | 286.0 | 152.1 | 384 | 339.0 | 180.3 | 444 | 392.0 | 208.4 | 504 | 445.0 | 236.6 | 564 | 498.0 | 264.7 |
| 325 | 286.9 | 152.6 | 385 | 339.9 | 180.8 | 445 | 392.9 | 208.9 | 505 | 445.9 | 237.1 | 565 | 498.9 | 265.2 |
| 326 | 287.8 | 153.1 | 386 | 340.8 | 181.2 | 446 | 393.8 | 209.4 | 506 | 446.8 | 237.5 | 566 | 499.8 | 265.7 |
| 327 | 288.7 | 153.5 | 387 | 341.7 | 181.7 | 447 | 394.6 | 209.9 | 507 | 447.6 | 238.0 | 567 | 500.7 | 266.2 |
| 328 | 289.6 | 154.0 | 388 | 342.6 | 182.2 | 448 | 395.5 | 210.3 | 508 | 448.5 | 238.5 | 568 | 501.6 | 266.6 |
| 329 | 290.5 | 154.5 | 389 | 343.4 | 182.6 | 449 | 396.4 | 210.8 | 509 | 449.4 | 239.0 | 569 | 502.4 | 267.1 |
| 330 | 291.3 | 154.9 | 390 | 344.3 | 183.1 | 450 | 397.3 | 211.3 | 510 | 450.3 | 239.4 | 570 | 503.3 | 267.6 |
| 331 | 292.2 | 155.4 | 391 | 345.2 | 183.6 | 451 | 398.2 | 211.7 | 511 | 451.2 | 239.9 | 571 | 504.2 | 268.0 |
| 332 | 293.1 | 155.9 | 392 | 346.1 | 184.0 | 452 | 399.1 | 212.2 | 512 | 452.1 | 240.4 | 572 | 505.1 | 268.5 |
| 333 | 294.0 | 156.3 | 393 | 347.0 | 184.5 | 453 | 399.9 | 212.7 | 513 | 452.9 | 240.8 | 573 | 505.9 | 269.0 |
| 334 | 294.9 | 156.8 | 394 | 347.9 | 185.0 | 454 | 400.8 | 213.1 | 514 | 453.8 | 241.3 | 574 | 506.8 | 269.4 |
| 335 | 295.8 | 157.3 | 395 | 348.7 | 185.4 | 455 | 401.7 | 213.6 | 515 | 454.7 | 241.8 | 575 | 507.7 | 269.9 |
| 336 | 296.6 | 157.7 | 396 | 349.6 | 185.9 | 456 | 402.6 | 214.1 | 516 | 455.6 | 242.2 | 576 | 508.6 | 270.4 |
| 337 | 297.5 | 158.2 | 397 | 350.5 | 186.4 | 457 | 403.5 | 214.6 | 517 | 456.4 | 242.7 | 577 | 509.4 | 270.9 |
| 338 | 298.4 | 158.7 | 398 | 351.4 | 186.9 | 458 | 404.4 | 215.0 | 518 | 457.3 | 243.2 | 578 | 510.3 | 271.3 |
| 339 | 299.3 | 159.2 | 399 | 352.3 | 187.3 | 459 | 405.2 | 215.5 | 519 | 458.2 | 243.7 | 579 | 511.2 | 271.8 |
| 340 | 300.2 | 159.6 | 400 | 353.1 | 187.8 | 460 | 406.1 | 216.0 | 520 | 459.1 | 244.1 | 580 | 512.1 | 272.3 |
| 341 | 301.0 | 160.1 | 401 | 354.0 | 188.3 | 461 | 407.0 | 216.4 | 521 | 460.0 | 244.6 | 581 | 513.0 | 272.7 |
| 342 | 301.9 | 160.6 | 402 | 354.9 | 188.7 | 462 | 407.9 | 216.9 | 522 | 460.9 | 245.0 | 582 | 513.9 | 273.2 |
| 343 | 302.8 | 161.0 | 403 | 355.8 | 189.2 | 463 | 408.8 | 217.4 | 523 | 461.8 | 245.5 | 583 | 514.8 | 273.7 |
| 344 | 303.7 | 161.5 | 404 | 356.7 | 189.7 | 464 | 409.7 | 217.8 | 524 | 462.7 | 246.0 | 584 | 515.7 | 274.2 |
| 345 | 304.6 | 162.0 | 405 | 357.6 | 190.1 | 465 | 410.5 | 218.3 | 525 | 463.5 | 246.5 | 585 | 516.5 | 274.7 |
| 346 | 305.5 | 162.4 | 406 | 358.4 | 190.6 | 466 | 411.4 | 218.8 | 526 | 464.4 | 246.9 | 586 | 517.4 | 275.1 |
| 347 | 306.4 | 162.9 | 407 | 359.3 | 191.1 | 467 | 412.3 | 219.2 | 527 | 465.3 | 247.4 | 587 | 518.3 | 275.5 |
| 348 | 307.2 | 163.4 | 408 | 360.2 | 191.5 | 468 | 413.2 | 219.7 | 528 | 466.2 | 247.9 | 588 | 519.2 | 276.0 |
| 349 | 308.1 | 163.8 | 409 | 361.1 | 192.0 | 469 | 414.1 | 220.2 | 529 | 467.1 | 248.3 | 589 | 520.1 | 276.5 |
| 350 | 309.0 | 164.3 | 410 | 362.0 | 192.5 | 470 | 415.0 | 220.7 | 530 | 468.0 | 248.8 | 590 | 521.0 | 277.0 |
| 351 | 309.9 | 164.8 | 411 | 362.9 | 193.0 | 471 | 415.8 | 221.1 | 531 | 468.9 | 249.3 | 591 | 521.8 | 277.4 |
| 352 | 310.8 | 165.3 | 412 | 363.7 | 193.4 | 472 | 416.7 | 221.6 | 532 | 469.8 | 249.8 | 592 | 522.6 | 277.9 |
| 353 | 311.7 | 165.7 | 413 | 364.6 | 193.9 | 473 | 417.6 | 222.1 | 533 | 470.7 | 250.2 | 593 | 523.5 | 278.4 |
| 354 | 312.5 | 166.2 | 414 | 365.5 | 194.4 | 474 | 418.5 | 222.5 | 534 | 471.5 | 250.7 | 594 | 524.4 | 278.8 |
| 355 | 313.4 | 166.7 | 415 | 366.4 | 194.8 | 475 | 419.4 | 223.0 | 535 | 472.4 | 251.1 | 595 | 525.3 | 279.3 |
| 356 | 314.3 | 167.1 | 416 | 367.3 | 195.3 | 476 | 420.3 | 223.5 | 536 | 473.3 | 251.6 | 596 | 526.2 | 279.8 |
| 357 | 315.2 | 167.6 | 417 | 368.2 | 195.8 | 477 | 421.1 | 223.9 | 537 | 474.2 | 252.1 | 597 | 527.1 | 280.3 |
| 358 | 316.1 | 168.1 | 418 | 369.0 | 196.2 | 478 | 422.0 | 224.4 | 538 | 475.1 | 252.6 | 598 | 528.0 | 280.8 |
| 359 | 316.9 | 168.5 | 419 | 369.9 | 196.7 | 479 | 422.9 | 224.9 | 539 | 476.0 | 253.1 | 599 | 528.9 | 281.3 |
| 360 | 317.8 | 169.0 | 420 | 370.8 | 197.2 | 480 | 423.8 | 225.3 | 540 | 476.8 | 253.6 | 600 | 529.8 | 281.7 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

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## TRAVERSE TABLE TO DEGREES

29° 1h 56m

| Dist. | D.Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.9 | 0.5 | 61 | 53.4 | 29.6 | 121 | 105.8 | 58.7 | 181 | 158.3 | 87.8 | 241 | 210.8 | 116.8 |
| 2 | 1.7 | 1.0 | 62 | 54.2 | 30.1 | 122 | 106.7 | 59.1 | 182 | 159.2 | 88.2 | 242 | 211.7 | 117.3 |
| 3 | 2.6 | 1.5 | 63 | 55.1 | 30.5 | 123 | 107.6 | 59.6 | 183 | 160.1 | 88.7 | 243 | 212.5 | 117.8 |
| 4 | 3.5 | 1.9 | 64 | 56.0 | 31.0 | 124 | 108.5 | 60.1 | 184 | 160.9 | 89.2 | 244 | 213.4 | 118.3 |
| 5 | 4.4 | 2.4 | 65 | 56.9 | 31.5 | 125 | 109.3 | 60.6 | 185 | 161.8 | 89.7 | 245 | 214.3 | 118.8 |
| 6 | 5.2 | 2.9 | 66 | 57.7 | 32.0 | 126 | 110.2 | 61.1 | 186 | 162.7 | 90.2 | 246 | 215.2 | 119.3 |
| 7 | 6.1 | 3.4 | 67 | 58.6 | 32.5 | 127 | 111.1 | 61.6 | 187 | 163.6 | 90.7 | 247 | 216.0 | 119.7 |
| 8 | 7.0 | 3.9 | 68 | 59.5 | 33.0 | 128 | 112.0 | 62.1 | 188 | 164.4 | 91.1 | 248 | 216.9 | 120.2 |
| 9 | 7.9 | 4.4 | 69 | 60.3 | 33.5 | 129 | 112.8 | 62.5 | 189 | 165.3 | 91.6 | 249 | 217.8 | 120.7 |
| 10 | 8.7 | 4.8 | 70 | 61.2 | 33.9 | 130 | 113.7 | 63.0 | 190 | 166.2 | 92.1 | 250 | 218.7 | 121.2 |
| 11 | 9.6 | 5.3 | 71 | 62.1 | 34.4 | 131 | 114.6 | 63.5 | 191 | 167.1 | 92.6 | 251 | 219.5 | 121.7 |
| 12 | 10.5 | 5.8 | 72 | 63.0 | 34.9 | 132 | 115.4 | 64.0 | 192 | 167.9 | 93.1 | 252 | 220.4 | 122.2 |
| 13 | 11.4 | 6.3 | 73 | 63.8 | 35.4 | 133 | 116.3 | 64.5 | 193 | 168.8 | 93.6 | 253 | 221.3 | 122.7 |
| 14 | 12.2 | 6.8 | 74 | 64.7 | 35.9 | 134 | 117.2 | 65.0 | 194 | 169.7 | 94.1 | 254 | 222.2 | 123.1 |
| 15 | 13.1 | 7.3 | 75 | 65.6 | 36.4 | 135 | 118.1 | 65.4 | 195 | 170.6 | 94.5 | 255 | 223.0 | 123.6 |
| 16 | 14.0 | 7.8 | 76 | 66.5 | 36.8 | 136 | 118.9 | 65.9 | 196 | 171.4 | 95.0 | 256 | 223.9 | 124.1 |
| 17 | 14.9 | 8.2 | 77 | 67.3 | 37.3 | 137 | 119.8 | 66.4 | 197 | 172.3 | 95.5 | 257 | 224.8 | 124.6 |
| 18 | 15.7 | 8.7 | 78 | 68.2 | 37.8 | 138 | 120.7 | 66.9 | 198 | 173.2 | 96.0 | 258 | 225.7 | 125.1 |
| 19 | 16.6 | 9.2 | 79 | 69.1 | 38.3 | 139 | 121.6 | 67.4 | 199 | 174.0 | 96.5 | 259 | 226.5 | 125.6 |
| 20 | 17.5 | 9.7 | 80 | 70.0 | 38.8 | 140 | 122.4 | 67.9 | 200 | 174.9 | 97.0 | 260 | 227.4 | 126.1 |
| 21 | 18.4 | 10.2 | 81 | 70.8 | 39.3 | 141 | 123.3 | 68.4 | 201 | 175.8 | 97.4 | 261 | 228.3 | 126.5 |
| 22 | 19.2 | 10.7 | 82 | 71.7 | 39.8 | 142 | 124.2 | 68.8 | 202 | 176.7 | 97.9 | 262 | 229.2 | 127.0 |
| 23 | 20.1 | 11.2 | 83 | 72.6 | 40.2 | 143 | 125.1 | 69.3 | 203 | 177.5 | 98.4 | 263 | 230.0 | 127.5 |
| 24 | 21.0 | 11.6 | 84 | 73.5 | 40.7 | 144 | 125.9 | 69.8 | 204 | 178.4 | 98.9 | 264 | 230.9 | 128.0 |
| 25 | 21.9 | 12.1 | 85 | 74.3 | 41.2 | 145 | 126.8 | 70.3 | 205 | 179.3 | 99.4 | 265 | 231.8 | 128.5 |
| 26 | 22.7 | 12.6 | 86 | 75.2 | 41.7 | 146 | 127.7 | 70.8 | 206 | 180.2 | 99.9 | 266 | 232.6 | 129.0 |
| 27 | 23.6 | 13.1 | 87 | 76.1 | 42.2 | 147 | 128.6 | 71.3 | 207 | 181.0 | 100.4 | 267 | 233.5 | 129.4 |
| 28 | 24.5 | 13.6 | 88 | 77.0 | 42.7 | 148 | 129.4 | 71.8 | 208 | 181.9 | 100.8 | 268 | 234.4 | 129.9 |
| 29 | 25.4 | 14.1 | 89 | 77.8 | 43.1 | 149 | 130.3 | 72.2 | 209 | 182.8 | 101.3 | 269 | 235.3 | 130.4 |
| 30 | 26.2 | 14.5 | 90 | 78.7 | 43.6 | 150 | 131.2 | 72.7 | 210 | 183.7 | 101.8 | 270 | 236.1 | 130.9 |
| 31 | 27.1 | 15.0 | 91 | 79.6 | 44.1 | 151 | 132.1 | 73.2 | 211 | 184.5 | 102.3 | 271 | 237.0 | 131.4 |
| 32 | 28.0 | 15.5 | 92 | 80.5 | 44.6 | 152 | 132.9 | 73.7 | 212 | 185.4 | 102.8 | 272 | 237.9 | 131.9 |
| 33 | 28.9 | 16.0 | 93 | 81.3 | 45.1 | 153 | 133.8 | 74.2 | 213 | 186.3 | 103.3 | 273 | 238.8 | 132.4 |
| 34 | 29.7 | 16.5 | 94 | 82.2 | 45.6 | 154 | 134.7 | 74.7 | 214 | 187.2 | 103.7 | 274 | 239.6 | 132.8 |
| 35 | 30.6 | 17.0 | 95 | 83.1 | 46.1 | 155 | 135.6 | 75.1 | 215 | 188.0 | 104.2 | 275 | 240.5 | 133.3 |
| 36 | 31.5 | 17.5 | 96 | 84.0 | 46.5 | 156 | 136.4 | 75.6 | 216 | 188.9 | 104.7 | 276 | 241.4 | 133.8 |
| 37 | 32.4 | 17.9 | 97 | 84.8 | 47.0 | 157 | 137.3 | 76.1 | 217 | 189.8 | 105.2 | 277 | 242.3 | 134.3 |
| 38 | 33.2 | 18.4 | 98 | 85.7 | 47.5 | 158 | 138.2 | 76.6 | 218 | 190.7 | 105.7 | 278 | 243.1 | 134.8 |
| 39 | 34.1 | 18.9 | 99 | 86.6 | 48.0 | 159 | 139.1 | 77.1 | 219 | 191.5 | 106.2 | 279 | 244.0 | 135.3 |
| 40 | 35.0 | 19.4 | 100 | 87.5 | 48.5 | 160 | 139.9 | 77.6 | 220 | 192.4 | 106.7 | 280 | 244.9 | 135.7 |
| 41 | 35.9 | 19.9 | 101 | 88.3 | 49.0 | 161 | 140.8 | 78.1 | 221 | 193.3 | 107.1 | 281 | 245.8 | 136.2 |
| 42 | 36.7 | 20.4 | 102 | 89.2 | 49.5 | 162 | 141.7 | 78.5 | 222 | 194.2 | 107.6 | 282 | 246.6 | 136.7 |
| 43 | 37.6 | 20.8 | 103 | 90.1 | 49.9 | 163 | 142.6 | 79.0 | 223 | 195.0 | 108.1 | 283 | 247.5 | 137.2 |
| 44 | 38.5 | 21.3 | 104 | 91.0 | 50.4 | 164 | 143.4 | 79.5 | 224 | 195.9 | 108.6 | 284 | 248.4 | 137.7 |
| 45 | 39.4 | 21.8 | 105 | 91.8 | 50.9 | 165 | 144.3 | 80.0 | 225 | 196.8 | 109.1 | 285 | 249.3 | 138.2 |
| 46 | 40.2 | 22.3 | 106 | 92.7 | 51.4 | 166 | 145.2 | 80.5 | 226 | 197.7 | 109.6 | 286 | 250.1 | 138.7 |
| 47 | 41.1 | 22.8 | 107 | 93.6 | 51.9 | 167 | 146.1 | 81.0 | 227 | 198.5 | 110.1 | 287 | 251.0 | 139.1 |
| 48 | 42.0 | 23.3 | 108 | 94.5 | 52.4 | 168 | 146.9 | 81.4 | 228 | 199.4 | 110.5 | 288 | 251.9 | 139.6 |
| 49 | 42.9 | 23.8 | 109 | 95.3 | 52.8 | 169 | 147.8 | 81.9 | 229 | 200.3 | 111.0 | 289 | 252.8 | 140.1 |
| 50 | 43.7 | 24.2 | 110 | 96.2 | 53.3 | 170 | 148.7 | 82.4 | 230 | 201.2 | 111.5 | 290 | 253.6 | 140.6 |
| 51 | 44.6 | 24.7 | 111 | 97.1 | 53.8 | 171 | 149.6 | 82.9 | 231 | 202.0 | 112.0 | 291 | 254.5 | 141.1 |
| 52 | 45.5 | 25.2 | 112 | 98.0 | 54.3 | 172 | 150.4 | 83.4 | 232 | 202.9 | 112.5 | 292 | 255.4 | 141.6 |
| 53 | 46.4 | 25.7 | 113 | 98.8 | 54.8 | 173 | 151.3 | 83.9 | 233 | 203.8 | 113.0 | 293 | 256.3 | 142.0 |
| 54 | 47.2 | 26.2 | 114 | 99.7 | 55.3 | 174 | 152.2 | 84.4 | 234 | 204.7 | 113.4 | 294 | 257.1 | 142.5 |
| 55 | 48.1 | 26.7 | 115 | 100.6 | 55.8 | 175 | 153.1 | 84.8 | 235 | 205.5 | 113.9 | 295 | 258.0 | 143.0 |
| 56 | 49.0 | 27.1 | 116 | 101.5 | 56.2 | 176 | 153.9 | 85.3 | 236 | 206.4 | 114.4 | 296 | 258.9 | 143.5 |
| 57 | 49.9 | 27.6 | 117 | 102.3 | 56.7 | 177 | 154.8 | 85.8 | 237 | 207.3 | 114.9 | 297 | 259.8 | 144.0 |
| 58 | 50.7 | 28.1 | 118 | 103.2 | 57.2 | 178 | 155.7 | 86.3 | 238 | 208.2 | 115.4 | 298 | 260.6 | 144.5 |
| 59 | 51.6 | 28.6 | 119 | 104.1 | 57.7 | 179 | 156.6 | 86.8 | 239 | 209.0 | 115.9 | 299 | 261.5 | 145.0 |
| 60 | 52.5 | 29.1 | 120 | 105.0 | 58.2 | 180 | 157.4 | 87.3 | 240 | 209.9 | 116.4 | 300 | 262.4 | 145.4 |
| Dist. | Dep. | D.Lat. | Dist. | Dep. | D.Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

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## TRAVERSE TABLE TO DEGREES

29° 1h 56m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 263·2 | 145·9 | 361 | 315·7 | 175·0 | 421 | 368·2 | 204·1 | 481 | 420·7 | 233·2 | 541 | 473·2 | 262·3 |
| 302 | 264·1 | 146·4 | 362 | 316·6 | 175·5 | 422 | 369·1 | 204·6 | 482 | 421·5 | 233·7 | 542 | 474·0 | 262·8 |
| 303 | 265·0 | 146·9 | 363 | 317·5 | 176·0 | 423 | 369·9 | 205·1 | 483 | 422·4 | 234·2 | 543 | 474·9 | 263·2 |
| 304 | 265·9 | 147·4 | 364 | 318·3 | 176·5 | 424 | 370·8 | 205·6 | 484 | 423·3 | 234·6 | 544 | 475·8 | 263·7 |
| 305 | 266·7 | 147·9 | 365 | 319·2 | 177·0 | 425 | 371·7 | 206·0 | 485 | 424·2 | 235·1 | 545 | 476·6 | 264·2 |
| 306 | 267·6 | 148·4 | 366 | 320·1 | 177·4 | 426 | 372·6 | 206·5 | 486 | 425·0 | 235·6 | 546 | 477·5 | 264·7 |
| 307 | 268·5 | 148·8 | 367 | 321·0 | 177·9 | 427 | 373·4 | 207·0 | 487 | 425·9 | 236·1 | 547 | 478·4 | 265·2 |
| 308 | 269·4 | 149·3 | 368 | 321·8 | 178·4 | 428 | 374·3 | 207·5 | 488 | 426·8 | 236·6 | 548 | 479·3 | 265·7 |
| 309 | 270·2 | 149·8 | 369 | 322·7 | 178·9 | 429 | 375·2 | 208·0 | 489 | 427·7 | 237·1 | 549 | 480·1 | 266·2 |
| 310 | 271·1 | 150·3 | 370 | 323·6 | 179·4 | 430 | 376·1 | 208·5 | 490 | 428·5 | 237·6 | 550 | 481·0 | 266·6 |
| 311 | 272·0 | 150·8 | 371 | 324·5 | 179·9 | 431 | 376·9 | 209·0 | 491 | 429·4 | 238·0 | 551 | 481·9 | 267·1 |
| 312 | 272·9 | 151·3 | 372 | 325·3 | 180·4 | 432 | 377·8 | 209·4 | 492 | 430·3 | 238·5 | 552 | 482·8 | 267·6 |
| 313 | 273·7 | 151·7 | 373 | 326·2 | 180·8 | 433 | 378·7 | 209·9 | 493 | 431·2 | 239·0 | 553 | 483·6 | 268·1 |
| 314 | 274·6 | 152·2 | 374 | 327·1 | 181·3 | 434 | 379·6 | 210·4 | 494 | 432·0 | 239·5 | 554 | 484·5 | 268·6 |
| 315 | 275·5 | 152·7 | 375 | 328·0 | 181·8 | 435 | 380·4 | 210·9 | 495 | 432·9 | 240·0 | 555 | 485·4 | 269·1 |
| 316 | 276·3 | 153·2 | 376 | 328·8 | 182·3 | 436 | 381·3 | 211·4 | 496 | 433·8 | 240·5 | 556 | 486·3 | 269·5 |
| 317 | 277·2 | 153·7 | 377 | 329·7 | 182·8 | 437 | 382·2 | 211·9 | 497 | 434·7 | 240·9 | 557 | 487·1 | 270·0 |
| 318 | 278·1 | 154·2 | 378 | 330·6 | 183·3 | 438 | 383·1 | 212·3 | 498 | 435·5 | 241·4 | 558 | 488·0 | 270·5 |
| 319 | 279·0 | 154·7 | 379 | 331·4 | 183·7 | 439 | 383·9 | 212·8 | 499 | 436·4 | 241·9 | 559 | 488·9 | 271·0 |
| 320 | 279·8 | 155·1 | 380 | 332·3 | 184·2 | 440 | 384·8 | 213·3 | 500 | 437·3 | 242·4 | 560 | 489·8 | 271·5 |
| 321 | 280·7 | 155·6 | 381 | 333·2 | 184·7 | 441 | 385·7 | 213·8 | 501 | 438·2 | 242·9 | 561 | 490·6 | 272·0 |
| 322 | 281·6 | 156·1 | 382 | 334·1 | 185·2 | 442 | 386·6 | 214·3 | 502 | 439·0 | 243·4 | 562 | 491·5 | 272·5 |
| 323 | 282·5 | 156·6 | 383 | 334·9 | 185·7 | 443 | 387·4 | 214·8 | 503 | 439·9 | 243·9 | 563 | 492·4 | 272·9 |
| 324 | 283·3 | 157·1 | 384 | 335·8 | 186·2 | 444 | 388·3 | 215·3 | 504 | 440·8 | 244·3 | 564 | 493·2 | 273·4 |
| 325 | 284·2 | 157·6 | 385 | 336·7 | 186·7 | 445 | 389·2 | 215·7 | 505 | 441·6 | 244·8 | 565 | 494·1 | 273·9 |
| 326 | 285·1 | 158·1 | 386 | 337·6 | 187·1 | 446 | 390·0 | 216·2 | 506 | 442·5 | 245·3 | 566 | 495·0 | 274·4 |
| 327 | 286·0 | 158·5 | 387 | 338·4 | 187·6 | 447 | 390·9 | 216·7 | 507 | 443·4 | 245·8 | 567 | 495·9 | 274·9 |
| 328 | 286·8 | 159·0 | 388 | 339·3 | 188·1 | 448 | 391·8 | 217·2 | 508 | 444·3 | 246·3 | 568 | 496·8 | 275·4 |
| 329 | 287·7 | 159·5 | 389 | 340·2 | 188·6 | 449 | 392·7 | 217·7 | 509 | 445·2 | 246·8 | 569 | 497·7 | 275·9 |
| 330 | 288·6 | 160·0 | 390 | 341·1 | 189·1 | 450 | 393·5 | 218·2 | 510 | 446·1 | 247·3 | 570 | 498·5 | 276·3 |
| 331 | 289·5 | 160·5 | 391 | 341·9 | 189·6 | 451 | 394·4 | 218·7 | 511 | 447·0 | 247·8 | 571 | 499·4 | 276·8 |
| 332 | 290·3 | 161·0 | 392 | 342·8 | 190·0 | 452 | 395·3 | 219·1 | 512 | 447·8 | 248·2 | 572 | 500·3 | 277·3 |
| 333 | 291·2 | 161·4 | 393 | 343·7 | 190·5 | 453 | 396·2 | 219·6 | 513 | 448·6 | 248·7 | 573 | 501·1 | 277·8 |
| 334 | 292·1 | 161·9 | 394 | 344·6 | 191·0 | 454 | 397·0 | 220·1 | 514 | 449·5 | 249·2 | 574 | 502·0 | 278·3 |
| 335 | 293·0 | 162·4 | 395 | 345·4 | 191·5 | 455 | 397·9 | 220·6 | 515 | 450·4 | 249·7 | 575 | 502·9 | 278·8 |
| 336 | 293·8 | 162·9 | 396 | 346·3 | 192·0 | 456 | 398·8 | 221·1 | 516 | 451·3 | 250·2 | 576 | 503·7 | 279·2 |
| 337 | 294·7 | 163·4 | 397 | 347·2 | 192·5 | 457 | 399·7 | 221·6 | 517 | 452·2 | 250·6 | 577 | 504·6 | 279·7 |
| 338 | 295·6 | 163·9 | 398 | 348·1 | 193·0 | 458 | 400·5 | 222·0 | 518 | 453·1 | 251·1 | 578 | 505·5 | 280·2 |
| 339 | 296·5 | 164·4 | 399 | 348·9 | 193·4 | 459 | 401·4 | 222·5 | 519 | 453·9 | 251·6 | 579 | 506·4 | 280·7 |
| 340 | 297·3 | 164·8 | 400 | 349·8 | 193·9 | 460 | 402·3 | 223·0 | 520 | 454·8 | 252·1 | 580 | 507·2 | 281·2 |
| 341 | 298·2 | 165·3 | 401 | 350·7 | 194·4 | 461 | 403·2 | 223·5 | 521 | 455·6 | 252·6 | 581 | 508·1 | 281·7 |
| 342 | 299·1 | 165·8 | 402 | 351·6 | 194·9 | 462 | 404·0 | 224·0 | 522 | 456·5 | 253·1 | 582 | 509·0 | 282·2 |
| 343 | 300·0 | 166·3 | 403 | 352·4 | 195·4 | 463 | 404·9 | 224·5 | 523 | 457·4 | 253·6 | 583 | 509·9 | 282·7 |
| 344 | 300·8 | 166·8 | 404 | 353·3 | 195·9 | 464 | 405·8 | 225·0 | 524 | 458·3 | 254·0 | 584 | 510·7 | 283·2 |
| 345 | 301·7 | 167·3 | 405 | 354·2 | 196·3 | 465 | 406·7 | 225·4 | 525 | 459·1 | 254·5 | 585 | 511·6 | 283·6 |
| 346 | 302·6 | 167·7 | 406 | 355·1 | 196·8 | 466 | 407·5 | 225·9 | 526 | 460·0 | 255·0 | 586 | 512·5 | 284·1 |
| 347 | 303·5 | 168·2 | 407 | 355·9 | 197·3 | 467 | 408·4 | 226·4 | 527 | 460·9 | 255·5 | 587 | 513·4 | 284·6 |
| 348 | 304·3 | 168·7 | 408 | 356·8 | 197·8 | 468 | 409·3 | 226·9 | 528 | 461·8 | 256·0 | 588 | 514·3 | 285·0 |
| 349 | 305·2 | 169·2 | 409 | 357·7 | 198·3 | 469 | 410·2 | 227·4 | 529 | 462·6 | 256·5 | 589 | 515·1 | 285·5 |
| 350 | 306·1 | 169·7 | 410 | 358·6 | 198·8 | 470 | 411·0 | 227·9 | 530 | 463·5 | 256·9 | 590 | 516·0 | 286·0 |
| 351 | 307·0 | 170·2 | 411 | 359·4 | 199·3 | 471 | 411·9 | 228·3 | 531 | 464·4 | 257·4 | 591 | 516·9 | 286·5 |
| 352 | 307·8 | 170·7 | 412 | 360·3 | 199·7 | 472 | 412·8 | 228·8 | 532 | 465·3 | 257·9 | 592 | 517·7 | 287·0 |
| 353 | 308·7 | 171·1 | 413 | 361·2 | 200·2 | 473 | 413·7 | 229·3 | 533 | 466·1 | 258·4 | 593 | 518·6 | 287·5 |
| 354 | 309·6 | 171·6 | 414 | 362·1 | 200·7 | 474 | 414·5 | 229·8 | 534 | 467·0 | 258·9 | 594 | 519·5 | 288·0 |
| 355 | 310·5 | 172·1 | 415 | 362·9 | 201·2 | 475 | 415·4 | 230·3 | 535 | 467·9 | 259·4 | 595 | 520·4 | 288·5 |
| 356 | 311·3 | 172·6 | 416 | 363·8 | 201·7 | 476 | 416·3 | 230·8 | 536 | 468·8 | 259·9 | 596 | 521·2 | 288·9 |
| 357 | 312·2 | 173·1 | 417 | 364·7 | 202·2 | 477 | 417·2 | 231·3 | 537 | 469·6 | 260·3 | 597 | 522·1 | 289·4 |
| 358 | 313·1 | 173·6 | 418 | 365·6 | 202·7 | 478 | 418·0 | 231·7 | 538 | 470·5 | 260·8 | 598 | 523·0 | 289·9 |
| 359 | 314·0 | 174·0 | 419 | 366·4 | 203·1 | 479 | 418·9 | 232·2 | 539 | 471·4 | 261·3 | 599 | 523·9 | 290·4 |
| 360 | 314·8 | 174·5 | 420 | 367·3 | 203·6 | 480 | 419·8 | 232·7 | 540 | 472·3 | 261·8 | 600 | 524·8 | 290·9 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

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## TRAVERSE TABLE TO DEGREES

30° — $2^h\ 0^m$

| Dist. | D.Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.9 | 0.5 | 61 | 52.8 | 30.5 | 121 | 104.8 | 60.5 | 181 | 156.8 | 90.5 | 241 | 208.7 | 120.5 |
| 2 | 1.7 | 1.0 | 62 | 53.7 | 31.0 | 122 | 105.7 | 61.0 | 182 | 157.6 | 91.0 | 242 | 209.6 | 121.0 |
| 3 | 2.6 | 1.5 | 63 | 54.6 | 31.5 | 123 | 106.5 | 61.5 | 183 | 158.5 | 91.5 | 243 | 210.4 | 121.5 |
| 4 | 3.5 | 2.0 | 64 | 55.4 | 32.0 | 124 | 107.4 | 62.0 | 184 | 159.3 | 92.0 | 244 | 211.3 | 122.0 |
| 5 | 4.3 | 2.5 | 65 | 56.3 | 32.5 | 125 | 108.3 | 62.5 | 185 | 160.2 | 92.5 | 245 | 212.2 | 122.5 |
| 6 | 5.2 | 3.0 | 66 | 57.2 | 33.0 | 126 | 109.1 | 63.0 | 186 | 161.1 | 93.0 | 246 | 213.0 | 123.0 |
| 7 | 6.1 | 3.5 | 67 | 58.0 | 33.5 | 127 | 110.0 | 63.5 | 187 | 161.9 | 93.5 | 247 | 213.9 | 123.5 |
| 8 | 6.9 | 4.0 | 68 | 58.9 | 34.0 | 128 | 110.9 | 64.0 | 188 | 162.8 | 94.0 | 248 | 214.8 | 124.0 |
| 9 | 7.8 | 4.5 | 69 | 59.8 | 34.5 | 129 | 111.7 | 64.5 | 189 | 163.7 | 94.5 | 249 | 215.6 | 124.5 |
| 10 | 8.7 | 5.0 | 70 | 60.6 | 35.0 | 130 | 112.6 | 65.0 | 190 | 164.5 | 95.0 | 250 | 216.5 | 125.0 |
| 11 | 9.5 | 5.5 | 71 | 61.5 | 35.5 | 131 | 113.4 | 65.5 | 191 | 165.4 | 95.5 | 251 | 217.4 | 125.5 |
| 12 | 10.4 | 6.0 | 72 | 62.4 | 36.0 | 132 | 114.3 | 66.0 | 192 | 166.3 | 96.0 | 252 | 218.2 | 126.0 |
| 13 | 11.3 | 6.5 | 73 | 63.2 | 36.5 | 133 | 115.2 | 66.5 | 193 | 167.1 | 96.5 | 253 | 219.1 | 126.5 |
| 14 | 12.1 | 7.0 | 74 | 64.1 | 37.0 | 134 | 116.0 | 67.0 | 194 | 168.0 | 97.0 | 254 | 220.0 | 127.0 |
| 15 | 13.0 | 7.5 | 75 | 65.0 | 37.5 | 135 | 116.9 | 67.5 | 195 | 168.9 | 97.5 | 255 | 220.8 | 127.5 |
| 16 | 13.9 | 8.0 | 76 | 65.8 | 38.0 | 136 | 117.8 | 68.0 | 196 | 169.7 | 98.0 | 256 | 221.7 | 128.0 |
| 17 | 14.7 | 8.5 | 77 | 66.7 | 38.5 | 137 | 118.6 | 68.5 | 197 | 170.6 | 98.5 | 257 | 222.6 | 128.5 |
| 18 | 15.6 | 9.0 | 78 | 67.5 | 39.0 | 138 | 119.5 | 69.0 | 198 | 171.5 | 99.0 | 258 | 223.4 | 129.0 |
| 19 | 16.5 | 9.5 | 79 | 68.4 | 39.5 | 139 | 120.4 | 69.5 | 199 | 172.3 | 99.5 | 259 | 224.3 | 129.5 |
| 20 | 17.3 | 10.0 | 80 | 69.3 | 40.0 | 140 | 121.2 | 70.0 | 200 | 173.2 | 100.0 | 260 | 225.2 | 130.0 |
| 21 | 18.2 | 10.5 | 81 | 70.1 | 40.5 | 141 | 122.1 | 70.5 | 201 | 174.1 | 100.5 | 261 | 226.0 | 130.5 |
| 22 | 19.1 | 11.0 | 82 | 71.0 | 41.0 | 142 | 123.0 | 71.0 | 202 | 174.9 | 101.0 | 262 | 226.9 | 131.0 |
| 23 | 19.9 | 11.5 | 83 | 71.9 | 41.5 | 143 | 123.8 | 71.5 | 203 | 175.8 | 101.5 | 263 | 227.8 | 131.5 |
| 24 | 20.8 | 12.0 | 84 | 72.7 | 42.0 | 144 | 124.7 | 72.0 | 204 | 176.7 | 102.0 | 264 | 228.6 | 132.0 |
| 25 | 21.7 | 12.5 | 85 | 73.6 | 42.5 | 145 | 125.6 | 72.5 | 205 | 177.5 | 102.5 | 265 | 229.5 | 132.5 |
| 26 | 22.5 | 13.0 | 86 | 74.5 | 43.0 | 146 | 126.4 | 73.0 | 206 | 178.4 | 103.0 | 266 | 230.4 | 133.0 |
| 27 | 23.4 | 13.5 | 87 | 75.3 | 43.5 | 147 | 127.3 | 73.5 | 207 | 179.3 | 103.5 | 267 | 231.2 | 133.5 |
| 28 | 24.2 | 14.0 | 88 | 76.2 | 44.0 | 148 | 128.2 | 74.0 | 208 | 180.1 | 104.0 | 268 | 232.1 | 134.0 |
| 29 | 25.1 | 14.5 | 89 | 77.1 | 44.5 | 149 | 129.0 | 74.5 | 209 | 181.0 | 104.5 | 269 | 233.0 | 134.5 |
| 30 | 26.0 | 15.0 | 90 | 77.9 | 45.0 | 150 | 129.9 | 75.0 | 210 | 181.9 | 105.0 | 270 | 233.8 | 135.0 |
| 31 | 26.8 | 15.5 | 91 | 78.8 | 45.5 | 151 | 130.8 | 75.5 | 211 | 182.7 | 105.5 | 271 | 234.7 | 135.5 |
| 32 | 27.7 | 16.0 | 92 | 79.7 | 46.0 | 152 | 131.6 | 76.0 | 212 | 183.6 | 106.0 | 272 | 235.6 | 136.0 |
| 33 | 28.6 | 16.5 | 93 | 80.5 | 46.5 | 153 | 132.5 | 76.5 | 213 | 184.5 | 106.5 | 273 | 236.4 | 136.5 |
| 34 | 29.4 | 17.0 | 94 | 81.4 | 47.0 | 154 | 133.4 | 77.0 | 214 | 185.3 | 107.0 | 274 | 237.3 | 137.0 |
| 35 | 30.3 | 17.5 | 95 | 82.3 | 47.5 | 155 | 134.2 | 77.5 | 215 | 186.2 | 107.5 | 275 | 238.2 | 137.5 |
| 36 | 31.2 | 18.0 | 96 | 83.1 | 48.0 | 156 | 135.1 | 78.0 | 216 | 187.1 | 108.0 | 276 | 239.0 | 138.0 |
| 37 | 32.0 | 18.5 | 97 | 84.0 | 48.5 | 157 | 136.0 | 78.5 | 217 | 187.9 | 108.5 | 277 | 239.9 | 138.5 |
| 38 | 32.9 | 19.0 | 98 | 84.9 | 49.0 | 158 | 136.8 | 79.0 | 218 | 188.8 | 109.0 | 278 | 240.8 | 139.0 |
| 39 | 33.8 | 19.5 | 99 | 85.7 | 49.5 | 159 | 137.7 | 79.5 | 219 | 189.7 | 109.5 | 279 | 241.6 | 139.5 |
| 40 | 34.6 | 20.0 | 100 | 86.6 | 50.0 | 160 | 138.6 | 80.0 | 220 | 190.5 | 110.0 | 280 | 242.5 | 140.0 |
| 41 | 35.5 | 20.5 | 101 | 87.5 | 50.5 | 161 | 139.4 | 80.5 | 221 | 191.4 | 110.5 | 281 | 243.4 | 140.5 |
| 42 | 36.4 | 21.0 | 102 | 88.3 | 51.0 | 162 | 140.3 | 81.0 | 222 | 192.3 | 111.0 | 282 | 244.2 | 141.0 |
| 43 | 37.2 | 21.5 | 103 | 89.2 | 51.5 | 163 | 141.2 | 81.5 | 223 | 193.1 | 111.5 | 283 | 245.1 | 141.5 |
| 44 | 38.1 | 22.0 | 104 | 90.1 | 52.0 | 164 | 142.0 | 82.0 | 224 | 194.0 | 112.0 | 284 | 246.0 | 142.0 |
| 45 | 39.0 | 22.5 | 105 | 90.9 | 52.5 | 165 | 142.9 | 82.5 | 225 | 194.9 | 112.5 | 285 | 246.8 | 142.5 |
| 46 | 39.8 | 23.0 | 106 | 91.8 | 53.0 | 166 | 143.8 | 83.0 | 226 | 195.7 | 113.0 | 286 | 247.7 | 143.0 |
| 47 | 40.7 | 23.5 | 107 | 92.7 | 53.5 | 167 | 144.6 | 83.5 | 227 | 196.6 | 113.5 | 287 | 248.5 | 143.5 |
| 48 | 41.6 | 24.0 | 108 | 93.5 | 54.0 | 168 | 145.5 | 84.0 | 228 | 197.5 | 114.0 | 288 | 249.4 | 144.0 |
| 49 | 42.4 | 24.5 | 109 | 94.4 | 54.5 | 169 | 146.4 | 84.5 | 229 | 198.3 | 114.5 | 289 | 250.3 | 144.5 |
| 50 | 43.3 | 25.0 | 110 | 95.3 | 55.0 | 170 | 147.2 | 85.0 | 230 | 199.2 | 115.0 | 290 | 251.1 | 145.0 |
| 51 | 44.2 | 25.5 | 111 | 96.1 | 55.5 | 171 | 148.1 | 85.5 | 231 | 200.1 | 115.5 | 291 | 252.0 | 145.5 |
| 52 | 45.0 | 26.0 | 112 | 97.0 | 56.0 | 172 | 149.0 | 86.0 | 232 | 200.9 | 116.0 | 292 | 252.9 | 146.0 |
| 53 | 45.9 | 26.5 | 113 | 97.9 | 56.5 | 173 | 149.8 | 86.5 | 233 | 201.8 | 116.5 | 293 | 253.7 | 146.5 |
| 54 | 46.8 | 27.0 | 114 | 98.7 | 57.0 | 174 | 150.7 | 87.0 | 234 | 202.6 | 117.0 | 294 | 254.6 | 147.0 |
| 55 | 47.6 | 27.5 | 115 | 99.6 | 57.5 | 175 | 151.6 | 87.5 | 235 | 203.5 | 117.5 | 295 | 255.5 | 147.5 |
| 56 | 48.5 | 28.0 | 116 | 100.5 | 58.0 | 176 | 152.4 | 88.0 | 236 | 204.4 | 118.0 | 296 | 256.3 | 148.0 |
| 57 | 49.4 | 28.5 | 117 | 101.3 | 58.5 | 177 | 153.3 | 88.5 | 237 | 205.2 | 118.5 | 297 | 257.2 | 148.5 |
| 58 | 50.2 | 29.0 | 118 | 102.2 | 59.0 | 178 | 154.2 | 89.0 | 238 | 206.1 | 119.0 | 298 | 258.1 | 149.0 |
| 59 | 51.1 | 29.5 | 119 | 103.1 | 59.5 | 179 | 155.0 | 89.5 | 239 | 207.0 | 119.5 | 299 | 258.9 | 149.5 |
| 60 | 52.0 | 30.0 | 120 | 103.9 | 60.0 | 180 | 155.9 | 90.0 | 240 | 207.8 | 120.0 | 300 | 259.8 | 150.0 |
| Dist. | Dep. | D.Lat. | Dist. | Dep. | D.Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

60° — $4^h\ 0^m$

## TRAVERSE TABLE TO DEGREES

30° $2^{h}\ 0^{m}$

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 260·7 | 150·5 | 361 | 312·6 | 180·5 | 421 | 364·6 | 210·5 | 481 | 416·6 | 240·5 | 541 | 468·5 | 270·5 |
| 302 | 261·5 | 151·0 | 362 | 313·5 | 181·0 | 422 | 365·5 | 211·0 | 482 | 417·4 | 241·0 | 542 | 469·4 | 271·0 |
| 303 | 262·4 | 151·5 | 363 | 314·4 | 181·5 | 423 | 366·3 | 211·5 | 483 | 418·3 | 241·5 | 543 | 470·3 | 271·5 |
| 304 | 263·3 | 152·0 | 364 | 315·2 | 182·0 | 424 | 367·2 | 212·0 | 484 | 419·2 | 242·0 | 544 | 471·1 | 272·0 |
| 305 | 264·1 | 152·5 | 365 | 316·1 | 182·5 | 425 | 368·1 | 212·5 | 485 | 420·0 | 242·5 | 545 | 472·0 | 272·5 |
| 306 | 265·0 | 153·0 | 366 | 317·0 | 183·0 | 426 | 368·9 | 213·0 | 486 | 420·9 | 243·0 | 546 | 472·9 | 273·0 |
| 307 | 265·9 | 153·5 | 367 | 317·8 | 183·5 | 427 | 369·8 | 213·5 | 487 | 421·8 | 243·5 | 547 | 473·7 | 273·5 |
| 308 | 266·7 | 154·0 | 368 | 318·7 | 184·0 | 428 | 370·7 | 214·0 | 488 | 422·6 | 244·0 | 548 | 474·6 | 274·0 |
| 309 | 267·6 | 154·5 | 369 | 319·6 | 184·5 | 429 | 371·5 | 214·5 | 489 | 423·5 | 244·5 | 549 | 475·5 | 274·5 |
| 310 | 268·5 | 155·0 | 370 | 320·4 | 185·0 | 430 | 372·4 | 215·0 | 490 | 424·4 | 245·0 | 550 | 476·3 | 275·0 |
| 311 | 269·3 | 155·5 | 371 | 321·3 | 185·5 | 431 | 373·3 | 215·5 | 491 | 425·2 | 245·5 | 551 | 477·2 | 275·5 |
| 312 | 270·2 | 156·0 | 372 | 322·2 | 186·0 | 432 | 374·1 | 216·0 | 492 | 426·1 | 246·0 | 552 | 478·1 | 276·0 |
| 313 | 271·1 | 156·5 | 373 | 323·0 | 186·5 | 433 | 375·0 | 216·5 | 493 | 426·9 | 246·5 | 553 | 478·9 | 276·5 |
| 314 | 271·9 | 157·0 | 374 | 323·9 | 187·0 | 434 | 375·9 | 217·0 | 494 | 427·8 | 247·0 | 554 | 479·8 | 277·0 |
| 315 | 272·8 | 157·5 | 375 | 324·8 | 187·5 | 435 | 376·7 | 217·5 | 495 | 428·7 | 247·5 | 555 | 480·7 | 277·5 |
| 316 | 273·7 | 158·0 | 376 | 325·6 | 188·0 | 436 | 377·6 | 218·0 | 496 | 429·6 | 248·0 | 556 | 481·5 | 278·0 |
| 317 | 274·5 | 158·5 | 377 | 326·5 | 188·5 | 437 | 378·5 | 218·5 | 497 | 430·4 | 248·5 | 557 | 482·4 | 278·5 |
| 318 | 275·4 | 159·0 | 378 | 327·4 | 189·0 | 438 | 579·3 | 219·0 | 498 | 431·3 | 249·0 | 558 | 483·3 | 279·0 |
| 319 | 276·3 | 159·5 | 379 | 328·2 | 189·5 | 439 | 380·2 | 219·5 | 499 | 432·2 | 249·5 | 559 | 484·1 | 279·5 |
| 320 | 277·1 | 160·0 | 380 | 329·1 | 190·0 | 440 | 381·1 | 220·0 | 500 | 433·0 | 250·0 | 560 | 485·0 | 280·0 |
| 321 | 278·0 | 160·5 | 381 | 330·0 | 190·5 | 441 | 381·9 | 220·5 | 501 | 433·9 | 250·5 | 561 | 485·9 | 280·5 |
| 322 | 278·9 | 161·0 | 382 | 330·8 | 191·0 | 442 | 382·8 | 221·0 | 502 | 434·8 | 251·0 | 562 | 486·7 | 281·0 |
| 323 | 279·7 | 161·5 | 383 | 331·7 | 191·5 | 443 | 383·7 | 221·5 | 503 | 435·6 | 251·5 | 563 | 487·6 | 281·5 |
| 324 | 280·6 | 162·0 | 384 | 332·6 | 192·0 | 444 | 384·5 | 222·0 | 504 | 436·5 | 252·0 | 564 | 488·5 | 282·0 |
| 325 | 281·5 | 162·5 | 385 | 333·4 | 192·5 | 445 | 385·4 | 222·5 | 505 | 437·4 | 252·5 | 565 | 489·3 | 282·5 |
| 326 | 282·3 | 163·0 | 386 | 334·3 | 193·0 | 446 | 386·3 | 223·0 | 506 | 438·2 | 253·0 | 566 | 490·2 | 283·0 |
| 327 | 283·2 | 163·5 | 387 | 335·2 | 193·5 | 447 | 387·1 | 223·5 | 507 | 439·1 | 253·5 | 567 | 491·1 | 283·5 |
| 328 | 284·1 | 164·0 | 388 | 336·0 | 194·0 | 448 | 388·0 | 224·0 | 508 | 440·0 | 254·0 | 568 | 491·9 | 284·0 |
| 329 | 284·9 | 164·5 | 389 | 336·9 | 194·5 | 449 | 388·9 | 224·5 | 509 | 440·8 | 254·5 | 569 | 492·8 | 284·5 |
| 330 | 285·8 | 165·0 | 390 | 337·8 | 195·0 | 450 | 389·7 | 225·0 | 510 | 441·7 | 255·0 | 570 | 493·6 | 285·0 |
| 331 | 286·7 | 165·5 | 391 | 338·6 | 195·5 | 451 | 390·6 | 225·5 | 511 | 442·6 | 255·5 | 571 | 494·5 | 285·5 |
| 332 | 287·5 | 166·0 | 392 | 339·5 | 196·0 | 452 | 391·5 | 226·0 | 512 | 443·4 | 256·0 | 572 | 495·4 | 286·0 |
| 333 | 288·4 | 166·5 | 393 | 340·4 | 196·5 | 453 | 392·3 | 226·5 | 513 | 444·3 | 256·5 | 573 | 496·3 | 286·5 |
| 334 | 289·3 | 167·0 | 394 | 341·2 | 197·0 | 454 | 393·2 | 227·0 | 514 | 445·2 | 257·0 | 574 | 497·1 | 287·0 |
| 335 | 290·1 | 167·5 | 395 | 342·1 | 197·5 | 455 | 394·0 | 227·5 | 515 | 446·0 | 257·5 | 575 | 497·9 | 287·5 |
| 336 | 291·0 | 168·0 | 396 | 343·0 | 198·0 | 456 | 394·9 | 228·0 | 516 | 446·9 | 258·0 | 576 | 498·8 | 288·0 |
| 337 | 291·9 | 168·5 | 397 | 343·8 | 198·5 | 457 | 395·8 | 228·5 | 517 | 447·8 | 258·5 | 577 | 499·7 | 288·5 |
| 338 | 292·7 | 169·0 | 398 | 344·7 | 199·0 | 458 | 396·6 | 229·0 | 518 | 448·6 | 259·0 | 578 | 500·5 | 289·0 |
| 339 | 293·6 | 169·5 | 399 | 345·6 | 199·5 | 459 | 397·5 | 229·5 | 519 | 449·4 | 259·5 | 579 | 501·3 | 289·5 |
| 340 | 294·5 | 170·0 | 400 | 346·4 | 200·0 | 460 | 398·4 | 230·0 | 520 | 450·3 | 260·0 | 580 | 502·2 | 290·0 |
| 341 | 295·3 | 170·5 | 401 | 347·3 | 200·5 | 461 | 399·2 | 230·5 | 521 | 451·2 | 260·5 | 581 | 503·1 | 290·5 |
| 342 | 296·2 | 171·0 | 402 | 348·1 | 201·0 | 462 | 400·1 | 231·0 | 522 | 452·1 | 261·0 | 582 | 504·0 | 291·0 |
| 343 | 297·1 | 171·5 | 403 | 349·0 | 201·5 | 463 | 401·0 | 231·5 | 523 | 452·9 | 261·5 | 583 | 504·9 | 291·5 |
| 344 | 297·9 | 172·0 | 404 | 349·9 | 202·0 | 464 | 401·8 | 232·0 | 524 | 453·8 | 262·0 | 584 | 505·8 | 292·0 |
| 345 | 298·8 | 172·5 | 405 | 350·7 | 202·5 | 465 | 402·7 | 232·5 | 525 | 454·7 | 262·5 | 585 | 506·6 | 292·5 |
| 346 | 299·7 | 173·0 | 406 | 351·6 | 203·0 | 466 | 403·6 | 233·0 | 526 | 455·5 | 263·0 | 586 | 507·5 | 293·0 |
| 347 | 300·5 | 173·5 | 407 | 352·5 | 203·5 | 467 | 404·4 | 233·5 | 527 | 456·4 | 263·5 | 587 | 508·4 | 293·5 |
| 348 | 301·4 | 174·0 | 408 | 353·3 | 204·0 | 468 | 405·3 | 234·0 | 528 | 457·3 | 264·0 | 588 | 509·2 | 294·0 |
| 349 | 302·3 | 174·5 | 409 | 354·2 | 204·5 | 469 | 406·2 | 234·5 | 529 | 458·1 | 264·5 | 589 | 510·1 | 294·5 |
| 350 | 303·1 | 175·0 | 410 | 355·1 | 205·0 | 470 | 407·0 | 235·0 | 530 | 459·0 | 265·0 | 590 | 511·0 | 295·0 |
| 351 | 304·0 | 175·5 | 411 | 355·9 | 205·5 | 471 | 407·9 | 235·5 | 531 | 459·9 | 265·5 | 591 | 511·8 | 295·5 |
| 352 | 304·8 | 176·0 | 412 | 356·8 | 206·0 | 472 | 408·8 | 236·0 | 532 | 460·7 | 266·0 | 592 | 512·7 | 296·0 |
| 353 | 305·7 | 176·5 | 413 | 357·7 | 206·5 | 473 | 409·6 | 236·5 | 533 | 461·6 | 266·5 | 593 | 513·6 | 296·5 |
| 354 | 306·6 | 177·0 | 414 | 358·5 | 207·0 | 474 | 410·5 | 237·0 | 534 | 462·5 | 267·0 | 594 | 514·4 | 297·0 |
| 355 | 307·4 | 177·5 | 415 | 359·4 | 207·5 | 475 | 411·4 | 237·5 | 535 | 463·3 | 267·5 | 595 | 515·3 | 297·5 |
| 356 | 308·3 | 178·0 | 416 | 360·3 | 208·0 | 476 | 412·2 | 238·0 | 536 | 464·2 | 268·0 | 596 | 516·2 | 298·0 |
| 357 | 309·2 | 178·5 | 417 | 361·1 | 208·5 | 477 | 413·1 | 238·5 | 537 | 465·1 | 268·5 | 597 | 517·0 | 298·5 |
| 358 | 310·0 | 179·0 | 418 | 362·0 | 209·0 | 478 | 414·0 | 239·0 | 538 | 465·9 | 269·0 | 598 | 517·9 | 299·0 |
| 359 | 310·9 | 179·5 | 419 | 362·9 | 209·5 | 479 | 414·8 | 239·5 | 539 | 466·8 | 269·5 | 599 | 518·8 | 299·5 |
| 360 | 311·8 | 180·0 | 420 | 363·7 | 210·0 | 480 | 415·7 | 240·0 | 540 | 467·7 | 270·0 | 600 | 519·6 | 300·0 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

60° $4^{h}\ 0^{m}$

## TRAVERSE TABLE TO DEGREES

31° 2h 4m

| Dist. | D.Lat | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0·9 | 0·5 | 61 | 52·3 | 31·4 | 121 | 103·7 | 62·3 | 181 | 155·1 | 93·2 | 241 | 206·6 | 124·1 |
| 2 | 1·7 | 1·0 | 62 | 53·1 | 31·9 | 122 | 104·6 | 62·8 | 182 | 156·0 | 93·7 | 242 | 207·4 | 124·6 |
| 3 | 2·6 | 1·5 | 63 | 54·0 | 32·4 | 123 | 105·4 | 63·3 | 183 | 156·9 | 94·3 | 243 | 208·3 | 125·2 |
| 4 | 3·4 | 2·1 | 64 | 54·9 | 33·0 | 124 | 106·3 | 63·9 | 184 | 157·7 | 94·8 | 244 | 209·1 | 125·7 |
| 5 | 4·3 | 2·6 | 65 | 55·7 | 33·5 | 125 | 107·1 | 64·4 | 185 | 158·6 | 95·3 | 245 | 210·0 | 126·2 |
| 6 | 5·1 | 3·1 | 66 | 56·6 | 34·0 | 126 | 108·0 | 64·9 | 186 | 159·4 | 95·8 | 246 | 210·9 | 126·7 |
| 7 | 6·0 | 3·6 | 67 | 57·4 | 34·5 | 127 | 108·9 | 65·4 | 187 | 160·3 | 96·3 | 247 | 211·7 | 127·2 |
| 8 | 6·9 | 4·1 | 68 | 58·3 | 35·0 | 128 | 109·7 | 65·9 | 188 | 161·1 | 96·8 | 248 | 212·6 | 127·7 |
| 9 | 7·7 | 4·6 | 69 | 59·1 | 35·5 | 129 | 110·6 | 66·4 | 189 | 162·0 | 97·3 | 249 | 213·4 | 128·2 |
| 10 | 8·6 | 5·2 | 70 | 60·0 | 36·1 | 130 | 111·4 | 67·0 | 190 | 162·9 | 97·9 | 250 | 214·3 | 128·8 |
| 11 | 9·4 | 5·7 | 71 | 60·9 | 36·6 | 131 | 112·3 | 67·5 | 191 | 163·7 | 98·4 | 251 | 215·1 | 129·3 |
| 12 | 10·3 | 6·2 | 72 | 61·7 | 37·1 | 132 | 113·1 | 68·0 | 192 | 164·6 | 98·9 | 252 | 216·0 | 129·8 |
| 13 | 11·1 | 6·7 | 73 | 62·6 | 37·6 | 133 | 114·0 | 68·5 | 193 | 165·4 | 99·4 | 253 | 216·9 | 130·3 |
| 14 | 12·0 | 7·2 | 74 | 63·4 | 38·1 | 134 | 114·9 | 69·0 | 194 | 166·3 | 99·9 | 254 | 217·7 | 130·8 |
| 15 | 12·9 | 7·7 | 75 | 64·3 | 38·6 | 135 | 115·7 | 69·5 | 195 | 167·1 | 100·4 | 255 | 218·6 | 131·3 |
| 16 | 13·7 | 8·2 | 76 | 65·1 | 39·1 | 136 | 116·6 | 70·0 | 196 | 168·0 | 100·9 | 256 | 219·4 | 131·8 |
| 17 | 14·6 | 8·8 | 77 | 66·0 | 39·7 | 137 | 117·4 | 70·6 | 197 | 168·9 | 101·5 | 257 | 220·3 | 132·4 |
| 18 | 15·4 | 9·3 | 78 | 66·9 | 40·2 | 138 | 118·3 | 71·1 | 198 | 169·7 | 102·0 | 258 | 221·1 | 132·9 |
| 19 | 16·3 | 9·8 | 79 | 67·7 | 40·7 | 139 | 119·1 | 71·6 | 199 | 170·6 | 102·5 | 259 | 222·0 | 133·4 |
| 20 | 17·1 | 10·3 | 80 | 68·6 | 41·2 | 140 | 120·0 | 72·1 | 200 | 171·4 | 103·0 | 260 | 222·9 | 133·9 |
| 21 | 18·0 | 10·8 | 81 | 69·4 | 41·7 | 141 | 120·9 | 72·6 | 201 | 172·3 | 103·5 | 261 | 223·7 | 134·4 |
| 22 | 18·9 | 11·3 | 82 | 70·3 | 42·2 | 142 | 121·7 | 73·1 | 202 | 173·1 | 104·0 | 262 | 224·6 | 134·9 |
| 23 | 19·7 | 11·8 | 83 | 71·1 | 42·7 | 143 | 122·6 | 73·7 | 203 | 174·0 | 104·6 | 263 | 225·4 | 135·5 |
| 24 | 20·6 | 12·4 | 84 | 72·0 | 43·3 | 144 | 123·4 | 74·2 | 204 | 174·9 | 105·1 | 264 | 226·3 | 136·0 |
| 25 | 21·4 | 12·9 | 85 | 72·9 | 43·8 | 145 | 124·3 | 74·7 | 205 | 175·7 | 105·6 | 265 | 227·1 | 136·5 |
| 26 | 22·3 | 13·4 | 86 | 73·7 | 44·3 | 146 | 125·1 | 75·2 | 206 | 176·6 | 106·1 | 266 | 228·0 | 137·0 |
| 27 | 23·1 | 13·9 | 87 | 74·6 | 44·8 | 147 | 126·0 | 75·7 | 207 | 177·4 | 106·6 | 267 | 228·9 | 137·5 |
| 28 | 24·0 | 14·4 | 88 | 75·4 | 45·3 | 148 | 126·9 | 76·2 | 208 | 178·3 | 107·1 | 268 | 229·7 | 138·0 |
| 29 | 24·9 | 14·9 | 89 | 76·3 | 45·8 | 149 | 127·7 | 76·7 | 209 | 179·1 | 107·6 | 269 | 230·6 | 138·5 |
| 30 | 25·7 | 15·5 | 90 | 77·1 | 46·4 | 150 | 128·6 | 77·3 | 210 | 180·0 | 108·2 | 270 | 231·4 | 139·1 |
| 31 | 26·6 | 16·0 | 91 | 78·0 | 46·9 | 151 | 129·4 | 77·8 | 211 | 180·9 | 108·7 | 271 | 232·3 | 139·6 |
| 32 | 27·4 | 16·5 | 92 | 78·9 | 47·4 | 152 | 130·3 | 78·3 | 212 | 181·7 | 109·2 | 272 | 233·1 | 140·1 |
| 33 | 28·3 | 17·0 | 93 | 79·7 | 47·9 | 153 | 131·1 | 78·8 | 213 | 182·6 | 109·7 | 273 | 234·0 | 140·6 |
| 34 | 29·1 | 17·5 | 94 | 80·6 | 48·4 | 154 | 132·0 | 79·3 | 214 | 183·4 | 110·2 | 274 | 234·9 | 141·1 |
| 35 | 30·0 | 18·0 | 95 | 81·4 | 48·9 | 155 | 132·9 | 79·8 | 215 | 184·3 | 110·7 | 275 | 235·7 | 141·6 |
| 36 | 30·9 | 18·5 | 96 | 82·3 | 49·4 | 156 | 133·7 | 80·3 | 216 | 185·1 | 111·2 | 276 | 236·6 | 142·2 |
| 37 | 31·7 | 19·1 | 97 | 83·1 | 50·0 | 157 | 134·6 | 80·9 | 217 | 186·0 | 111·8 | 277 | 237·4 | 142·7 |
| 38 | 32·6 | 19·6 | 98 | 84·0 | 50·5 | 158 | 135·4 | 81·4 | 218 | 186·9 | 112·3 | 278 | 238·3 | 143·2 |
| 39 | 33·4 | 20·1 | 99 | 84·9 | 51·0 | 159 | 136·3 | 81·9 | 219 | 187·7 | 112·8 | 279 | 239·1 | 143·7 |
| 40 | 34·3 | 20·6 | 100 | 85·7 | 51·5 | 160 | 137·1 | 82·4 | 220 | 188·6 | 113·3 | 280 | 240·0 | 144·2 |
| 41 | 35·1 | 21·1 | 101 | 86·6 | 52·0 | 161 | 138·0 | 82·9 | 221 | 189·4 | 113·8 | 281 | 240·9 | 144·7 |
| 42 | 36·0 | 21·6 | 102 | 87·4 | 52·5 | 162 | 138·9 | 83·4 | 222 | 190·3 | 114·3 | 282 | 241·7 | 145·2 |
| 43 | 36·9 | 22·1 | 103 | 88·3 | 53·0 | 163 | 139·7 | 84·0 | 223 | 191·1 | 114·9 | 283 | 242·6 | 145·8 |
| 44 | 37·7 | 22·7 | 104 | 89·1 | 53·6 | 164 | 140·6 | 84·5 | 224 | 192·0 | 115·4 | 284 | 243·4 | 146·3 |
| 45 | 38·6 | 23·2 | 105 | 90·0 | 54·1 | 165 | 141·4 | 85·0 | 225 | 192·9 | 115·9 | 285 | 244·3 | 146·8 |
| 46 | 39·4 | 23·7 | 106 | 90·9 | 54·6 | 166 | 142·3 | 85·5 | 226 | 193·7 | 116·4 | 286 | 245·1 | 147·3 |
| 47 | 40·3 | 24·2 | 107 | 91·7 | 55·1 | 167 | 143·1 | 86·0 | 227 | 194·6 | 116·9 | 287 | 246·0 | 147·8 |
| 48 | 41·1 | 24·7 | 108 | 92·6 | 55·6 | 168 | 144·0 | 86·5 | 228 | 195·4 | 117·4 | 288 | 246·9 | 148·3 |
| 49 | 42·0 | 25·2 | 109 | 93·4 | 56·1 | 169 | 144·9 | 87·0 | 229 | 196·3 | 117·9 | 289 | 247·7 | 148·8 |
| 50 | 42·9 | 25·8 | 110 | 94·3 | 56·7 | 170 | 145·7 | 87·6 | 230 | 197·1 | 118·5 | 290 | 248·6 | 149·4 |
| 51 | 43·7 | 26·3 | 111 | 95·1 | 57·2 | 171 | 146·6 | 88·1 | 231 | 198·0 | 119·0 | 291 | 249·4 | 149·9 |
| 52 | 44·6 | 26·8 | 112 | 96·0 | 57·7 | 172 | 147·4 | 88·6 | 232 | 198·9 | 119·5 | 292 | 250·3 | 150·4 |
| 53 | 45·4 | 27·3 | 113 | 96·9 | 58·2 | 173 | 148·3 | 89·1 | 233 | 199·7 | 120·0 | 293 | 251·2 | 150·9 |
| 54 | 46·3 | 27·8 | 114 | 97·7 | 58·7 | 174 | 149·1 | 89·6 | 234 | 200·6 | 120·5 | 294 | 252·0 | 151·4 |
| 55 | 47·1 | 28·3 | 115 | 98·6 | 59·2 | 175 | 150·0 | 90·1 | 235 | 201·4 | 121·0 | 295 | 252·9 | 151·9 |
| 56 | 48·0 | 28·8 | 116 | 99·4 | 59·7 | 176 | 150·9 | 90·6 | 236 | 202·3 | 121·5 | 296 | 253·7 | 152·5 |
| 57 | 48·9 | 29·4 | 117 | 100·3 | 60·3 | 177 | 151·7 | 91·2 | 237 | 203·1 | 122·1 | 297 | 254·6 | 153·0 |
| 58 | 49·7 | 29·9 | 118 | 101·1 | 60·8 | 178 | 152·6 | 91·7 | 238 | 204·0 | 122·6 | 298 | 255·4 | 153·5 |
| 59 | 50·6 | 30·4 | 119 | 102·0 | 61·3 | 179 | 153·4 | 92·2 | 239 | 204·9 | 123·1 | 299 | 256·3 | 154·0 |
| 60 | 51·4 | 30·9 | 120 | 102·9 | 61·8 | 180 | 154·3 | 92·7 | 240 | 205·7 | 123·6 | 300 | 257·1 | 154·5 |
| Dist. | Dep. | D.Lat | Dist. | Dep. | D.Lat | Dist. | Dep. | D. Lat. | Dist. | Dep | D. Lat. | Dist. | Dep. | D. Lat. |

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## TRAVERSE TABLE TO DEGREES

31° $2^h\ 4^m$

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 258.0 | 155.0 | 361 | 309.4 | 185.9 | 421 | 360.9 | 216.8 | 481 | 412.3 | 247.7 | 541 | 463.7 | 278.6 |
| 302 | 258.9 | 155.5 | 362 | 310.3 | 186.4 | 422 | 361.7 | 217.3 | 482 | 413.2 | 248.2 | 542 | 464.6 | 279.1 |
| 303 | 259.7 | 156.1 | 363 | 311.2 | 187.0 | 423 | 362.6 | 217.9 | 483 | 414.0 | 248.8 | 543 | 465.4 | 279.7 |
| 304 | 260.6 | 156.6 | 364 | 312.0 | 187.5 | 424 | 363.4 | 218.4 | 484 | 414.9 | 249.3 | 544 | 466.3 | 280.2 |
| 305 | 261.4 | 157.1 | 365 | 312.9 | 188.0 | 425 | 364.3 | 218.9 | 485 | 415.7 | 249.8 | 545 | 467.2 | 280.7 |
| 306 | 262.3 | 157.6 | 366 | 313.7 | 188.5 | 426 | 365.2 | 219.4 | 486 | 416.6 | 250.3 | 546 | 468.0 | 281.2 |
| 307 | 263.2 | 158.1 | 367 | 314.6 | 189.0 | 427 | 366.0 | 219.9 | 487 | 417.4 | 250.8 | 547 | 468.9 | 281.7 |
| 308 | 264.0 | 158.6 | 368 | 315.4 | 189.5 | 428 | 366.9 | 220.4 | 488 | 418.3 | 251.3 | 548 | 469.7 | 282.3 |
| 309 | 264.9 | 159.2 | 369 | 316.3 | 190.1 | 429 | 367.7 | 221.0 | 489 | 419.2 | 251.9 | 549 | 470.6 | 282.8 |
| 310 | 265.7 | 159.7 | 370 | 317.2 | 190.6 | 430 | 368.6 | 221.5 | 490 | 420.0 | 252.4 | 550 | 471.4 | 283.3 |
| 311 | 266.6 | 160.2 | 371 | 318.0 | 191.1 | 431 | 369.4 | 222.0 | 491 | 420.9 | 252.9 | 551 | 472.3 | 283.8 |
| 312 | 267.4 | 160.7 | 372 | 318.9 | 191.6 | 432 | 370.3 | 222.5 | 492 | 421.7 | 253.4 | 552 | 473.2 | 284.3 |
| 313 | 268.3 | 161.2 | 373 | 319.7 | 192.1 | 433 | 371.2 | 223.0 | 493 | 422.6 | 253.9 | 553 | 474.0 | 284.8 |
| 314 | 269.2 | 161.7 | 374 | 320.6 | 192.6 | 434 | 372.0 | 223.5 | 494 | 423.4 | 254.4 | 554 | 474.9 | 285.3 |
| 315 | 270.0 | 162.2 | 375 | 321.4 | 193.1 | 435 | 372.9 | 224.0 | 495 | 424.3 | 254.9 | 555 | 475.7 | 285.8 |
| 316 | 270.9 | 162.8 | 376 | 322.3 | 193.7 | 436 | 373.7 | 224.6 | 496 | 425.2 | 255.5 | 556 | 476.6 | 286.4 |
| 317 | 271.7 | 163.3 | 377 | 323.2 | 194.2 | 437 | 374.6 | 225.1 | 497 | 426.0 | 256.0 | 557 | 477.4 | 286.9 |
| 318 | 272.6 | 163.8 | 378 | 324.0 | 194.7 | 438 | 375.4 | 225.6 | 498 | 426.9 | 256.5 | 558 | 478.3 | 287.4 |
| 319 | 273.4 | 164.3 | 379 | 324.9 | 195.2 | 439 | 376.3 | 226.1 | 499 | 427.7 | 257.0 | 559 | 479.2 | 287.9 |
| 320 | 274.3 | 164.8 | 380 | 325.7 | 195.7 | 440 | 377.2 | 226.6 | 500 | 428.6 | 257.5 | 560 | 480.0 | 288.4 |
| 321 | 275.2 | 165.3 | 381 | 326.6 | 196.2 | 441 | 378.0 | 227.1 | 501 | 429.4 | 258.0 | 561 | 480.9 | 288.9 |
| 322 | 276.0 | 165.8 | 382 | 327.4 | 196.7 | 442 | 378.9 | 227.7 | 502 | 430.3 | 258.6 | 562 | 481.7 | 289.5 |
| 323 | 276.9 | 166.4 | 383 | 328.3 | 197.3 | 443 | 379.7 | 228.2 | 503 | 431.2 | 259.1 | 563 | 482.6 | 290.0 |
| 324 | 277.7 | 166.9 | 384 | 329.2 | 197.8 | 444 | 380.6 | 228.7 | 504 | 432.0 | 259.6 | 564 | 483.4 | 290.5 |
| 325 | 278.6 | 167.4 | 385 | 330.0 | 198.3 | 445 | 381.4 | 229.2 | 505 | 432.9 | 260.1 | 565 | 484.3 | 291.0 |
| 326 | 279.4 | 167.9 | 386 | 330.9 | 198.8 | 446 | 382.3 | 229.7 | 506 | 433.7 | 260.6 | 566 | 485.2 | 291.5 |
| 327 | 280.3 | 168.4 | 387 | 331.7 | 199.3 | 447 | 383.2 | 230.2 | 507 | 434.6 | 261.1 | 567 | 486.0 | 292.0 |
| 328 | 281.2 | 168.9 | 388 | 332.6 | 199.8 | 448 | 384.0 | 230.7 | 508 | 435.4 | 261.6 | 568 | 486.9 | 292.5 |
| 329 | 282.0 | 169.5 | 389 | 333.4 | 200.4 | 449 | 384.9 | 231.3 | 509 | 436.3 | 262.2 | 569 | 487.7 | 293.1 |
| 330 | 282.9 | 170.0 | 390 | 334.3 | 200.9 | 450 | 385.7 | 231.8 | 510 | 437.2 | 262.7 | 570 | 488.6 | 293.6 |
| 331 | 283.7 | 170.5 | 391 | 335.2 | 201.4 | 451 | 386.6 | 232.3 | 511 | 438.0 | 263.2 | 571 | 489.4 | 294.1 |
| 332 | 284.6 | 171.0 | 392 | 336.0 | 201.9 | 452 | 387.4 | 232.8 | 512 | 438.9 | 263.7 | 572 | 490.3 | 294.6 |
| 333 | 285.4 | 171.5 | 393 | 336.9 | 202.4 | 453 | 388.3 | 233.3 | 513 | 439.7 | 264.2 | 573 | 491.2 | 295.1 |
| 334 | 286.3 | 172.0 | 394 | 337.7 | 202.9 | 454 | 389.2 | 233.8 | 514 | 440.6 | 264.7 | 574 | 492.0 | 295.6 |
| 335 | 287.2 | 172.5 | 395 | 338.6 | 203.4 | 455 | 390.0 | 234.3 | 515 | 441.4 | 265.2 | 575 | 492.9 | 296.1 |
| 336 | 288.0 | 173.1 | 396 | 339.4 | 204.0 | 456 | 390.9 | 234.9 | 516 | 442.3 | 265.8 | 576 | 493.7 | 296.7 |
| 337 | 288.9 | 173.6 | 397 | 340.3 | 204.5 | 457 | 391.7 | 235.4 | 517 | 443.2 | 266.3 | 577 | 494.6 | 297.2 |
| 338 | 289.7 | 174.1 | 398 | 341.2 | 205.0 | 458 | 392.6 | 235.9 | 518 | 444.0 | 266.8 | 578 | 495.4 | 297.7 |
| 339 | 290.6 | 174.6 | 399 | 342.0 | 205.5 | 459 | 393.4 | 236.4 | 519 | 444.9 | 267.3 | 579 | 496.3 | 298.2 |
| 340 | 291.4 | 175.1 | 400 | 342.9 | 206.0 | 460 | 394.3 | 236.9 | 520 | 445.7 | 267.8 | 580 | 497.2 | 298.7 |
| 341 | 292.3 | 175.6 | 401 | 343.7 | 206.5 | 461 | 395.2 | 237.4 | 521 | 446.6 | 268.3 | 581 | 498.0 | 299.2 |
| 342 | 293.2 | 176.1 | 402 | 344.6 | 207.0 | 462 | 396.0 | 238.0 | 522 | 447.4 | 268.9 | 582 | 498.9 | 299.8 |
| 343 | 294.0 | 176.7 | 403 | 345.4 | 207.6 | 463 | 396.9 | 238.5 | 523 | 448.3 | 269.4 | 583 | 499.7 | 300.3 |
| 344 | 294.9 | 177.2 | 404 | 346.3 | 208.1 | 464 | 397.7 | 239.0 | 524 | 449.2 | 269.9 | 584 | 500.6 | 300.8 |
| 345 | 295.7 | 177.7 | 405 | 347.2 | 208.6 | 465 | 398.6 | 239.5 | 525 | 450.0 | 270.4 | 585 | 501.4 | 301.3 |
| 346 | 296.6 | 178.2 | 406 | 348.0 | 209.1 | 466 | 399.4 | 240.0 | 526 | 450.9 | 270.9 | 586 | 502.3 | 301.8 |
| 347 | 297.4 | 178.7 | 407 | 348.9 | 209.6 | 467 | 400.3 | 240.5 | 527 | 451.7 | 271.4 | 587 | 503.2 | 302.3 |
| 348 | 298.3 | 179.2 | 408 | 349.7 | 210.1 | 468 | 401.2 | 241.0 | 528 | 452.6 | 271.9 | 588 | 504.0 | 302.8 |
| 349 | 299.2 | 179.8 | 409 | 350.6 | 210.7 | 469 | 402.0 | 241.5 | 529 | 453.4 | 272.4 | 589 | 504.9 | 303.3 |
| 350 | 300.0 | 180.3 | 410 | 351.4 | 211.2 | 470 | 402.9 | 242.1 | 530 | 454.3 | 273.0 | 590 | 505.7 | 303.9 |
| 351 | 300.9 | 180.8 | 411 | 352.3 | 211.7 | 471 | 403.7 | 242.6 | 531 | 455.2 | 273.5 | 591 | 506.6 | 304.4 |
| 352 | 301.7 | 181.3 | 412 | 353.2 | 212.2 | 472 | 404.6 | 243.1 | 532 | 456.0 | 274.0 | 592 | 507.4 | 304.9 |
| 353 | 302.6 | 181.8 | 413 | 354.0 | 212.7 | 473 | 405.4 | 243.6 | 533 | 456.9 | 274.5 | 593 | 508.3 | 305.4 |
| 354 | 303.4 | 182.3 | 414 | 354.9 | 213.2 | 474 | 406.3 | 244.1 | 534 | 457.7 | 275.0 | 594 | 509.2 | 305.9 |
| 355 | 304.3 | 182.8 | 415 | 355.7 | 213.7 | 475 | 407.2 | 244.6 | 535 | 458.6 | 275.5 | 595 | 510.0 | 306.4 |
| 356 | 305.2 | 183.4 | 416 | 356.6 | 214.3 | 476 | 408.0 | 245.2 | 536 | 459.4 | 276.1 | 596 | 510.9 | 307.0 |
| 357 | 306.0 | 183.9 | 417 | 357.4 | 214.8 | 477 | 408.9 | 245.7 | 537 | 460.3 | 276.6 | 597 | 511.7 | 307.5 |
| 358 | 306.9 | 184.4 | 418 | 358.3 | 215.3 | 478 | 409.7 | 246.2 | 538 | 461.2 | 277.1 | 598 | 512.6 | 308.0 |
| 359 | 307.7 | 184.9 | 419 | 359.2 | 215.8 | 479 | 410.6 | 246.7 | 539 | 462.0 | 277.6 | 599 | 513.4 | 308.5 |
| 360 | 308.6 | 185.4 | 420 | 360.0 | 216.3 | 480 | 411.4 | 247.2 | 540 | 462.9 | 278.1 | 600 | 514.3 | 309.0 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

59° $8^h\ 56^m$

## TRAVERSE TABLE TO DEGREES

32° — 2h 8m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0·8 | 0·5 | 61 | 51·7 | 32·3 | 121 | 102·6 | 64·1 | 181 | 153·5 | 95·9 | 241 | 204·4 | 127·7 |
| 2 | 1·7 | 1·1 | 62 | 52·6 | 32·9 | 122 | 103·5 | 64·7 | 182 | 154·3 | 96·4 | 242 | 205·2 | 128·2 |
| 3 | 2·5 | 1·6 | 63 | 53·4 | 33·4 | 123 | 104·3 | 65·2 | 183 | 155·2 | 97·0 | 243 | 206·1 | 128·8 |
| 4 | 3·4 | 2·1 | 64 | 54·3 | 33·9 | 124 | 105·2 | 65·7 | 184 | 156·0 | 97·5 | 244 | 206·9 | 129·3 |
| 5 | 4·2 | 2·6 | 65 | 55·1 | 34·4 | 125 | 106·0 | 66·2 | 185 | 156·9 | 98·0 | 245 | 207·8 | 129·8 |
| 6 | 5·1 | 3·2 | 66 | 56·0 | 35·0 | 126 | 106·9 | 66·8 | 186 | 157·7 | 98·6 | 246 | 208·6 | 130·4 |
| 7 | 5·9 | 3·7 | 67 | 56·8 | 35·5 | 127 | 107·7 | 67·3 | 187 | 158·6 | 99·1 | 247 | 209·5 | 130·9 |
| 8 | 6·8 | 4·2 | 68 | 57·7 | 36·0 | 128 | 108·6 | 67·8 | 188 | 159·4 | 99·6 | 248 | 210·3 | 131·4 |
| 9 | 7·6 | 4·8 | 69 | 58·5 | 36·6 | 129 | 109·4 | 68·4 | 189 | 160·3 | 100·2 | 249 | 211·2 | 131·9 |
| 10 | 8·5 | 5·3 | 70 | 59·4 | 37·1 | 130 | 110·2 | 68·9 | 190 | 161·1 | 100·7 | 250 | 212·0 | 132·5 |
| 11 | 9·3 | 5·8 | 71 | 60·2 | 37·6 | 131 | 111·1 | 69·4 | 191 | 162·0 | 101·2 | 251 | 212·9 | 133·0 |
| 12 | 10·2 | 6·4 | 72 | 61·1 | 38·2 | 132 | 111·9 | 69·9 | 192 | 162·8 | 101·7 | 252 | 213·7 | 133·5 |
| 13 | 11·0 | 6·9 | 73 | 61·9 | 38·7 | 133 | 112·8 | 70·5 | 193 | 163·7 | 102·3 | 253 | 214·6 | 134·1 |
| 14 | 11·9 | 7·4 | 74 | 62·8 | 39·2 | 134 | 113·6 | 71·0 | 194 | 164·5 | 102·8 | 254 | 215·4 | 134·6 |
| 15 | 12·7 | 7·9 | 75 | 63·6 | 39·7 | 135 | 114·5 | 71·5 | 195 | 165·4 | 103·3 | 255 | 216·3 | 135·1 |
| 16 | 13·6 | 8·5 | 76 | 64·5 | 40·3 | 136 | 115·3 | 72·1 | 196 | 166·2 | 103·9 | 256 | 217·1 | 135·7 |
| 17 | 14·4 | 9·0 | 77 | 65·3 | 40·8 | 137 | 116·2 | 72·6 | 197 | 167·1 | 104·4 | 257 | 217·9 | 136·2 |
| 18 | 15·3 | 9·5 | 78 | 66·1 | 41·3 | 138 | 117·0 | 73·1 | 198 | 167·9 | 104·9 | 258 | 218·8 | 136·7 |
| 19 | 16·1 | 10·1 | 79 | 67·0 | 41·9 | 139 | 117·9 | 73·7 | 199 | 168·8 | 105·5 | 259 | 219·6 | 137·2 |
| 20 | 17·0 | 10·6 | 80 | 67·8 | 42·4 | 140 | 118·7 | 74·2 | 200 | 169·6 | 106·0 | 260 | 220·5 | 137·8 |
| 21 | 17·8 | 11·1 | 81 | 68·7 | 42·9 | 141 | 119·6 | 74·7 | 201 | 170·5 | 106·5 | 261 | 221·3 | 138·3 |
| 22 | 18·7 | 11·7 | 82 | 69·5 | 43·5 | 142 | 120·4 | 75·2 | 202 | 171·3 | 107·0 | 262 | 222·2 | 138·8 |
| 23 | 19·5 | 12·2 | 83 | 70·4 | 44·0 | 143 | 121·3 | 75·8 | 203 | 172·2 | 107·6 | 263 | 223·0 | 139·4 |
| 24 | 20·4 | 12·7 | 84 | 71·2 | 44·5 | 144 | 122·1 | 76·3 | 204 | 173·0 | 108·1 | 264 | 223·9 | 139·9 |
| 25 | 21·2 | 13·2 | 85 | 72·1 | 45·0 | 145 | 123·0 | 76·8 | 205 | 173·8 | 108·6 | 265 | 224·7 | 140·4 |
| 26 | 22·0 | 13·8 | 86 | 72·9 | 45·6 | 146 | 123·8 | 77·4 | 206 | 174·7 | 109·2 | 266 | 225·6 | 141·0 |
| 27 | 22·9 | 14·3 | 87 | 73·8 | 46·1 | 147 | 124·7 | 77·9 | 207 | 175·5 | 109·7 | 267 | 226·4 | 141·5 |
| 28 | 23·7 | 14·8 | 88 | 74·6 | 46·6 | 148 | 125·5 | 78·4 | 208 | 176·4 | 110·2 | 268 | 227·3 | 142·0 |
| 29 | 24·6 | 15·4 | 89 | 75·5 | 47·2 | 149 | 126·4 | 79·0 | 209 | 177·2 | 110·8 | 269 | 228·1 | 142·5 |
| 30 | 25·4 | 15·9 | 90 | 76·3 | 47·7 | 150 | 127·2 | 79·5 | 210 | 178·1 | 111·3 | 270 | 229·0 | 143·1 |
| 31 | 26·3 | 16·4 | 91 | 77·2 | 48·2 | 151 | 128·1 | 80·0 | 211 | 178·9 | 111·8 | 271 | 229·8 | 143·6 |
| 32 | 27·1 | 17·0 | 92 | 78·0 | 48·8 | 152 | 128·9 | 80·5 | 212 | 179·8 | 112·3 | 272 | 230·7 | 144·1 |
| 33 | 28·0 | 17·5 | 93 | 78·9 | 49·3 | 153 | 129·8 | 81·1 | 213 | 180·6 | 112·9 | 273 | 231·5 | 144·7 |
| 34 | 28·8 | 18·0 | 94 | 79·7 | 49·8 | 154 | 130·6 | 81·6 | 214 | 181·5 | 113·4 | 274 | 232·4 | 145·2 |
| 35 | 29·7 | 18·5 | 95 | 80·6 | 50·3 | 155 | 131·4 | 82·1 | 215 | 182·3 | 113·9 | 275 | 233·2 | 145·7 |
| 36 | 30·5 | 19·1 | 96 | 81·4 | 50·9 | 156 | 132·3 | 82·7 | 216 | 183·2 | 114·5 | 276 | 234·1 | 146·3 |
| 37 | 31·4 | 19·6 | 97 | 82·3 | 51·4 | 157 | 133·1 | 83·2 | 217 | 184·0 | 115·0 | 277 | 234·9 | 146·8 |
| 38 | 32·2 | 20·1 | 98 | 83·1 | 51·9 | 158 | 134·0 | 83·7 | 218 | 184·9 | 115·5 | 278 | 235·8 | 147·3 |
| 39 | 33·1 | 20·7 | 99 | 84·0 | 52·5 | 159 | 134·8 | 84·3 | 219 | 185·7 | 116·1 | 279 | 236·6 | 147·8 |
| 40 | 33·9 | 21·2 | 100 | 84·8 | 53·0 | 160 | 135·7 | 84·8 | 220 | 186·6 | 116·6 | 280 | 237·5 | 148·4 |
| 41 | 34·8 | 21·7 | 101 | 85·7 | 53·5 | 161 | 136·5 | 85·3 | 221 | 187·4 | 117·1 | 281 | 238·3 | 148·9 |
| 42 | 35·6 | 22·3 | 102 | 86·5 | 54·1 | 162 | 137·4 | 85·8 | 222 | 188·3 | 117·6 | 282 | 239·1 | 149·4 |
| 43 | 36·5 | 22·8 | 103 | 87·3 | 54·6 | 163 | 138·2 | 86·4 | 223 | 189·1 | 118·2 | 283 | 240·0 | 150·0 |
| 44 | 37·3 | 23·3 | 104 | 88·2 | 55·1 | 164 | 139·1 | 86·9 | 224 | 190·0 | 118·7 | 284 | 240·8 | 150·5 |
| 45 | 38·2 | 23·8 | 105 | 89·0 | 55·6 | 165 | 139·9 | 87·4 | 225 | 190·8 | 119·2 | 285 | 241·7 | 151·0 |
| 46 | 39·0 | 24·4 | 106 | 89·9 | 56·2 | 166 | 140·8 | 88·0 | 226 | 191·7 | 119·8 | 286 | 242·5 | 151·6 |
| 47 | 39·9 | 24·9 | 107 | 90·7 | 56·7 | 167 | 141·6 | 88·5 | 227 | 192·5 | 120·3 | 287 | 243·4 | 152·1 |
| 48 | 40·7 | 25·4 | 108 | 91·6 | 57·2 | 168 | 142·5 | 89·0 | 228 | 193·4 | 120·8 | 288 | 244·2 | 152·6 |
| 49 | 41·6 | 26·0 | 109 | 92·4 | 57·8 | 169 | 143·3 | 89·6 | 229 | 194·2 | 121·4 | 289 | 245·1 | 153·1 |
| 50 | 42·4 | 26·5 | 110 | 93·3 | 58·3 | 170 | 144·2 | 90·1 | 230 | 195·1 | 121·9 | 290 | 245·9 | 153·7 |
| 51 | 43·3 | 27·0 | 111 | 94·1 | 58·8 | 171 | 145·0 | 90·6 | 231 | 195·9 | 122·4 | 291 | 246·8 | 154·2 |
| 52 | 44·1 | 27·6 | 112 | 95·0 | 59·4 | 172 | 145·9 | 91·1 | 232 | 196·7 | 122·9 | 292 | 247·6 | 154·7 |
| 53 | 44·9 | 28·1 | 113 | 95·8 | 59·9 | 173 | 146·7 | 91·7 | 233 | 197·6 | 123·5 | 293 | 248·5 | 155·3 |
| 54 | 45·8 | 28·6 | 114 | 96·7 | 60·4 | 174 | 147·6 | 92·2 | 234 | 198·4 | 124·0 | 294 | 249·3 | 155·8 |
| 55 | 46·6 | 29·1 | 115 | 97·5 | 60·9 | 175 | 148·4 | 92·7 | 235 | 199·3 | 124·5 | 295 | 250·2 | 156·3 |
| 56 | 47·5 | 29·7 | 116 | 98·4 | 61·5 | 176 | 149·3 | 93·3 | 236 | 200·1 | 125·1 | 296 | 251·0 | 156·9 |
| 57 | 48·3 | 30·2 | 117 | 99·2 | 62·0 | 177 | 150·1 | 93·8 | 237 | 201·0 | 125·6 | 297 | 251·9 | 157·4 |
| 58 | 49·2 | 30·7 | 118 | 100·1 | 62·5 | 178 | 151·0 | 94·3 | 238 | 201·8 | 126·1 | 298 | 252·7 | 157·9 |
| 59 | 50·0 | 31·3 | 119 | 100·9 | 63·1 | 179 | 151·8 | 94·9 | 239 | 202·7 | 126·7 | 299 | 253·6 | 158·4 |
| 60 | 50·9 | 31·8 | 120 | 101·8 | 63·6 | 180 | 152·6 | 95·4 | 240 | 203·5 | 127·2 | 300 | 254·4 | 159·0 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

58° — 3h 52m

## TRAVERSE TABLE TO DEGREES

32° 2h 8m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 255.3 | 159.5 | 361 | 306.2 | 191.3 | 421 | 357.0 | 223.1 | 481 | 407.9 | 254.9 | 541 | 458.8 | 286.7 |
| 302 | 256.1 | 160.0 | 362 | 307.0 | 191.8 | 422 | 357.9 | 223.6 | 482 | 408.8 | 255.4 | 542 | 459.6 | 287.2 |
| 303 | 257.0 | 160.5 | 363 | 307.9 | 192.3 | 423 | 358.7 | 224.1 | 483 | 409.6 | 255.9 | 543 | 460.5 | 287.7 |
| 304 | 257.8 | 161.1 | 364 | 308.7 | 192.9 | 424 | 359.6 | 224.7 | 484 | 410.5 | 256.5 | 544 | 461.3 | 288.3 |
| 305 | 258.7 | 161.6 | 365 | 309.5 | 193.4 | 425 | 360.4 | 225.2 | 485 | 411.3 | 257.0 | 545 | 462.2 | 288.8 |
| 306 | 259.5 | 162.1 | 366 | 310.4 | 193.9 | 426 | 361.3 | 225.7 | 486 | 412.2 | 257.5 | 546 | 463.0 | 289.3 |
| 307 | 260.4 | 162.7 | 367 | 311.2 | 194.5 | 427 | 362.1 | 226.3 | 487 | 413.0 | 258.1 | 547 | 463.9 | 289.9 |
| 308 | 261.2 | 163.2 | 368 | 312.1 | 195.0 | 428 | 363.0 | 226.8 | 488 | 413.9 | 258.6 | 548 | 464.7 | 290.4 |
| 309 | 262.1 | 163.7 | 369 | 312.9 | 195.5 | 429 | 363.8 | 227.3 | 489 | 414.7 | 259.1 | 549 | 465.6 | 290.9 |
| 310 | 262.9 | 164.3 | 370 | 313.8 | 196.0 | 430 | 364.7 | 227.8 | 490 | 415.6 | 259.6 | 550 | 466.4 | 291.5 |
| 311 | 263.8 | 164.8 | 371 | 314.6 | 196.6 | 431 | 365.5 | 228.4 | 491 | 416.4 | 260.2 | 551 | 467.3 | 292.0 |
| 312 | 264.6 | 165.3 | 372 | 315.5 | 197.1 | 432 | 366.4 | 228.9 | 492 | 417.3 | 260.7 | 552 | 468.1 | 292.5 |
| 313 | 265.4 | 165.8 | 373 | 316.3 | 197.6 | 433 | 367.2 | 229.4 | 493 | 418.1 | 261.2 | 553 | 469.0 | 293.0 |
| 314 | 266.3 | 166.4 | 374 | 317.2 | 198.2 | 434 | 368.1 | 230.0 | 494 | 419.0 | 261.8 | 554 | 469.8 | 293.6 |
| 315 | 267.1 | 166.9 | 375 | 318.0 | 198.7 | 435 | 368.9 | 230.5 | 495 | 419.8 | 262.3 | 555 | 470.7 | 294.1 |
| 316 | 268.0 | 167.4 | 376 | 318.9 | 199.2 | 436 | 369.8 | 231.0 | 496 | 420.6 | 262.8 | 556 | 471.5 | 294.6 |
| 317 | 268.8 | 168.0 | 377 | 319.7 | 199.8 | 437 | 370.6 | 231.6 | 497 | 421.5 | 263.4 | 557 | 472.4 | 295.2 |
| 318 | 269.7 | 168.5 | 378 | 320.6 | 200.3 | 438 | 371.5 | 232.1 | 498 | 422.3 | 263.9 | 558 | 473.2 | 295.7 |
| 319 | 270.5 | 169.0 | 379 | 321.4 | 200.8 | 439 | 372.3 | 232.6 | 499 | 423.2 | 264.4 | 559 | 474.1 | 296.2 |
| 320 | 271.4 | 169.6 | 380 | 322.3 | 201.3 | 440 | 373.2 | 233.1 | 500 | 424.0 | 265.0 | 560 | 474.9 | 296.7 |
| 321 | 272.2 | 170.1 | 381 | 323.1 | 201.9 | 441 | 374.0 | 233.7 | 501 | 424.9 | 265.5 | 561 | 475.8 | 297.3 |
| 322 | 273.1 | 170.6 | 382 | 324.0 | 202.4 | 442 | 374.8 | 234.2 | 502 | 425.7 | 266.0 | 562 | 476.6 | 297.8 |
| 323 | 273.9 | 171.1 | 383 | 324.8 | 202.9 | 443 | 375.7 | 234.7 | 503 | 426.6 | 266.5 | 563 | 477.5 | 298.3 |
| 324 | 274.8 | 171.7 | 384 | 325.7 | 203.5 | 444 | 376.5 | 235.3 | 504 | 427.4 | 267.1 | 564 | 478.3 | 298.9 |
| 325 | 275.6 | 172.2 | 385 | 326.5 | 204.0 | 445 | 377.4 | 235.8 | 505 | 428.3 | 267.6 | 565 | 479.2 | 299.4 |
| 326 | 276.5 | 172.7 | 386 | 327.4 | 204.5 | 446 | 378.2 | 236.3 | 506 | 429.1 | 268.1 | 566 | 480.0 | 299.9 |
| 327 | 277.3 | 173.3 | 387 | 328.2 | 205.1 | 447 | 379.1 | 236.9 | 507 | 430.0 | 268.7 | 567 | 480.9 | 300.5 |
| 328 | 278.2 | 173.8 | 388 | 329.1 | 205.6 | 448 | 379.9 | 237.4 | 508 | 430.8 | 269.2 | 568 | 481.7 | 301.0 |
| 329 | 279.0 | 174.3 | 389 | 329.9 | 206.1 | 449 | 380.8 | 237.9 | 509 | 431.7 | 269.7 | 569 | 482.6 | 301.5 |
| 330 | 279.9 | 174.9 | 390 | 330.8 | 206.6 | 450 | 381.6 | 238.4 | 510 | 432.5 | 270.3 | 570 | 483.4 | 302.1 |
| 331 | 280.7 | 175.4 | 391 | 331.6 | 207.2 | 451 | 382.5 | 239.0 | 511 | 433.4 | 270.8 | 571 | 484.3 | 302.6 |
| 332 | 281.6 | 175.9 | 392 | 332.5 | 207.7 | 452 | 383.3 | 239.5 | 512 | 434.2 | 271.4 | 572 | 485.1 | 303.2 |
| 333 | 282.4 | 176.4 | 393 | 333.3 | 208.2 | 453 | 384.2 | 240.0 | 513 | 435.1 | 271.9 | 573 | 486.0 | 303.7 |
| 334 | 283.3 | 177.0 | 394 | 334.2 | 208.8 | 454 | 385.0 | 240.6 | 514 | 435.9 | 272.4 | 574 | 486.8 | 304.2 |
| 335 | 284.1 | 177.5 | 395 | 335.0 | 209.3 | 455 | 385.9 | 241.1 | 515 | 436.8 | 272.9 | 575 | 487.7 | 304.7 |
| 336 | 285.0 | 178.0 | 396 | 335.8 | 209.8 | 456 | 386.7 | 241.6 | 516 | 437.6 | 273.5 | 576 | 488.5 | 305.3 |
| 337 | 285.8 | 178.6 | 397 | 336.7 | 210.4 | 457 | 387.6 | 242.2 | 517 | 438.5 | 274.0 | 577 | 489.4 | 305.8 |
| 338 | 286.7 | 179.1 | 398 | 337.5 | 210.9 | 458 | 388.4 | 242.7 | 518 | 439.3 | 274.5 | 578 | 490.2 | 306.3 |
| 339 | 287.5 | 179.6 | 399 | 338.4 | 211.4 | 459 | 389.3 | 243.2 | 519 | 440.2 | 275.0 | 579 | 491.1 | 306.8 |
| 340 | 288.3 | 180.2 | 400 | 339.2 | 211.9 | 460 | 390.1 | 243.8 | 520 | 441.0 | 275.6 | 580 | 491.9 | 307.4 |
| 341 | 289.2 | 180.7 | 401 | 340.1 | 212.5 | 461 | 391.0 | 244.3 | 521 | 441.9 | 276.1 | 581 | 492.8 | 307.9 |
| 342 | 290.0 | 181.2 | 402 | 340.9 | 213.0 | 462 | 391.8 | 244.8 | 522 | 442.7 | 276.6 | 582 | 493.6 | 308.4 |
| 343 | 290.9 | 181.7 | 403 | 341.8 | 213.5 | 463 | 392.7 | 245.4 | 523 | 443.6 | 277.2 | 583 | 494.5 | 309.0 |
| 344 | 291.7 | 182.3 | 404 | 342.6 | 214.1 | 464 | 393.5 | 245.9 | 524 | 444.4 | 277.7 | 584 | 495.3 | 309.5 |
| 345 | 292.6 | 182.8 | 405 | 343.5 | 214.6 | 465 | 394.4 | 246.4 | 525 | 445.3 | 278.2 | 585 | 496.2 | 310.0 |
| 346 | 293.4 | 183.3 | 406 | 344.3 | 215.1 | 466 | 395.2 | 246.9 | 526 | 446.1 | 278.7 | 586 | 497.0 | 310.5 |
| 347 | 294.3 | 183.9 | 407 | 345.2 | 215.7 | 467 | 396.0 | 247.5 | 527 | 446.9 | 279.3 | 587 | 497.8 | 311.1 |
| 348 | 295.1 | 184.4 | 408 | 346.0 | 216.2 | 468 | 396.9 | 248.0 | 528 | 447.8 | 279.8 | 588 | 498.7 | 311.6 |
| 349 | 296.0 | 184.9 | 409 | 346.9 | 216.7 | 469 | 397.7 | 248.5 | 529 | 448.6 | 280.3 | 589 | 499.5 | 312.1 |
| 350 | 296.8 | 185.4 | 410 | 347.7 | 217.2 | 470 | 398.6 | 249.0 | 530 | 449.5 | 280.9 | 590 | 500.3 | 312.6 |
| 351 | 297.7 | 186.0 | 411 | 348.6 | 217.8 | 471 | 399.4 | 249.6 | 531 | 450.3 | 281.4 | 591 | 501.2 | 313.2 |
| 352 | 298.5 | 186.5 | 412 | 349.4 | 218.3 | 472 | 400.3 | 250.1 | 532 | 451.1 | 281.9 | 592 | 502.0 | 313.7 |
| 353 | 299.4 | 187.0 | 413 | 350.3 | 218.8 | 473 | 401.1 | 250.6 | 533 | 452.0 | 282.4 | 593 | 502.9 | 314.2 |
| 354 | 300.2 | 187.6 | 414 | 351.1 | 219.4 | 474 | 402.0 | 251.2 | 534 | 452.8 | 283.0 | 594 | 503.7 | 314.8 |
| 355 | 301.1 | 188.1 | 415 | 352.0 | 219.9 | 475 | 402.8 | 251.7 | 535 | 453.7 | 283.5 | 595 | 504.6 | 315.3 |
| 356 | 301.9 | 188.6 | 416 | 352.8 | 220.4 | 476 | 403.7 | 252.2 | 536 | 454.5 | 284.0 | 596 | 505.4 | 315.8 |
| 357 | 302.8 | 189.2 | 417 | 353.6 | 221.0 | 477 | 404.5 | 252.8 | 537 | 455.4 | 284.6 | 597 | 506.2 | 316.4 |
| 358 | 303.6 | 189.7 | 418 | 354.5 | 221.5 | 478 | 405.4 | 253.3 | 538 | 456.2 | 285.1 | 598 | 507.1 | 316.9 |
| 359 | 304.5 | 190.2 | 419 | 355.3 | 222.0 | 479 | 406.2 | 253.8 | 539 | 457.1 | 285.6 | 599 | 508.0 | 317.4 |
| 360 | 305.3 | 190.8 | 420 | 356.2 | 222.5 | 480 | 407.1 | 254.3 | 540 | 457.9 | 286.2 | 600 | 508.8 | 318.0 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

58° 3h 52m

## TRAVERSE TABLE TO DEGREES

33° $2^h\ 12^m$

| Dist. | D.Lat | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.8 | 0.5 | 61 | 51.2 | 33.2 | 121 | 101.5 | 65.9 | 181 | 151.8 | 98.6 | 241 | 202.1 | 131.3 |
| 2 | 1.7 | 1.1 | 62 | 52.0 | 33.8 | 122 | 102.3 | 66.4 | 182 | 152.6 | 99.1 | 242 | 203.0 | 131.8 |
| 3 | 2.5 | 1.6 | 63 | 52.8 | 34.3 | 123 | 103.2 | 67.0 | 183 | 153.5 | 99.7 | 243 | 203.8 | 132.3 |
| 4 | 3.4 | 2.2 | 64 | 53.7 | 34.9 | 124 | 104.0 | 67.5 | 184 | 154.3 | 100.2 | 244 | 204.6 | 132.9 |
| 5 | 4.2 | 2.7 | 65 | 54.5 | 35.4 | 125 | 104.8 | 68.1 | 185 | 155.2 | 100.8 | 245 | 205.5 | 133.4 |
| 6 | 5.0 | 3.3 | 66 | 55.4 | 35.9 | 126 | 105.7 | 68.6 | 186 | 156.0 | 101.3 | 246 | 206.3 | 134.0 |
| 7 | 5.9 | 3.8 | 67 | 56.2 | 36.5 | 127 | 106.5 | 69.2 | 187 | 156.8 | 101.8 | 247 | 207.2 | 134.5 |
| 8 | 6.7 | 4.4 | 68 | 57.0 | 37.0 | 128 | 107.3 | 69.7 | 188 | 157.7 | 102.4 | 248 | 208.0 | 135.1 |
| 9 | 7.5 | 4.9 | 69 | 57.9 | 37.6 | 129 | 108.2 | 70.3 | 189 | 158.5 | 102.9 | 249 | 208.8 | 135.6 |
| 10 | 8.4 | 5.4 | 70 | 58.7 | 38.1 | 130 | 109.0 | 70.8 | 190 | 159.3 | 103.5 | 250 | 209.7 | 136.2 |
| 11 | 9.2 | 6.0 | 71 | 59.5 | 38.7 | 131 | 109.9 | 71.3 | 191 | 160.2 | 104.0 | 251 | 210.5 | 136.7 |
| 12 | 10.1 | 6.5 | 72 | 60.4 | 39.2 | 132 | 110.7 | 71.9 | 192 | 161.0 | 104.6 | 252 | 211.3 | 137.2 |
| 13 | 10.9 | 7.1 | 73 | 61.2 | 39.8 | 133 | 111.5 | 72.4 | 193 | 161.9 | 105.1 | 253 | 212.2 | 137.8 |
| 14 | 11.7 | 7.6 | 74 | 62.1 | 40.3 | 134 | 112.4 | 73.0 | 194 | 162.7 | 105.7 | 254 | 213.0 | 138.3 |
| 15 | 12.6 | 8.2 | 75 | 62.9 | 40.8 | 135 | 113.2 | 73.5 | 195 | 163.5 | 106.2 | 255 | 213.9 | 138.9 |
| 16 | 13.4 | 8.7 | 76 | 63.7 | 41.4 | 136 | 114.1 | 74.1 | 196 | 164.4 | 106.7 | 256 | 214.7 | 139.4 |
| 17 | 14.3 | 9.3 | 77 | 64.6 | 41.9 | 137 | 114.9 | 74.6 | 197 | 165.2 | 107.3 | 257 | 215.5 | 140.0 |
| 18 | 15.1 | 9.8 | 78 | 65.4 | 42.5 | 138 | 115.7 | 75.2 | 198 | 166.1 | 107.8 | 258 | 216.4 | 140.5 |
| 19 | 15.9 | 10.3 | 79 | 66.3 | 43.0 | 139 | 116.6 | 75.7 | 199 | 166.9 | 108.4 | 259 | 217.2 | 141.1 |
| 20 | 16.8 | 10.9 | 80 | 67.1 | 43.6 | 140 | 117.4 | 76.2 | 200 | 167.7 | 108.9 | 260 | 218.1 | 141.6 |
| 21 | 17.6 | 11.4 | 81 | 67.9 | 44.1 | 141 | 118.3 | 76.8 | 201 | 168.6 | 109.5 | 261 | 218.9 | 142.2 |
| 22 | 18.5 | 12.0 | 82 | 68.8 | 44.7 | 142 | 119.1 | 77.3 | 202 | 169.4 | 110.0 | 262 | 219.7 | 142.7 |
| 23 | 19.3 | 12.5 | 83 | 69.6 | 45.2 | 143 | 119.9 | 77.9 | 203 | 170.3 | 110.6 | 263 | 220.6 | 143.2 |
| 24 | 20.1 | 13.1 | 84 | 70.4 | 45.7 | 144 | 120.8 | 78.4 | 204 | 171.1 | 111.1 | 264 | 221.4 | 143.8 |
| 25 | 21.0 | 13.6 | 85 | 71.3 | 46.3 | 145 | 121.6 | 79.0 | 205 | 171.9 | 111.7 | 265 | 222.2 | 144.3 |
| 26 | 21.8 | 14.2 | 86 | 72.1 | 46.8 | 146 | 122.4 | 79.5 | 206 | 172.8 | 112.2 | 266 | 223.1 | 144.9 |
| 27 | 22.6 | 14.7 | 87 | 73.0 | 47.4 | 147 | 123.3 | 80.1 | 207 | 173.6 | 112.7 | 267 | 223.9 | 145.4 |
| 28 | 23.5 | 15.2 | 88 | 73.8 | 47.9 | 148 | 124.1 | 80.6 | 208 | 174.4 | 113.3 | 268 | 224.8 | 146.0 |
| 29 | 24.3 | 15.8 | 89 | 74.6 | 48.5 | 149 | 125.0 | 81.2 | 209 | 175.3 | 113.8 | 269 | 225.6 | 146.5 |
| 30 | 25.2 | 16.3 | 90 | 75.5 | 49.0 | 150 | 125.8 | 81.7 | 210 | 176.1 | 114.4 | 270 | 226.4 | 147.1 |
| 31 | 26.0 | 16.9 | 91 | 76.3 | 49.6 | 151 | 126.6 | 82.2 | 211 | 177.0 | 114.9 | 271 | 227.3 | 147.6 |
| 32 | 26.8 | 17.4 | 92 | 77.2 | 50.1 | 152 | 127.5 | 82.8 | 212 | 177.8 | 115.5 | 272 | 228.1 | 148.1 |
| 33 | 27.7 | 18.0 | 93 | 78.0 | 50.7 | 153 | 128.3 | 83.3 | 213 | 178.6 | 116.0 | 273 | 229.0 | 148.7 |
| 34 | 28.5 | 18.5 | 94 | 78.8 | 51.2 | 154 | 129.2 | 83.9 | 214 | 179.5 | 116.6 | 274 | 229.8 | 149.2 |
| 35 | 29.4 | 19.1 | 95 | 79.7 | 51.7 | 155 | 130.0 | 84.4 | 215 | 180.3 | 117.1 | 275 | 230.6 | 149.8 |
| 36 | 30.2 | 19.6 | 96 | 80.5 | 52.3 | 156 | 130.8 | 85.0 | 216 | 181.2 | 117.6 | 276 | 231.5 | 150.3 |
| 37 | 31.0 | 20.2 | 97 | 81.4 | 52.8 | 157 | 131.7 | 85.5 | 217 | 182.0 | 118.2 | 277 | 232.3 | 150.9 |
| 38 | 31.9 | 20.7 | 98 | 82.2 | 53.4 | 158 | 132.5 | 86.1 | 218 | 182.8 | 118.7 | 278 | 233.2 | 151.4 |
| 39 | 32.7 | 21.2 | 99 | 83.0 | 53.9 | 159 | 133.3 | 86.6 | 219 | 183.7 | 119.3 | 279 | 234.0 | 152.0 |
| 40 | 33.5 | 21.8 | 100 | 83.9 | 54.5 | 160 | 134.2 | 87.1 | 220 | 184.5 | 119.8 | 280 | 234.8 | 152.5 |
| 41 | 34.4 | 22.3 | 101 | 84.7 | 55.0 | 161 | 135.0 | 87.7 | 221 | 185.3 | 120.4 | 281 | 235.7 | 153.0 |
| 42 | 35.2 | 22.9 | 102 | 85.5 | 55.6 | 162 | 135.9 | 88.2 | 222 | 186.2 | 120.9 | 282 | 236.5 | 153.6 |
| 43 | 36.1 | 23.4 | 103 | 86.4 | 56.1 | 163 | 136.7 | 88.8 | 223 | 187.0 | 121.5 | 283 | 237.3 | 154.1 |
| 44 | 36.9 | 24.0 | 104 | 87.2 | 56.6 | 164 | 137.5 | 89.3 | 224 | 187.9 | 122.0 | 284 | 238.2 | 154.7 |
| 45 | 37.7 | 24.5 | 105 | 88.1 | 57.2 | 165 | 138.4 | 89.9 | 225 | 188.7 | 122.5 | 285 | 239.0 | 155.2 |
| 46 | 38.6 | 25.1 | 106 | 88.9 | 57.7 | 166 | 139.2 | 90.4 | 226 | 189.5 | 123.1 | 286 | 239.9 | 155.8 |
| 47 | 39.4 | 25.6 | 107 | 89.7 | 58.3 | 167 | 140.1 | 91.0 | 227 | 190.4 | 123.6 | 287 | 240.7 | 156.3 |
| 48 | 40.3 | 26.1 | 108 | 90.6 | 58.8 | 168 | 140.9 | 91.5 | 228 | 191.2 | 124.2 | 288 | 241.5 | 156.9 |
| 49 | 41.1 | 26.7 | 109 | 91.4 | 59.4 | 169 | 141.7 | 92.0 | 229 | 192.1 | 124.7 | 289 | 242.4 | 157.4 |
| 50 | 41.9 | 27.2 | 110 | 92.3 | 59.9 | 170 | 142.6 | 92.6 | 230 | 192.9 | 125.3 | 290 | 243.2 | 157.9 |
| 51 | 42.8 | 27.8 | 111 | 93.1 | 60.5 | 171 | 143.4 | 93.1 | 231 | 193.7 | 125.8 | 291 | 244.1 | 158.5 |
| 52 | 43.6 | 28.3 | 112 | 93.9 | 61.0 | 172 | 144.3 | 93.7 | 232 | 194.6 | 126.4 | 292 | 244.9 | 159.0 |
| 53 | 44.4 | 28.9 | 113 | 94.8 | 61.5 | 173 | 145.1 | 94.2 | 233 | 195.4 | 126.9 | 293 | 245.7 | 159.6 |
| 54 | 45.3 | 29.4 | 114 | 95.6 | 62.1 | 174 | 145.9 | 94.8 | 234 | 196.2 | 127.4 | 294 | 246.6 | 160.1 |
| 55 | 46.1 | 30.0 | 115 | 96.4 | 62.6 | 175 | 146.8 | 95.3 | 235 | 197.1 | 128.0 | 295 | 247.4 | 160.7 |
| 56 | 47.0 | 30.5 | 116 | 97.3 | 63.2 | 176 | 147.6 | 95.9 | 236 | 197.9 | 128.5 | 296 | 248.2 | 161.2 |
| 57 | 47.8 | 31.0 | 117 | 98.1 | 63.7 | 177 | 148.4 | 96.4 | 237 | 198.8 | 129.1 | 297 | 249.1 | 161.8 |
| 58 | 48.6 | 31.6 | 118 | 99.0 | 64.3 | 178 | 149.3 | 96.9 | 238 | 199.6 | 129.6 | 298 | 249.9 | 162.3 |
| 59 | 49.5 | 32.1 | 119 | 99.8 | 64.8 | 179 | 150.1 | 97.5 | 239 | 200.4 | 130.2 | 299 | 250.8 | 162.8 |
| 60 | 50.3 | 32.7 | 120 | 100.6 | 65.4 | 180 | 151.0 | 98.0 | 240 | 201.3 | 130.7 | 300 | 251.6 | 163.4 |
| Dist. | Dep. | D.Lat | Dist. | Dep. | D.Lat | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

57° $3^h\ 48^m$

## TRAVERSE TABLE TO DEGREES

33° 2h 12m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 252.4 | 163.9 | 361 | 302.8 | 196.6 | 421 | 353.1 | 229.3 | 481 | 403.4 | 262.0 | 541 | 453.7 | 294.6 |
| 302 | 253.3 | 164.4 | 362 | 303.6 | 197.1 | 422 | 353.9 | 229.8 | 482 | 404.2 | 262.5 | 542 | 454.6 | 295.2 |
| 303 | 254.1 | 165.0 | 363 | 304.4 | 197.7 | 423 | 354.7 | 230.4 | 483 | 405.1 | 263.1 | 543 | 455.4 | 295.7 |
| 304 | 255.0 | 165.5 | 364 | 305.3 | 198.2 | 424 | 355.6 | 230.9 | 484 | 405.9 | 263.6 | 544 | 456.2 | 296.2 |
| 305 | 255.8 | 166.1 | 365 | 306.1 | 198.8 | 425 | 356.4 | 231.4 | 485 | 406.7 | 264.1 | 545 | 457.1 | 296.8 |
| 306 | 256.6 | 166.6 | 366 | 307.0 | 199.3 | 426 | 357.3 | 232.0 | 486 | 407.6 | 264.7 | 546 | 457.9 | 297.3 |
| 307 | 257.5 | 167.2 | 367 | 307.8 | 199.8 | 427 | 358.1 | 232.5 | 487 | 408.4 | 265.2 | 547 | 458.8 | 297.9 |
| 308 | 258.3 | 167.7 | 368 | 308.6 | 200.4 | 428 | 359.0 | 233.1 | 488 | 409.3 | 265.8 | 548 | 459.6 | 298.4 |
| 309 | 259.2 | 168.3 | 369 | 309.5 | 200.9 | 429 | 359.8 | 233.6 | 489 | 410.1 | 266.3 | 549 | 460.4 | 299.0 |
| 310 | 260.0 | 168.8 | 370 | 310.3 | 201.5 | 430 | 360.6 | 234.2 | 490 | 411.0 | 266.8 | 550 | 461.3 | 299.5 |
| 311 | 260.8 | 169.3 | 371 | 311.2 | 202.0 | 431 | 361.5 | 234.7 | 491 | 411.8 | 267.4 | 551 | 462.1 | 300.1 |
| 312 | 261.7 | 169.9 | 372 | 312.0 | 202.6 | 432 | 362.3 | 235.3 | 492 | 412.6 | 267.9 | 552 | 463.0 | 300.6 |
| 313 | 262.5 | 170.4 | 373 | 312.8 | 203.1 | 433 | 363.1 | 235.8 | 493 | 413.5 | 268.5 | 553 | 463.8 | 301.2 |
| 314 | 263.3 | 171.0 | 374 | 313.7 | 203.7 | 434 | 364.0 | 236.3 | 494 | 414.3 | 269.0 | 554 | 464.6 | 301.7 |
| 315 | 264.2 | 171.5 | 375 | 314.5 | 204.2 | 435 | 364.8 | 236.9 | 495 | 415.1 | 269.6 | 555 | 465.5 | 302.3 |
| 316 | 265.0 | 172.1 | 376 | 315.3 | 204.7 | 436 | 365.7 | 237.4 | 496 | 416.0 | 270.1 | 556 | 466.3 | 302.9 |
| 317 | 265.9 | 172.6 | 377 | 316.2 | 205.3 | 437 | 366.5 | 238.0 | 497 | 416.8 | 270.7 | 557 | 467.2 | 303.4 |
| 318 | 266.7 | 173.2 | 378 | 317.0 | 205.8 | 438 | 367.3 | 238.5 | 498 | 417.6 | 271.2 | 558 | 468.0 | 303.9 |
| 319 | 267.5 | 173.7 | 379 | 317.9 | 206.4 | 439 | 368.2 | 239.1 | 499 | 418.5 | 271.8 | 559 | 468.8 | 304.5 |
| 320 | 268.4 | 174.2 | 380 | 318.7 | 206.9 | 440 | 369.0 | 239.6 | 500 | 419.3 | 272.3 | 560 | 469.7 | 305.0 |
| 321 | 269.2 | 174.8 | 381 | 319.5 | 207.5 | 441 | 369.9 | 240.1 | 501 | 420.2 | 272.8 | 561 | 470.5 | 305.5 |
| 322 | 270.1 | 175.3 | 382 | 320.4 | 208.0 | 442 | 370.7 | 240.7 | 502 | 421.0 | 273.4 | 562 | 471.3 | 306.1 |
| 323 | 270.9 | 175.9 | 383 | 321.2 | 208.6 | 443 | 371.5 | 241.2 | 503 | 421.9 | 273.9 | 563 | 472.2 | 306.6 |
| 324 | 271.7 | 176.4 | 384 | 322.1 | 209.1 | 444 | 372.4 | 241.8 | 504 | 422.7 | 274.5 | 564 | 473.0 | 307.2 |
| 325 | 272.6 | 177.0 | 385 | 322.9 | 209.6 | 445 | 373.2 | 242.3 | 505 | 423.5 | 275.0 | 565 | 473.8 | 307.7 |
| 326 | 273.4 | 177.5 | 386 | 323.7 | 210.2 | 446 | 374.1 | 242.9 | 506 | 424.4 | 275.6 | 566 | 474.7 | 308.3 |
| 327 | 274.2 | 178.1 | 387 | 324.6 | 210.7 | 447 | 374.9 | 243.4 | 507 | 425.2 | 276.1 | 567 | 475.5 | 308.8 |
| 328 | 275.1 | 178.6 | 388 | 325.4 | 211.3 | 448 | 375.7 | 244.0 | 508 | 426.0 | 276.7 | 568 | 476.4 | 309.4 |
| 329 | 275.9 | 179.1 | 389 | 326.2 | 211.8 | 449 | 376.6 | 244.5 | 509 | 426.9 | 277.2 | 569 | 477.2 | 309.9 |
| 330 | 276.8 | 179.7 | 390 | 327.1 | 212.4 | 450 | 377.4 | 245.1 | 510 | 427.7 | 277.8 | 570 | 478.0 | 310.4 |
| 331 | 277.6 | 180.2 | 391 | 327.9 | 212.9 | 451 | 378.2 | 245.6 | 511 | 428.5 | 278.3 | 571 | 478.9 | 311.0 |
| 332 | 278.4 | 180.8 | 392 | 328.8 | 213.5 | 452 | 379.1 | 246.1 | 512 | 429.4 | 278.8 | 572 | 479.7 | 311.5 |
| 333 | 279.3 | 181.3 | 393 | 329.6 | 214.0 | 453 | 379.9 | 246.7 | 513 | 430.2 | 279.4 | 573 | 480.6 | 312.0 |
| 334 | 280.1 | 181.9 | 394 | 330.4 | 214.6 | 454 | 380.8 | 247.2 | 514 | 431.1 | 279.9 | 574 | 481.4 | 312.6 |
| 335 | 281.0 | 182.4 | 395 | 331.3 | 215.1 | 455 | 381.6 | 247.8 | 515 | 431.9 | 280.4 | 575 | 482.2 | 313.1 |
| 336 | 281.8 | 183.0 | 396 | 332.1 | 215.6 | 456 | 382.4 | 248.3 | 516 | 432.7 | 281.0 | 576 | 483.1 | 313.7 |
| 337 | 282.6 | 183.5 | 397 | 333.0 | 216.2 | 457 | 383.3 | 248.9 | 517 | 433.6 | 281.5 | 577 | 483.9 | 314.2 |
| 338 | 283.5 | 184.1 | 398 | 333.8 | 216.7 | 458 | 384.1 | 249.4 | 518 | 434.4 | 282.1 | 578 | 484.7 | 314.8 |
| 339 | 284.3 | 184.6 | 399 | 334.6 | 217.3 | 459 | 385.0 | 250.0 | 519 | 435.3 | 282.6 | 579 | 485.6 | 315.3 |
| 340 | 285.2 | 185.1 | 400 | 335.5 | 217.8 | 460 | 385.8 | 250.5 | 520 | 436.1 | 283.2 | 580 | 486.4 | 315.9 |
| 341 | 286.0 | 185.7 | 401 | 336.3 | 218.4 | 461 | 386.6 | 251.0 | 521 | 436.9 | 283.7 | 581 | 487.2 | 316.4 |
| 342 | 286.8 | 186.2 | 402 | 337.1 | 218.9 | 462 | 387.5 | 251.6 | 522 | 437.8 | 284.3 | 582 | 488.1 | 317.0 |
| 343 | 287.7 | 186.8 | 403 | 338.0 | 219.5 | 463 | 388.3 | 252.1 | 523 | 438.6 | 284.8 | 583 | 488.9 | 317.5 |
| 344 | 288.5 | 187.3 | 404 | 338.8 | 220.0 | 464 | 389.1 | 252.7 | 524 | 439.4 | 285.4 | 584 | 489.8 | 318.1 |
| 345 | 289.3 | 187.9 | 405 | 339.7 | 220.5 | 465 | 390.0 | 253.2 | 525 | 440.3 | 285.9 | 585 | 490.6 | 318.6 |
| 346 | 290.2 | 188.4 | 406 | 340.5 | 221.1 | 466 | 390.8 | 253.8 | 526 | 441.1 | 286.5 | 586 | 491.5 | 319.2 |
| 347 | 291.0 | 189.0 | 407 | 341.3 | 221.6 | 467 | 391.7 | 254.3 | 527 | 442.0 | 287.0 | 587 | 492.3 | 319.7 |
| 348 | 291.9 | 189.5 | 408 | 342.2 | 222.2 | 468 | 392.5 | 254.9 | 528 | 442.8 | 287.5 | 588 | 493.1 | 320.2 |
| 349 | 292.7 | 190.0 | 409 | 343.0 | 222.7 | 469 | 393.3 | 255.4 | 529 | 443.6 | 288.1 | 589 | 494.0 | 320.8 |
| 350 | 293.5 | 190.6 | 410 | 343.9 | 223.3 | 470 | 394.2 | 255.9 | 530 | 444.5 | 288.6 | 590 | 494.8 | 321.3 |
| 351 | 294.4 | 191.1 | 411 | 344.7 | 223.8 | 471 | 395.0 | 256.5 | 531 | 445.3 | 289.2 | 591 | 495.7 | 321.9 |
| 352 | 295.2 | 191.7 | 412 | 345.5 | 224.4 | 472 | 395.8 | 257.0 | 532 | 446.1 | 289.7 | 592 | 496.5 | 322.4 |
| 353 | 296.1 | 192.2 | 413 | 346.4 | 224.9 | 473 | 396.7 | 257.6 | 533 | 447.0 | 290.3 | 593 | 497.3 | 322.9 |
| 354 | 296.9 | 192.8 | 414 | 347.2 | 225.4 | 474 | 397.5 | 258.1 | 534 | 447.8 | 290.8 | 594 | 498.1 | 323.5 |
| 355 | 297.7 | 193.3 | 415 | 348.1 | 226.0 | 475 | 398.3 | 258.7 | 535 | 448.7 | 291.4 | 595 | 499.0 | 324.1 |
| 356 | 298.6 | 193.9 | 416 | 348.9 | 226.5 | 476 | 399.2 | 259.2 | 536 | 449.5 | 291.9 | 596 | 499.8 | 324.6 |
| 357 | 299.4 | 194.4 | 417 | 349.7 | 227.1 | 477 | 400.0 | 259.8 | 537 | 450.3 | 292.5 | 597 | 500.6 | 325.1 |
| 358 | 300.2 | 194.9 | 418 | 350.6 | 227.6 | 478 | 400.9 | 260.3 | 538 | 451.2 | 293.0 | 598 | 501.5 | 325.7 |
| 359 | 301.1 | 195.5 | 419 | 351.4 | 228.2 | 479 | 401.7 | 260.9 | 539 | 452.0 | 293.6 | 599 | 502.3 | 326.2 |
| 360 | 301.9 | 196.0 | 420 | 352.2 | 228.7 | 480 | 402.6 | 261.4 | 540 | 452.9 | 294.1 | 600 | 503.2 | 326.8 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

57° 3h 48m

## TRAVERSE TABLE TO DEGREES

| 34° | | | | | | | | | | | | | 2h 16m | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
| 1 | 0·8 | 0·6 | 61 | 50·6 | 34·1 | 121 | 100·3 | 67·7 | 181 | 150·1 | 101·2 | 241 | 199·8 | 134·8 |
| 2 | 1·7 | 1·1 | 62 | 51·4 | 34·7 | 122 | 101·1 | 68·2 | 182 | 150·9 | 101·8 | 242 | 200·6 | 135·3 |
| 3 | 2·5 | 1·7 | 63 | 52·2 | 35·2 | 123 | 102·0 | 68·8 | 183 | 151·7 | 102·3 | 243 | 201·5 | 135·9 |
| 4 | 3·3 | 2·2 | 64 | 53·1 | 35·8 | 124 | 102·8 | 69·3 | 184 | 152·5 | 102·9 | 244 | 202·3 | 136·4 |
| 5 | 4·1 | 2·8 | 65 | 53·9 | 36·3 | 125 | 103·6 | 69·9 | 185 | 153·4 | 103·5 | 245 | 203·1 | 137·0 |
| 6 | 5·0 | 3·4 | 66 | 54·7 | 36·9 | 126 | 104·5 | 70·5 | 186 | 154·2 | 104·0 | 246 | 203·9 | 137·6 |
| 7 | 5·8 | 3·9 | 67 | 55·5 | 37·5 | 127 | 105·3 | 71·0 | 187 | 155·0 | 104·6 | 247 | 204·8 | 138·1 |
| 8 | 6·6 | 4·5 | 68 | 56·4 | 38·0 | 128 | 106·1 | 71·6 | 188 | 155·9 | 105·1 | 248 | 205·6 | 138·7 |
| 9 | 7·5 | 5·0 | 69 | 57·2 | 38·6 | 129 | 106·9 | 72·1 | 189 | 156·7 | 105·7 | 249 | 206·4 | 139·2 |
| 10 | 8·3 | 5·6 | 70 | 58·0 | 39·1 | 130 | 107·8 | 72·7 | 190 | 157·5 | 106·2 | 250 | 207·3 | 139·8 |
| 11 | 9·1 | 6·2 | 71 | 58·9 | 39·7 | 131 | 108·6 | 73·3 | 191 | 158·3 | 106·8 | 251 | 208·1 | 140·4 |
| 12 | 9·9 | 6·7 | 72 | 59·7 | 40·3 | 132 | 109·4 | 73·8 | 192 | 159·2 | 107·4 | 252 | 208·9 | 140·9 |
| 13 | 10·8 | 7·3 | 73 | 60·5 | 40·8 | 133 | 110·3 | 74·4 | 193 | 160·0 | 107·9 | 253 | 209·7 | 141·5 |
| 14 | 11·6 | 7·8 | 74 | 61·3 | 41·4 | 134 | 111·1 | 74·9 | 194 | 160·8 | 108·5 | 254 | 210·6 | 142·0 |
| 15 | 12·4 | 8·4 | 75 | 62·2 | 41·9 | 135 | 111·9 | 75·5 | 195 | 161·7 | 109·0 | 255 | 211·4 | 142·6 |
| 16 | 13·3 | 8·9 | 76 | 63·0 | 42·5 | 136 | 112·7 | 76·1 | 196 | 162·5 | 109·6 | 256 | 212·2 | 143·2 |
| 17 | 14·1 | 9·5 | 77 | 63·8 | 43·1 | 137 | 113·6 | 76·6 | 197 | 163·3 | 110·2 | 257 | 213·1 | 143·7 |
| 18 | 14·9 | 10·1 | 78 | 64·7 | 43·6 | 138 | 114·4 | 77·2 | 198 | 164·1 | 110·7 | 258 | 213·9 | 144·3 |
| 19 | 15·8 | 10·6 | 79 | 65·5 | 44·2 | 139 | 115·2 | 77·7 | 199 | 165·0 | 111·3 | 259 | 214·7 | 144·8 |
| 20 | 16·6 | 11·2 | 80 | 66·3 | 44·7 | 140 | 116·1 | 78·3 | 200 | 165·8 | 111·8 | 260 | 215·5 | 145·4 |
| 21 | 17·4 | 11·7 | 81 | 67·2 | 45·3 | 141 | 116·9 | 78·8 | 201 | 166·6 | 112·4 | 261 | 216·4 | 145·9 |
| 22 | 18·2 | 12·3 | 82 | 68·0 | 45·9 | 142 | 117·7 | 79·4 | 202 | 167·5 | 113·0 | 262 | 217·2 | 146·5 |
| 23 | 19·1 | 12·9 | 83 | 68·8 | 46·4 | 143 | 118·6 | 80·0 | 203 | 168·3 | 113·5 | 263 | 218·0 | 147·1 |
| 24 | 19·9 | 13·4 | 84 | 69·6 | 47·0 | 144 | 119·4 | 80·5 | 204 | 169·1 | 114·1 | 264 | 218·9 | 147·6 |
| 25 | 20·7 | 14·0 | 85 | 70·5 | 47·5 | 145 | 120·2 | 81·1 | 205 | 170·0 | 114·6 | 265 | 219·7 | 148·2 |
| 26 | 21·6 | 14·5 | 86 | 71·3 | 48·1 | 146 | 121·0 | 81·6 | 206 | 170·8 | 115·2 | 266 | 220·5 | 148·7 |
| 27 | 22·4 | 15·1 | 87 | 72·1 | 48·6 | 147 | 121·9 | 82·2 | 207 | 171·6 | 115·8 | 267 | 221·4 | 149·3 |
| 28 | 23·2 | 15·7 | 88 | 73·0 | 49·2 | 148 | 122·7 | 82·8 | 208 | 172·4 | 116·3 | 268 | 222·2 | 149·9 |
| 29 | 24·0 | 16·2 | 89 | 73·8 | 49·8 | 149 | 123·5 | 83·3 | 209 | 173·3 | 116·9 | 269 | 223·0 | 150·4 |
| 30 | 24·9 | 16·8 | 90 | 74·6 | 50·3 | 150 | 124·4 | 83·9 | 210 | 174·1 | 117·4 | 270 | 223·8 | 151·0 |
| 31 | 25·7 | 17·3 | 91 | 75·4 | 50·9 | 151 | 125·2 | 84·4 | 211 | 174·9 | 118·0 | 271 | 224·7 | 151·5 |
| 32 | 26·5 | 17·9 | 92 | 76·3 | 51·4 | 152 | 126·0 | 85·0 | 212 | 175·8 | 118·5 | 272 | 225·5 | 152·1 |
| 33 | 27·4 | 18·5 | 93 | 77·1 | 52·0 | 153 | 126·8 | 85·6 | 213 | 176·6 | 119·1 | 273 | 226·3 | 152·7 |
| 34 | 28·2 | 19·0 | 94 | 77·9 | 52·6 | 154 | 127·7 | 86·1 | 214 | 177·4 | 119·7 | 274 | 227·2 | 153·2 |
| 35 | 29·0 | 19·6 | 95 | 78·8 | 53·1 | 155 | 128·5 | 86·7 | 215 | 178·2 | 120·2 | 275 | 228·0 | 153·8 |
| 36 | 29·8 | 20·1 | 96 | 79·6 | 53·7 | 156 | 129·3 | 87·2 | 216 | 179·1 | 120·8 | 276 | 228·8 | 154·3 |
| 37 | 30·7 | 20·7 | 97 | 80·4 | 54·2 | 157 | 130·2 | 87·8 | 217 | 179·9 | 121·3 | 277 | 229·6 | 154·9 |
| 38 | 31·5 | 21·2 | 98 | 81·2 | 54·8 | 158 | 131·0 | 88·4 | 218 | 180·7 | 121·9 | 278 | 230·5 | 155·5 |
| 39 | 32·3 | 21·8 | 99 | 82·1 | 55·4 | 159 | 131·8 | 88·9 | 219 | 181·6 | 122·5 | 279 | 231·3 | 156·0 |
| 40 | 33·2 | 22·4 | 100 | 82·9 | 55·9 | 160 | 132·6 | 89·5 | 220 | 182·4 | 123·0 | 280 | 232·1 | 156·6 |
| 41 | 34·0 | 22·9 | 101 | 83·7 | 56·5 | 161 | 133·5 | 90·0 | 221 | 183·2 | 123·6 | 281 | 233·0 | 157·1 |
| 42 | 34·8 | 23·5 | 102 | 84·6 | 57·0 | 162 | 134·3 | 90·6 | 222 | 184·0 | 124·1 | 282 | 233·8 | 157·7 |
| 43 | 35·6 | 24·0 | 103 | 85·4 | 57·6 | 163 | 135·1 | 91·1 | 223 | 184·9 | 124·7 | 283 | 234·6 | 158·3 |
| 44 | 36·5 | 24·6 | 104 | 86·2 | 58·2 | 164 | 136·0 | 91·7 | 224 | 185·7 | 125·3 | 284 | 235·4 | 158·8 |
| 45 | 37·3 | 25·2 | 105 | 87·0 | 58·7 | 165 | 136·8 | 92·3 | 225 | 186·5 | 125·8 | 285 | 236·3 | 159·4 |
| 46 | 38·1 | 25·7 | 106 | 87·9 | 59·3 | 166 | 137·6 | 92·8 | 226 | 187·4 | 126·4 | 286 | 237·1 | 159·9 |
| 47 | 39·0 | 26·3 | 107 | 88·7 | 59·8 | 167 | 138·4 | 93·4 | 227 | 188·2 | 126·9 | 287 | 237·9 | 160·5 |
| 48 | 39·8 | 26·8 | 108 | 89·5 | 60·4 | 168 | 139·3 | 93·9 | 228 | 189·0 | 127·5 | 288 | 238·8 | 161·0 |
| 49 | 40·6 | 27·4 | 109 | 90·4 | 61·0 | 169 | 140·1 | 94·5 | 229 | 189·8 | 128·1 | 289 | 239·6 | 161·6 |
| 50 | 41·5 | 28·0 | 110 | 91·2 | 61·5 | 170 | 140·9 | 95·1 | 230 | 190·7 | 128·6 | 290 | 240·4 | 162·2 |
| 51 | 42·3 | 28·5 | 111 | 92·0 | 62·1 | 171 | 141·8 | 95·6 | 231 | 191·5 | 129·2 | 291 | 241·2 | 162·7 |
| 52 | 43·1 | 29·1 | 112 | 92·9 | 62·6 | 172 | 142·6 | 96·2 | 232 | 192·3 | 129·7 | 292 | 242·1 | 163·3 |
| 53 | 43·9 | 29·6 | 113 | 93·7 | 63·2 | 173 | 143·4 | 96·7 | 233 | 193·2 | 130·3 | 293 | 242·9 | 163·8 |
| 54 | 44·8 | 30·2 | 114 | 94·5 | 63·7 | 174 | 144·3 | 97·3 | 234 | 194·0 | 130·9 | 294 | 243·7 | 164·4 |
| 55 | 45·6 | 30·8 | 115 | 95·3 | 64·3 | 175 | 145·1 | 97·9 | 235 | 194·8 | 131·4 | 295 | 244·6 | 165·0 |
| 56 | 46·4 | 31·3 | 116 | 96·2 | 64·9 | 176 | 145·9 | 98·4 | 236 | 195·7 | 132·0 | 296 | 245·4 | 165·5 |
| 57 | 47·3 | 31·9 | 117 | 97·0 | 65·4 | 177 | 146·7 | 99·0 | 237 | 196·5 | 132·5 | 297 | 246·2 | 166·1 |
| 58 | 48·1 | 32·4 | 118 | 97·8 | 66·0 | 178 | 147·6 | 99·5 | 238 | 197·3 | 133·1 | 298 | 247·1 | 166·6 |
| 59 | 48·9 | 33·0 | 119 | 98·7 | 66·5 | 179 | 148·4 | 100·1 | 239 | 198·1 | 133·6 | 299 | 247·9 | 167·2 |
| 60 | 49·7 | 33·6 | 120 | 99·5 | 67·1 | 180 | 149·2 | 100·7 | 240 | 199·0 | 134·2 | 300 | 248·7 | 167·8 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |
| 56° | | | | | | | | | | | | | 3h 44m | |

## TRAVERSE TABLE TO DEGREES

34° 2h 16m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 249·5 | 168·3 | 361 | 299·3 | 201·9 | 421 | 349·0 | 235·4 | 481 | 398·8 | 269·0 | 541 | 448·5 | 302·5 |
| 302 | 250·4 | 168·9 | 362 | 300·1 | 202·4 | 422 | 349·9 | 236·0 | 482 | 399·6 | 269·5 | 542 | 449·4 | 303·1 |
| 303 | 251·2 | 169·4 | 363 | 300·9 | 203·0 | 423 | 350·7 | 236·5 | 483 | 400·4 | 270·1 | 543 | 450·2 | 303·6 |
| 304 | 252·0 | 170·0 | 364 | 301·8 | 203·5 | 424 | 351·5 | 237·1 | 484 | 401·3 | 270·6 | 544 | 451·0 | 304·2 |
| 305 | 252·9 | 170·6 | 365 | 302·6 | 204·1 | 425 | 352·3 | 237·7 | 485 | 402·1 | 271·2 | 545 | 451·8 | 304·8 |
| 306 | 253·7 | 171·1 | 366 | 303·4 | 204·7 | 426 | 353·2 | 238·2 | 486 | 402·9 | 271·8 | 546 | 452·6 | 305·3 |
| 307 | 254·5 | 171·7 | 367 | 304·3 | 205·2 | 427 | 354·0 | 238·8 | 487 | 403·8 | 272·3 | 547 | 453·5 | 305·9 |
| 308 | 255·3 | 172·2 | 368 | 305·1 | 205·8 | 428 | 354·8 | 239·3 | 488 | 404·6 | 272·8 | 548 | 454·3 | 306·4 |
| 309 | 256·2 | 172·8 | 369 | 305·9 | 206·3 | 429 | 355·7 | 239·9 | 489 | 405·4 | 273·4 | 549 | 455·2 | 307·0 |
| 310 | 257·0 | 173·3 | 370 | 306·7 | 206·9 | 430 | 356·5 | 240·4 | 490 | 406·2 | 274·0 | 550 | 456·0 | 307·5 |
| 311 | 257·8 | 173·9 | 371 | 307·6 | 207·5 | 431 | 357·3 | 241·0 | 491 | 407·1 | 274·6 | 551 | 456·8 | 308·1 |
| 312 | 258·7 | 174·5 | 372 | 308·4 | 208·0 | 432 | 358·1 | 241·6 | 492 | 407·9 | 275·1 | 552 | 457·6 | 308·7 |
| 313 | 259·5 | 175·0 | 373 | 309·2 | 208·6 | 433 | 359·0 | 242·1 | 493 | 408·7 | 275·7 | 553 | 458·4 | 309·2 |
| 314 | 260·3 | 175·6 | 374 | 310·1 | 209·1 | 434 | 359·8 | 242·7 | 494 | 409·5 | 276·2 | 554 | 459·3 | 309·8 |
| 315 | 261·2 | 176·1 | 375 | 310·9 | 209·7 | 435 | 360·6 | 243·2 | 495 | 410·4 | 276·8 | 555 | 460·1 | 310·3 |
| 316 | 262·0 | 176·7 | 376 | 311·7 | 210·3 | 436 | 361·5 | 243·8 | 496 | 411·2 | 277·4 | 556 | 460·9 | 310·9 |
| 317 | 262·8 | 177·3 | 377 | 312·6 | 210·8 | 437 | 362·3 | 244·4 | 497 | 412·0 | 277·9 | 557 | 461·7 | 311·5 |
| 318 | 263·7 | 177·8 | 378 | 313·4 | 211·4 | 438 | 363·1 | 244·9 | 498 | 412·8 | 278·4 | 558 | 462·6 | 312·0 |
| 319 | 264·5 | 178·4 | 379 | 314·2 | 211·9 | 439 | 364·0 | 245·5 | 499 | 413·7 | 279·0 | 559 | 463·4 | 312·6 |
| 320 | 265·3 | 178·9 | 380 | 315·0 | 212·5 | 440 | 364·8 | 246·0 | 500 | 414·5 | 279·6 | 560 | 464·2 | 313·1 |
| 321 | 266·1 | 179·5 | 381 | 315·9 | 213·0 | 441 | 365·6 | 246·6 | 501 | 415·3 | 280·1 | 561 | 465·1 | 313·7 |
| 322 | 267·0 | 180·1 | 382 | 316·7 | 213·6 | 442 | 366·4 | 247·2 | 502 | 416·2 | 280·7 | 562 | 465·9 | 314·3 |
| 323 | 267·8 | 180·6 | 383 | 317·5 | 214·2 | 443 | 367·3 | 247·7 | 503 | 417·0 | 281·3 | 563 | 466·8 | 314·8 |
| 324 | 268·6 | 181·2 | 384 | 318·4 | 214·7 | 444 | 368·1 | 248·3 | 504 | 417·8 | 281·8 | 564 | 467·6 | 315·4 |
| 325 | 269·5 | 181·7 | 385 | 319·2 | 215·3 | 445 | 368·9 | 248·8 | 505 | 418·6 | 282·4 | 565 | 468·4 | 315·9 |
| 326 | 270·3 | 182·3 | 386 | 320·0 | 215·8 | 446 | 369·8 | 249·4 | 506 | 419·4 | 282·9 | 566 | 469·2 | 316·5 |
| 327 | 271·1 | 182·9 | 387 | 320·8 | 216·4 | 447 | 370·6 | 250·0 | 507 | 420·3 | 283·5 | 567 | 470·1 | 317·1 |
| 328 | 271·9 | 183·4 | 388 | 321·7 | 217·0 | 448 | 371·4 | 250·5 | 508 | 421·1 | 284·1 | 568 | 470·9 | 317·6 |
| 329 | 272·8 | 184·0 | 389 | 322·5 | 217·5 | 449 | 372·2 | 251·1 | 509 | 421·9 | 284·6 | 569 | 471·7 | 318·2 |
| 330 | 273·6 | 184·5 | 390 | 323·3 | 218·1 | 450 | 373·1 | 251·6 | 510 | 422·8 | 285·2 | 570 | 472·6 | 318·7 |
| 331 | 274·4 | 185·1 | 391 | 324·2 | 218·6 | 451 | 373·9 | 252·2 | 511 | 423·6 | 285·8 | 571 | 473·4 | 319·3 |
| 332 | 275·2 | 185·6 | 392 | 325·0 | 219·2 | 452 | 374·7 | 252·8 | 512 | 424·4 | 286·3 | 572 | 474·2 | 319·9 |
| 333 | 276·1 | 186·2 | 393 | 325·8 | 219·8 | 453 | 375·6 | 253·3 | 513 | 425·3 | 286·9 | 573 | 475·0 | 320·4 |
| 334 | 276·9 | 186·8 | 394 | 326·6 | 220·3 | 454 | 376·4 | 253·9 | 514 | 426·1 | 287·4 | 574 | 475·9 | 321·0 |
| 335 | 277·7 | 187·3 | 395 | 327·5 | 220·9 | 455 | 377·2 | 254·4 | 515 | 426·9 | 288·0 | 575 | 476·7 | 321·5 |
| 336 | 278·6 | 187·9 | 396 | 328·3 | 221·4 | 456 | 378·0 | 255·0 | 516 | 427·8 | 288·5 | 576 | 477·5 | 322·1 |
| 337 | 279·4 | 188·4 | 397 | 329·1 | 222·0 | 457 | 378·9 | 255·5 | 517 | 428·6 | 289·1 | 577 | 478·3 | 322·7 |
| 338 | 280·2 | 189·0 | 398 | 330·0 | 222·6 | 458 | 379·7 | 256·1 | 518 | 429·4 | 289·6 | 578 | 479·2 | 323·2 |
| 339 | 281·0 | 189·6 | 399 | 330·8 | 223·1 | 459 | 380·5 | 256·7 | 519 | 430·3 | 290·2 | 579 | 480·0 | 323·8 |
| 340 | 281·9 | 190·1 | 400 | 331·6 | 223·7 | 460 | 381·3 | 257·2 | 520 | 431·1 | 290·8 | 580 | 480·8 | 324·3 |
| 341 | 282·7 | 190·7 | 401 | 332·4 | 224·2 | 461 | 382·2 | 257·8 | 521 | 431·9 | 291·3 | 581 | 481·6 | 324·9 |
| 342 | 283·5 | 191·2 | 402 | 333·3 | 224·8 | 462 | 383·0 | 258·3 | 522 | 432·8 | 291·9 | 582 | 482·5 | 325·4 |
| 343 | 284·4 | 191·8 | 403 | 334·1 | 225·4 | 463 | 383·8 | 258·9 | 523 | 433·6 | 292·5 | 583 | 483·3 | 326·0 |
| 344 | 285·2 | 192·4 | 404 | 334·9 | 225·9 | 464 | 384·7 | 259·5 | 524 | 434·4 | 293·0 | 584 | 484·1 | 326·6 |
| 345 | 286·0 | 192·9 | 405 | 335·8 | 226·5 | 465 | 385·5 | 260·0 | 525 | 435·3 | 293·6 | 585 | 485·0 | 327·2 |
| 346 | 286·9 | 193·5 | 406 | 336·6 | 227·0 | 466 | 386·3 | 260·6 | 526 | 436·1 | 294·1 | 586 | 485·8 | 327·7 |
| 347 | 287·7 | 194·0 | 407 | 337·4 | 227·6 | 467 | 387·2 | 261·1 | 527 | 436·9 | 294·7 | 587 | 486·6 | 328·2 |
| 348 | 288·5 | 194·6 | 408 | 338·3 | 228·1 | 468 | 388·0 | 261·7 | 528 | 437·8 | 295·3 | 588 | 487·5 | 328·8 |
| 349 | 289·3 | 195·2 | 409 | 339·1 | 228·7 | 469 | 388·8 | 262·3 | 529 | 438·6 | 295·8 | 589 | 488·3 | 329·4 |
| 350 | 290·2 | 195·7 | 410 | 339·9 | 229·3 | 470 | 389·7 | 262·8 | 530 | 439·4 | 296·4 | 590 | 489·2 | 329·9 |
| 351 | 291·0 | 196·3 | 411 | 340·7 | 229·8 | 471 | 390·5 | 263·4 | 531 | 440·3 | 296·9 | 591 | 490·0 | 330·5 |
| 352 | 291·8 | 196·8 | 412 | 341·6 | 230·4 | 472 | 391·3 | 263·9 | 532 | 441·1 | 297·4 | 592 | 490·8 | 331·0 |
| 353 | 292·7 | 197·4 | 413 | 342·4 | 230·9 | 473 | 392·1 | 264·5 | 533 | 441·9 | 298·0 | 593 | 491·6 | 331·6 |
| 354 | 293·5 | 198·0 | 414 | 343·2 | 231·5 | 474 | 393·0 | 265·0 | 534 | 442·7 | 298·6 | 594 | 492·5 | 332·2 |
| 355 | 294·3 | 198·5 | 415 | 344·1 | 232·1 | 475 | 393·8 | 265·6 | 535 | 443·6 | 299·1 | 595 | 493·3 | 332·7 |
| 356 | 295·1 | 199·1 | 416 | 344·9 | 232·6 | 476 | 394·6 | 266·2 | 536 | 444·4 | 299·7 | 596 | 494·1 | 333·3 |
| 357 | 296·0 | 199·6 | 417 | 345·7 | 233·2 | 477 | 395·5 | 266·7 | 537 | 445·3 | 300·2 | 597 | 494·9 | 333·8 |
| 358 | 296·8 | 200·2 | 418 | 346·5 | 233·7 | 478 | 396·3 | 267·3 | 538 | 446·1 | 300·8 | 598 | 495·8 | 334·4 |
| 359 | 297·6 | 200·7 | 419 | 347·4 | 234·3 | 479 | 397·1 | 267·9 | 539 | 446·9 | 301·4 | 599 | 496·6 | 334·9 |
| 360 | 298·5 | 201·3 | 420 | 348·2 | 234·9 | 480 | 397·9 | 268·4 | 540 | 447·7 | 302·0 | 600 | 497·4 | 335·5 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

56° 3h 44m

## TRAVERSE TABLE TO DEGREES

35° — $2^h\ 20^m$

| Dist. | D.Lat | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0·8 | 0·6 | 61 | 50·0 | 35·0 | 121 | 99·1 | 69·4 | 181 | 148·3 | 103·8 | 241 | 197·4 | 138·2 |
| 2 | 1·6 | 1·1 | 62 | 50·8 | 35·6 | 122 | 99·9 | 70·0 | 182 | 149·1 | 104·4 | 242 | 198·2 | 138·8 |
| 3 | 2·5 | 1·7 | 63 | 51·6 | 36·1 | 123 | 100·8 | 70·5 | 183 | 149·9 | 105·0 | 243 | 199·1 | 139·4 |
| 4 | 3·3 | 2·3 | 64 | 52·4 | 36·7 | 124 | 101·6 | 71·1 | 184 | 150·7 | 105·5 | 244 | 199·9 | 140·0 |
| 5 | 4·1 | 2·9 | 65 | 53·2 | 37·3 | 125 | 102·4 | 71·7 | 185 | 151·5 | 106·1 | 245 | 200·7 | 140·5 |
| 6 | 4·9 | 3·4 | 66 | 54·1 | 37·9 | 126 | 103·2 | 72·3 | 186 | 152·4 | 106·7 | 246 | 201·5 | 141·1 |
| 7 | 5·7 | 4·0 | 67 | 54·9 | 38·4 | 127 | 104·0 | 72·8 | 187 | 153·2 | 107·3 | 247 | 202·3 | 141·7 |
| 8 | 6·6 | 4·6 | 68 | 55·7 | 39·0 | 128 | 104·9 | 73·4 | 188 | 154·0 | 107·8 | 248 | 203·1 | 142·2 |
| 9 | 7·4 | 5·2 | 69 | 56·5 | 39·6 | 129 | 105·7 | 74·0 | 189 | 154·8 | 108·4 | 249 | 204·0 | 142·8 |
| 10 | 8·2 | 5·7 | 70 | 57·3 | 40·2 | 130 | 106·5 | 74·6 | 190 | 155·6 | 109·0 | 250 | 204·8 | 143·4 |
| 11 | 9·0 | 6·3 | 71 | 58·2 | 40·7 | 131 | 107·3 | 75·1 | 191 | 156·5 | 109·6 | 251 | 205·6 | 144·0 |
| 12 | 9·8 | 6·9 | 72 | 59·0 | 41·3 | 132 | 108·1 | 75·7 | 192 | 157·3 | 110·1 | 252 | 206·4 | 144·5 |
| 13 | 10·6 | 7·5 | 73 | 59·8 | 41·9 | 133 | 108·9 | 76·3 | 193 | 158·1 | 110·7 | 253 | 207·2 | 145·1 |
| 14 | 11·5 | 8·0 | 74 | 60·6 | 42·4 | 134 | 109·8 | 76·9 | 194 | 158·9 | 111·3 | 254 | 208·1 | 145·7 |
| 15 | 12·3 | 8·6 | 75 | 61·4 | 43·0 | 135 | 110·6 | 77·4 | 195 | 159·7 | 111·8 | 255 | 208·9 | 146·3 |
| 16 | 13·1 | 9·2 | 76 | 62·3 | 43·6 | 136 | 111·4 | 78·0 | 196 | 160·6 | 112·4 | 256 | 209·7 | 146·8 |
| 17 | 13·9 | 9·8 | 77 | 63·1 | 44·2 | 137 | 112·2 | 78·6 | 197 | 161·4 | 113·0 | 257 | 210·5 | 147·4 |
| 18 | 14·7 | 10·3 | 78 | 63·9 | 44·7 | 138 | 113·0 | 79·2 | 198 | 162·2 | 113·6 | 258 | 211·3 | 148·0 |
| 19 | 15·6 | 10·9 | 79 | 64·7 | 45·3 | 139 | 113·9 | 79·7 | 199 | 163·0 | 114·1 | 259 | 212·2 | 148·6 |
| 20 | 16·4 | 11·5 | 80 | 65·5 | 45·9 | 140 | 114·7 | 80·3 | 200 | 163·8 | 114·7 | 260 | 213·0 | 149·1 |
| 21 | 17·2 | 12·0 | 81 | 66·4 | 46·5 | 141 | 115·5 | 80·9 | 201 | 164·6 | 115·3 | 261 | 213·8 | 149·7 |
| 22 | 18·0 | 12·6 | 82 | 67·2 | 47·0 | 142 | 116·3 | 81·4 | 202 | 165·5 | 115·9 | 262 | 214·6 | 150·3 |
| 23 | 18·8 | 13·2 | 83 | 68·0 | 47·6 | 143 | 117·1 | 82·0 | 203 | 166·3 | 116·4 | 263 | 215·4 | 150·9 |
| 24 | 19·7 | 13·8 | 84 | 68·8 | 48·2 | 144 | 118·0 | 82·6 | 204 | 167·1 | 117·0 | 264 | 216·3 | 151·4 |
| 25 | 20·5 | 14·3 | 85 | 69·6 | 48·8 | 145 | 118·8 | 83·2 | 205 | 167·9 | 117·6 | 265 | 217·1 | 152·0 |
| 26 | 21·3 | 14·9 | 86 | 70·4 | 49·3 | 146 | 119·6 | 83·7 | 206 | 168·7 | 118·2 | 266 | 217·9 | 152·6 |
| 27 | 22·1 | 15·5 | 87 | 71·3 | 49·9 | 147 | 120·4 | 84·3 | 207 | 169·6 | 118·7 | 267 | 218·7 | 153·1 |
| 28 | 22·9 | 16·1 | 88 | 72·1 | 50·5 | 148 | 121·2 | 84·9 | 208 | 170·4 | 119·3 | 268 | 219·5 | 153·7 |
| 29 | 23·8 | 16·6 | 89 | 72·9 | 51·0 | 149 | 122·1 | 85·5 | 209 | 171·2 | 119·9 | 269 | 220·4 | 154·3 |
| 30 | 24·6 | 17·2 | 90 | 73·7 | 51·6 | 150 | 122·9 | 86·0 | 210 | 172·0 | 120·5 | 270 | 221·2 | 154·9 |
| 31 | 25·4 | 17·8 | 91 | 74·5 | 52·2 | 151 | 123·7 | 86·6 | 211 | 172·8 | 121·0 | 271 | 222·0 | 155·4 |
| 32 | 26·2 | 18·4 | 92 | 75·4 | 52·8 | 152 | 124·5 | 87·2 | 212 | 173·7 | 121·6 | 272 | 222·8 | 156·0 |
| 33 | 27·0 | 18·9 | 93 | 76·2 | 53·3 | 153 | 125·3 | 87·8 | 213 | 174·5 | 122·2 | 273 | 223·6 | 156·6 |
| 34 | 27·9 | 19·5 | 94 | 77·0 | 53·9 | 154 | 126·1 | 88·3 | 214 | 175·3 | 122·7 | 274 | 224·4 | 157·2 |
| 35 | 28·7 | 20·1 | 95 | 77·8 | 54·5 | 155 | 127·0 | 88·9 | 215 | 176·1 | 123·3 | 275 | 225·3 | 157·7 |
| 36 | 29·5 | 20·6 | 96 | 78·6 | 55·1 | 156 | 127·8 | 89·5 | 216 | 176·9 | 123·9 | 276 | 226·1 | 158·3 |
| 37 | 30·3 | 21·2 | 97 | 79·5 | 55·6 | 157 | 128·6 | 90·1 | 217 | 177·8 | 124·5 | 277 | 226·9 | 158·9 |
| 38 | 31·1 | 21·8 | 98 | 80·3 | 56·2 | 158 | 129·4 | 90·6 | 218 | 178·6 | 125·0 | 278 | 227·7 | 159·5 |
| 39 | 31·9 | 22·4 | 99 | 81·1 | 56·8 | 159 | 130·2 | 91·2 | 219 | 179·4 | 125·6 | 279 | 228·5 | 160·0 |
| 40 | 32·8 | 22·9 | 100 | 81·9 | 57·4 | 160 | 131·1 | 91·8 | 220 | 180·2 | 126·2 | 280 | 229·4 | 160·6 |
| 41 | 33·6 | 23·5 | 101 | 82·7 | 57·9 | 161 | 131·9 | 92·3 | 221 | 181·0 | 126·8 | 281 | 230·2 | 161·2 |
| 42 | 34·4 | 24·1 | 102 | 83·6 | 58·5 | 162 | 132·7 | 92·9 | 222 | 181·9 | 127·3 | 282 | 231·0 | 161·7 |
| 43 | 35·2 | 24·7 | 103 | 84·4 | 59·1 | 163 | 133·5 | 93·5 | 223 | 182·7 | 127·9 | 283 | 231·8 | 162·3 |
| 44 | 36·0 | 25·2 | 104 | 85·2 | 59·7 | 164 | 134·3 | 94·1 | 224 | 183·5 | 128·5 | 284 | 232·6 | 162·9 |
| 45 | 36·9 | 25·8 | 105 | 86·0 | 60·2 | 165 | 135·2 | 94·6 | 225 | 184·3 | 129·1 | 285 | 233·5 | 163·5 |
| 46 | 37·7 | 26·4 | 106 | 86·8 | 60·8 | 166 | 136·0 | 95·2 | 226 | 185·1 | 129·6 | 286 | 234·3 | 164·0 |
| 47 | 38·5 | 27·0 | 107 | 87·6 | 61·4 | 167 | 136·8 | 95·8 | 227 | 185·9 | 130·2 | 287 | 235·1 | 164·6 |
| 48 | 39·3 | 27·5 | 108 | 88·5 | 61·9 | 168 | 137·6 | 96·4 | 228 | 186·8 | 130·8 | 288 | 235·9 | 165·2 |
| 49 | 40·1 | 28·1 | 109 | 89·3 | 62·5 | 169 | 138·4 | 96·9 | 229 | 187·6 | 131·3 | 289 | 236·7 | 165·8 |
| 50 | 41·0 | 28·7 | 110 | 90·1 | 63·1 | 170 | 139·3 | 97·5 | 230 | 188·4 | 131·9 | 290 | 237·6 | 166·3 |
| 51 | 41·8 | 29·3 | 111 | 90·9 | 63·7 | 171 | 140·1 | 98·1 | 231 | 189·2 | 132·5 | 291 | 238·4 | 166·9 |
| 52 | 42·6 | 29·8 | 112 | 91·7 | 64·2 | 172 | 140·9 | 98·7 | 232 | 190·0 | 133·1 | 292 | 239·2 | 167·5 |
| 53 | 43·4 | 30·4 | 113 | 92·6 | 64·8 | 173 | 141·7 | 99·2 | 233 | 190·9 | 133·6 | 293 | 240·0 | 168·1 |
| 54 | 44·2 | 31·0 | 114 | 93·4 | 65·4 | 174 | 142·5 | 99·8 | 234 | 191·7 | 134·2 | 294 | 240·8 | 168·6 |
| 55 | 45·1 | 31·5 | 115 | 94·2 | 66·0 | 175 | 143·4 | 100·4 | 235 | 192·5 | 134·8 | 295 | 241·6 | 169·2 |
| 56 | 45·9 | 32·1 | 116 | 95·0 | 66·5 | 176 | 144·2 | 100·9 | 236 | 193·3 | 135·4 | 296 | 242·5 | 169·8 |
| 57 | 46·7 | 32·7 | 117 | 95·8 | 67·1 | 177 | 145·0 | 101·5 | 237 | 194·1 | 135·9 | 297 | 243·3 | 170·4 |
| 58 | 47·5 | 33·3 | 118 | 96·7 | 67·7 | 178 | 145·8 | 102·1 | 238 | 195·0 | 136·5 | 298 | 244·1 | 170·9 |
| 59 | 48·3 | 33·8 | 119 | 97·5 | 68·3 | 179 | 146·6 | 102·7 | 239 | 195·8 | 137·1 | 299 | 244·9 | 171·5 |
| 60 | 49·1 | 34·4 | 120 | 98·3 | 68·8 | 180 | 147·4 | 103·2 | 240 | 196·6 | 137·7 | 300 | 245·7 | 172·1 |
| Dist. | Dep. | D.Lat | Dist. | Dep. | D.Lat | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

55° — $3^h\ 40^m$

## TRAVERSE TABLE TO DEGREES

35° 2h 20m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 246.6 | 172.6 | 361 | 295.7 | 207.0 | 421 | 344.9 | 241.5 | 481 | 394.0 | 275.9 | 541 | 443.2 | 310.3 |
| 302 | 247.4 | 173.2 | 362 | 296.5 | 207.6 | 422 | 345.7 | 242.0 | 482 | 394.8 | 276.4 | 542 | 444.0 | 310.9 |
| 303 | 248.2 | 173.8 | 363 | 297.4 | 208.2 | 423 | 346.5 | 242.6 | 483 | 395.7 | 277.0 | 543 | 444.8 | 311.4 |
| 304 | 249.0 | 174.3 | 364 | 298.2 | 208.8 | 424 | 347.3 | 243.2 | 484 | 396.5 | 277.6 | 544 | 445.6 | 312.0 |
| 305 | 249.9 | 174.9 | 365 | 299.0 | 209.3 | 425 | 348.1 | 243.8 | 485 | 397.3 | 278.2 | 545 | 446.4 | 312.6 |
| 306 | 250.7 | 175.5 | 366 | 299.8 | 209.9 | 426 | 349.0 | 244.3 | 486 | 398.1 | 278.7 | 546 | 447.3 | 313.2 |
| 307 | 251.5 | 176.1 | 367 | 300.6 | 210.5 | 427 | 349.8 | 244.9 | 487 | 398.9 | 279.3 | 547 | 448.1 | 313.7 |
| 308 | 252.3 | 176.6 | 368 | 301.5 | 211.1 | 428 | 350.6 | 245.5 | 488 | 399.8 | 279.9 | 548 | 448.9 | 314.3 |
| 309 | 253.1 | 177.2 | 369 | 302.3 | 211.6 | 429 | 351.4 | 246.0 | 489 | 400.6 | 280.5 | 549 | 449.7 | 314.9 |
| 310 | 253.9 | 177.8 | 370 | 303.1 | 212.2 | 430 | 352.2 | 246.6 | 490 | 401.4 | 281.0 | 550 | 450.5 | 315.4 |
| 311 | 254.8 | 178.4 | 371 | 303.9 | 212.8 | 431 | 353.1 | 247.2 | 491 | 402.2 | 281.6 | 551 | 451.4 | 316.0 |
| 312 | 255.6 | 178.9 | 372 | 304.7 | 213.4 | 432 | 353.9 | 247.8 | 492 | 403.0 | 282.2 | 552 | 452.2 | 316.6 |
| 313 | 256.4 | 179.5 | 373 | 305.6 | 213.9 | 433 | 354.7 | 248.3 | 493 | 403.9 | 282.8 | 553 | 453.0 | 317.2 |
| 314 | 257.2 | 180.1 | 374 | 306.4 | 214.5 | 434 | 355.5 | 248.9 | 494 | 404.7 | 283.3 | 554 | 453.8 | 317.7 |
| 315 | 258.0 | 180.7 | 375 | 307.2 | 215.1 | 435 | 356.3 | 249.5 | 495 | 405.5 | 283.9 | 555 | 454.6 | 318.3 |
| 316 | 258.9 | 181.2 | 376 | 308.0 | 215.6 | 436 | 357.2 | 250.1 | 496 | 406.3 | 284.5 | 556 | 455.5 | 318.9 |
| 317 | 259.7 | 181.8 | 377 | 308.8 | 216.2 | 437 | 358.0 | 250.6 | 497 | 407.1 | 285.1 | 557 | 456.3 | 319.5 |
| 318 | 260.5 | 182.4 | 378 | 309.6 | 216.8 | 438 | 358.8 | 251.2 | 498 | 408.0 | 285.6 | 558 | 457.1 | 320.0 |
| 319 | 261.3 | 183.0 | 379 | 310.5 | 217.4 | 439 | 359.6 | 251.8 | 499 | 408.8 | 286.2 | 559 | 457.9 | 320.6 |
| 320 | 262.1 | 183.5 | 380 | 311.3 | 217.9 | 440 | 360.4 | 252.4 | 500 | 409.6 | 286.8 | 560 | 458.7 | 321.2 |
| 321 | 263.0 | 184.1 | 381 | 312.1 | 218.5 | 441 | 361.3 | 252.9 | 501 | 410.4 | 287.4 | 561 | 459.6 | 321.8 |
| 322 | 263.8 | 184.7 | 382 | 312.9 | 219.1 | 442 | 362.1 | 253.5 | 502 | 411.2 | 287.9 | 562 | 460.4 | 322.3 |
| 323 | 264.6 | 185.2 | 383 | 313.7 | 219.7 | 443 | 362.9 | 254.1 | 503 | 412.1 | 288.5 | 563 | 461.2 | 322.9 |
| 324 | 265.4 | 185.8 | 384 | 314.6 | 220.2 | 444 | 363.7 | 254.7 | 504 | 412.9 | 289.1 | 564 | 462.0 | 323.5 |
| 325 | 266.2 | 186.4 | 385 | 315.4 | 220.8 | 445 | 364.5 | 255.2 | 505 | 413.7 | 289.7 | 565 | 462.8 | 324.1 |
| 326 | 267.1 | 187.0 | 386 | 316.2 | 221.4 | 446 | 365.4 | 255.8 | 506 | 414.5 | 290.2 | 566 | 463.7 | 324.6 |
| 327 | 267.9 | 187.5 | 387 | 317.0 | 222.0 | 447 | 366.2 | 256.4 | 507 | 415.3 | 290.8 | 567 | 464.5 | 325.2 |
| 328 | 268.7 | 188.1 | 388 | 317.8 | 222.5 | 448 | 367.0 | 256.9 | 508 | 416.1 | 291.4 | 568 | 465.3 | 325.8 |
| 329 | 269.5 | 188.7 | 389 | 318.7 | 223.1 | 449 | 367.8 | 257.5 | 509 | 417.0 | 291.9 | 569 | 466.1 | 326.4 |
| 330 | 270.3 | 189.3 | 390 | 319.5 | 223.7 | 450 | 368.6 | 258.1 | 510 | 417.8 | 292.5 | 570 | 466.9 | 326.9 |
| 331 | 271.1 | 189.8 | 391 | 320.3 | 224.3 | 451 | 369.4 | 258.7 | 511 | 418.6 | 293.1 | 571 | 467.8 | 327.5 |
| 332 | 272.0 | 190.4 | 392 | 321.1 | 224.8 | 452 | 370.3 | 259.2 | 512 | 419.4 | 293.7 | 572 | 468.6 | 328.1 |
| 333 | 272.8 | 191.0 | 393 | 321.9 | 225.4 | 453 | 371.1 | 259.8 | 513 | 420.2 | 294.2 | 573 | 469.4 | 328.7 |
| 334 | 273.6 | 191.6 | 394 | 322.8 | 226.0 | 454 | 371.9 | 260.4 | 514 | 421.1 | 294.8 | 574 | 470.2 | 329.2 |
| 335 | 274.4 | 192.1 | 395 | 323.6 | 226.5 | 455 | 372.7 | 261.0 | 515 | 421.9 | 295.4 | 575 | 471.0 | 329.8 |
| 336 | 275.2 | 192.7 | 396 | 324.4 | 227.1 | 456 | 373.5 | 261.5 | 516 | 422.7 | 296.0 | 576 | 471.9 | 330.4 |
| 337 | 276.1 | 193.3 | 397 | 325.2 | 227.7 | 457 | 374.4 | 262.1 | 517 | 423.5 | 296.5 | 577 | 472.7 | 331.0 |
| 338 | 276.9 | 193.9 | 398 | 326.0 | 228.3 | 458 | 375.2 | 262.7 | 518 | 424.3 | 297.1 | 578 | 473.5 | 331.5 |
| 339 | 277.7 | 194.4 | 399 | 326.9 | 228.8 | 459 | 376.0 | 263.3 | 519 | 425.2 | 297.7 | 579 | 474.3 | 332.1 |
| 340 | 278.5 | 195.0 | 400 | 327.7 | 229.4 | 460 | 376.8 | 263.8 | 520 | 426.0 | 298.3 | 580 | 475.1 | 332.7 |
| 341 | 279.3 | 195.6 | 401 | 328.5 | 230.0 | 461 | 377.6 | 264.4 | 521 | 426.8 | 298.8 | 581 | 476.0 | 333.3 |
| 342 | 280.2 | 196.1 | 402 | 329.3 | 230.6 | 462 | 378.5 | 265.0 | 522 | 427.6 | 299.4 | 582 | 476.8 | 333.8 |
| 343 | 281.0 | 196.7 | 403 | 330.1 | 231.1 | 463 | 379.3 | 265.5 | 523 | 428.4 | 300.0 | 583 | 477.6 | 334.4 |
| 344 | 281.8 | 197.3 | 404 | 330.9 | 231.7 | 464 | 380.1 | 266.1 | 524 | 429.3 | 300.5 | 584 | 478.4 | 335.0 |
| 345 | 282.6 | 197.9 | 405 | 331.8 | 232.3 | 465 | 380.9 | 266.7 | 525 | 430.1 | 301.1 | 585 | 479.2 | 335.6 |
| 346 | 283.4 | 198.4 | 406 | 332.6 | 232.9 | 466 | 381.7 | 267.3 | 526 | 430.9 | 301.7 | 586 | 480.1 | 336.1 |
| 347 | 284.3 | 199.0 | 407 | 333.4 | 233.4 | 467 | 382.6 | 267.8 | 527 | 431.7 | 302.3 | 587 | 480.9 | 336.7 |
| 348 | 285.1 | 199.6 | 408 | 334.2 | 234.0 | 468 | 383.4 | 268.4 | 528 | 432.5 | 302.8 | 588 | 481.7 | 337.3 |
| 349 | 285.9 | 200.2 | 409 | 335.0 | 234.6 | 469 | 384.2 | 269.0 | 529 | 433.4 | 303.4 | 589 | 482.5 | 337.9 |
| 350 | 286.7 | 200.7 | 410 | 335.9 | 235.1 | 470 | 385.0 | 269.6 | 530 | 434.2 | 304.0 | 590 | 483.3 | 338.4 |
| 351 | 287.5 | 201.3 | 411 | 336.7 | 235.7 | 471 | 385.8 | 270.1 | 531 | 435.0 | 304.5 | 591 | 484.2 | 339.0 |
| 352 | 288.3 | 201.9 | 412 | 337.5 | 236.3 | 472 | 386.6 | 270.7 | 532 | 435.8 | 305.1 | 592 | 485.0 | 339.6 |
| 353 | 289.2 | 202.5 | 413 | 338.3 | 236.9 | 473 | 387.5 | 271.3 | 533 | 436.6 | 305.7 | 593 | 485.8 | 340.2 |
| 354 | 290.0 | 203.0 | 414 | 339.1 | 237.4 | 474 | 388.3 | 271.9 | 534 | 437.5 | 306.3 | 594 | 486.6 | 340.7 |
| 355 | 290.8 | 203.6 | 415 | 340.0 | 238.0 | 475 | 389.1 | 272.4 | 535 | 438.3 | 306.8 | 595 | 487.4 | 341.3 |
| 356 | 291.6 | 204.2 | 416 | 340.8 | 238.6 | 476 | 389.9 | 273.0 | 536 | 439.1 | 307.4 | 596 | 488.3 | 341.9 |
| 357 | 292.4 | 204.7 | 417 | 341.6 | 239.2 | 477 | 390.7 | 273.6 | 537 | 439.9 | 308.0 | 597 | 489.1 | 342.5 |
| 358 | 293.3 | 205.3 | 418 | 342.4 | 239.7 | 478 | 391.6 | 274.2 | 538 | 440.7 | 308.6 | 598 | 489.9 | 343.0 |
| 359 | 294.1 | 205.9 | 419 | 343.2 | 240.3 | 479 | 392.4 | 274.7 | 539 | 441.5 | 309.1 | 599 | 490.7 | 343.6 |
| 360 | 294.9 | 206.5 | 420 | 344.1 | 240.9 | 480 | 393.2 | 275.3 | 540 | 442.3 | 309.7 | 600 | 491.5 | 344.1 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

55° 8h 40m

## TRAVERSE TABLE TO DEGREES

36° — $2^h\ 24^m$

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0·8 | 0·6 | 61 | 49·4 | 35·9 | 121 | 97·9 | 71·1 | 181 | 146·4 | 106·4 | 241 | 195·0 | 141·7 |
| 2 | 1·6 | 1·2 | 62 | 50·2 | 36·4 | 122 | 98·7 | 71·7 | 182 | 147·2 | 107·0 | 242 | 195·8 | 142·2 |
| 3 | 2·4 | 1·8 | 63 | 51·0 | 37·0 | 123 | 99·5 | 72·3 | 183 | 148·1 | 107·6 | 243 | 196·6 | 142·8 |
| 4 | 3·2 | 2·4 | 64 | 51·8 | 37·6 | 124 | 100·3 | 72·9 | 184 | 148·9 | 108·2 | 244 | 197·4 | 143·4 |
| 5 | 4·0 | 2·9 | 65 | 52·6 | 38·2 | 125 | 101·1 | 73·5 | 185 | 149·7 | 108·7 | 245 | 198·2 | 144·0 |
| 6 | 4·9 | 3·5 | 66 | 53·4 | 38·8 | 126 | 101·9 | 74·1 | 186 | 150·5 | 109·3 | 246 | 199·0 | 144·6 |
| 7 | 5·7 | 4·1 | 67 | 54·2 | 39·4 | 127 | 102·7 | 74·6 | 187 | 151·3 | 109·9 | 247 | 199·8 | 145·2 |
| 8 | 6·5 | 4·7 | 68 | 55·0 | 40·0 | 128 | 103·6 | 75·2 | 188 | 152·1 | 110·5 | 248 | 200·6 | 145·8 |
| 9 | 7·3 | 5·3 | 69 | 55·8 | 40·6 | 129 | 104·4 | 75·8 | 189 | 152·9 | 111·1 | 249 | 201·4 | 146·4 |
| 10 | 8·1 | 5·9 | 70 | 56·6 | 41·1 | 130 | 105·2 | 76·4 | 190 | 153·7 | 111·7 | 250 | 202·3 | 146·9 |
| 11 | 8·9 | 6·5 | 71 | 57·4 | 41·7 | 131 | 106·0 | 77·0 | 191 | 154·5 | 112·3 | 251 | 203·1 | 147·5 |
| 12 | 9·7 | 7·1 | 72 | 58·2 | 42·3 | 132 | 106·8 | 77·6 | 192 | 155·3 | 112·9 | 252 | 203·9 | 148·1 |
| 13 | 10·5 | 7·6 | 73 | 59·1 | 42·9 | 133 | 107·6 | 78·2 | 193 | 156·1 | 113·4 | 253 | 204·7 | 148·7 |
| 14 | 11·3 | 8·2 | 74 | 59·9 | 43·5 | 134 | 108·4 | 78·8 | 194 | 156·9 | 114·0 | 254 | 205·5 | 149·3 |
| 15 | 12·1 | 8·8 | 75 | 60·7 | 44·1 | 135 | 109·2 | 79·4 | 195 | 157·8 | 114·6 | 255 | 206·3 | 149·9 |
| 16 | 12·9 | 9·4 | 76 | 61·5 | 44·7 | 136 | 110·0 | 79·9 | 196 | 158·6 | 115·2 | 256 | 207·1 | 150·5 |
| 17 | 13·8 | 10·0 | 77 | 62·3 | 45·3 | 137 | 110·8 | 80·5 | 197 | 159·4 | 115·8 | 257 | 207·9 | 151·1 |
| 18 | 14·6 | 10·6 | 78 | 63·1 | 45·8 | 138 | 111·6 | 81·1 | 198 | 160·2 | 116·4 | 258 | 208·7 | 151·6 |
| 19 | 15·4 | 11·2 | 79 | 63·9 | 46·4 | 139 | 112·5 | 81·7 | 199 | 161·0 | 117·0 | 259 | 209·5 | 152·2 |
| 20 | 16·2 | 11·8 | 80 | 64·7 | 47·0 | 140 | 113·3 | 82·3 | 200 | 161·8 | 117·6 | 260 | 210·3 | 152·8 |
| 21 | 17·0 | 12·3 | 81 | 65·5 | 47·6 | 141 | 114·1 | 82·9 | 201 | 162·6 | 118·1 | 261 | 211·2 | 153·4 |
| 22 | 17·8 | 12·9 | 82 | 66·3 | 48·2 | 142 | 114·9 | 83·5 | 202 | 163·4 | 118·7 | 262 | 212·0 | 154·0 |
| 23 | 18·6 | 13·5 | 83 | 67·1 | 48·8 | 143 | 115·7 | 84·1 | 203 | 164·2 | 119·3 | 263 | 212·8 | 154·6 |
| 24 | 19·4 | 14·1 | 84 | 68·0 | 49·4 | 144 | 116·5 | 84·6 | 204 | 165·0 | 119·9 | 264 | 213·6 | 155·2 |
| 25 | 20·2 | 14·7 | 85 | 68·8 | 50·0 | 145 | 117·3 | 85·2 | 205 | 165·8 | 120·5 | 265 | 214·4 | 155·8 |
| 26 | 21·0 | 15·3 | 86 | 69·6 | 50·5 | 146 | 118·1 | 85·8 | 206 | 166·7 | 121·1 | 266 | 215·2 | 156·4 |
| 27 | 21·8 | 15·9 | 87 | 70·4 | 51·1 | 147 | 118·9 | 86·4 | 207 | 167·5 | 121·7 | 267 | 216·0 | 156·9 |
| 28 | 22·7 | 16·5 | 88 | 71·2 | 51·7 | 148 | 119·7 | 87·0 | 208 | 168·3 | 122·3 | 268 | 216·8 | 157·5 |
| 29 | 23·5 | 17·0 | 89 | 72·0 | 52·3 | 149 | 120·5 | 87·6 | 209 | 169·1 | 122·8 | 269 | 217·6 | 158·1 |
| 30 | 24·3 | 17·6 | 90 | 72·8 | 52·9 | 150 | 121·4 | 88·2 | 210 | 169·9 | 123·4 | 270 | 218·4 | 158·7 |
| 31 | 25·1 | 18·2 | 91 | 73·6 | 53·5 | 151 | 122·2 | 88·8 | 211 | 170·7 | 124·0 | 271 | 219·2 | 159·3 |
| 32 | 25·9 | 18·8 | 92 | 74·4 | 54·1 | 152 | 123·0 | 89·3 | 212 | 171·5 | 124·6 | 272 | 220·1 | 159·9 |
| 33 | 26·7 | 19·4 | 93 | 75·2 | 54·7 | 153 | 123·8 | 89·9 | 213 | 172·3 | 125·2 | 273 | 220·9 | 160·5 |
| 34 | 27·5 | 20·0 | 94 | 76·0 | 55·3 | 154 | 124·6 | 90·5 | 214 | 173·1 | 125·8 | 274 | 221·7 | 161·1 |
| 35 | 28·3 | 20·6 | 95 | 76·9 | 55·8 | 155 | 125·4 | 91·1 | 215 | 173·9 | 126·4 | 275 | 222·5 | 161·6 |
| 36 | 29·1 | 21·2 | 96 | 77·7 | 56·4 | 156 | 126·2 | 91·7 | 216 | 174·7 | 127·0 | 276 | 223·3 | 162·2 |
| 37 | 29·9 | 21·7 | 97 | 78·5 | 57·0 | 157 | 127·0 | 92·3 | 217 | 175·6 | 127·5 | 277 | 224·1 | 162·8 |
| 38 | 30·7 | 22·3 | 98 | 79·3 | 57·6 | 158 | 127·8 | 92·9 | 218 | 176·4 | 128·1 | 278 | 224·9 | 163·4 |
| 39 | 31·6 | 22·9 | 99 | 80·1 | 58·2 | 159 | 128·6 | 93·5 | 219 | 177·2 | 128·7 | 279 | 225·7 | 164·0 |
| 40 | 32·4 | 23·5 | 100 | 80·9 | 58·8 | 160 | 129·4 | 94·0 | 220 | 178·0 | 129·3 | 280 | 226·5 | 164·6 |
| 41 | 33·2 | 24·1 | 101 | 81·7 | 59·4 | 161 | 130·3 | 94·6 | 221 | 178·8 | 129·9 | 281 | 227·3 | 165·2 |
| 42 | 34·0 | 24·7 | 102 | 82·5 | 60·0 | 162 | 131·1 | 95·2 | 222 | 179·6 | 130·5 | 282 | 228·1 | 165·8 |
| 43 | 34·8 | 25·3 | 103 | 83·3 | 60·5 | 163 | 131·9 | 95·8 | 223 | 180·4 | 131·1 | 283 | 229·0 | 166·3 |
| 44 | 35·6 | 25·9 | 104 | 84·1 | 61·1 | 164 | 132·7 | 96·4 | 224 | 181·2 | 131·7 | 284 | 229·8 | 166·9 |
| 45 | 36·4 | 26·5 | 105 | 84·9 | 61·7 | 165 | 133·5 | 97·0 | 225 | 182·0 | 132·3 | 285 | 230·6 | 167·5 |
| 46 | 37·2 | 27·0 | 106 | 85·8 | 62·3 | 166 | 134·3 | 97·6 | 226 | 182·8 | 132·8 | 286 | 231·4 | 168·1 |
| 47 | 38·0 | 27·6 | 107 | 86·6 | 62·9 | 167 | 135·1 | 98·2 | 227 | 183·6 | 133·4 | 287 | 232·2 | 168·7 |
| 48 | 38·8 | 28·2 | 108 | 87·4 | 63·5 | 168 | 135·9 | 98·7 | 228 | 184·5 | 134·0 | 288 | 233·0 | 169·3 |
| 49 | 39·6 | 28·8 | 109 | 88·2 | 64·1 | 169 | 136·7 | 99·3 | 229 | 185·3 | 134·6 | 289 | 233·8 | 169·9 |
| 50 | 40·5 | 29·4 | 110 | 89·0 | 64·7 | 170 | 137·5 | 99·9 | 230 | 186·1 | 135·2 | 290 | 234·6 | 170·5 |
| 51 | 41·3 | 30·0 | 111 | 89·8 | 65·2 | 171 | 138·3 | 100·5 | 231 | 186·9 | 135·8 | 291 | 235·4 | 171·0 |
| 52 | 42·1 | 30·6 | 112 | 90·6 | 65·8 | 172 | 139·2 | 101·1 | 232 | 187·7 | 136·4 | 292 | 236·2 | 171·6 |
| 53 | 42·9 | 31·2 | 113 | 91·4 | 66·4 | 173 | 140·0 | 101·7 | 233 | 188·5 | 137·0 | 293 | 237·0 | 172·2 |
| 54 | 43·7 | 31·7 | 114 | 92·2 | 67·0 | 174 | 140·8 | 102·3 | 234 | 189·3 | 137·5 | 294 | 237·9 | 172·8 |
| 55 | 44·5 | 32·3 | 115 | 93·0 | 67·6 | 175 | 141·6 | 102·9 | 235 | 190·1 | 138·1 | 295 | 238·7 | 173·4 |
| 56 | 45·3 | 32·9 | 116 | 93·8 | 68·2 | 176 | 142·4 | 103·5 | 236 | 190·9 | 138·7 | 296 | 239·5 | 174·0 |
| 57 | 46·1 | 33·5 | 117 | 94·7 | 68·8 | 177 | 143·2 | 104·0 | 237 | 191·7 | 139·3 | 297 | 240·3 | 174·6 |
| 58 | 46·9 | 34·1 | 118 | 95·5 | 69·4 | 178 | 144·0 | 104·6 | 238 | 192·5 | 139·9 | 298 | 241·1 | 175·2 |
| 59 | 47·7 | 34·7 | 119 | 96·3 | 69·9 | 179 | 144·8 | 105·2 | 239 | 193·4 | 140·5 | 299 | 241·9 | 175·7 |
| 60 | 48·5 | 35·3 | 120 | 97·1 | 70·5 | 180 | 145·6 | 105·8 | 240 | 194·2 | 141·1 | 300 | 242·7 | 176·3 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

54° — $3^h\ 36^m$

## TRAVERSE TABLE TO DEGREES

36° — $3^h\ 24^m$

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 243.5 | 176.9 | 361 | 292.1 | 212.2 | 421 | 340.6 | 247.5 | 481 | 389.1 | 282.7 | 541 | 437.7 | 318.0 |
| 302 | 244.3 | 177.5 | 362 | 292.9 | 212.8 | 422 | 341.4 | 248.1 | 482 | 390.0 | 283.3 | 542 | 438.5 | 318.6 |
| 303 | 245.1 | 178.1 | 363 | 293.7 | 213.4 | 423 | 342.2 | 248.6 | 483 | 390.8 | 283.9 | 543 | 439.3 | 319.1 |
| 304 | 246.0 | 178.7 | 364 | 294.5 | 214.0 | 424 | 343.0 | 249.2 | 484 | 391.6 | 284.5 | 544 | 440.2 | 319.7 |
| 305 | 246.8 | 179.3 | 365 | 295.3 | 214.6 | 425 | 343.8 | 249.8 | 485 | 392.4 | 285.1 | 545 | 441.0 | 320.3 |
| 306 | 247.6 | 179.9 | 366 | 296.1 | 215.1 | 426 | 344.7 | 250.4 | 486 | 393.2 | 285.6 | 546 | 441.8 | 320.9 |
| 307 | 248.4 | 180.5 | 367 | 296.9 | 215.7 | 427 | 345.5 | 251.0 | 487 | 394.0 | 286.2 | 547 | 442.6 | 321.5 |
| 308 | 249.2 | 181.1 | 368 | 297.7 | 216.3 | 428 | 346.3 | 251.6 | 488 | 394.8 | 286.8 | 548 | 443.4 | 322.1 |
| 309 | 250.0 | 181.6 | 369 | 298.5 | 216.9 | 429 | 347.1 | 252.2 | 489 | 395.6 | 287.4 | 549 | 444.2 | 322.7 |
| 310 | 250.8 | 182.2 | 370 | 299.3 | 217.5 | 430 | 347.9 | 252.8 | 490 | 396.4 | 288.0 | 550 | 445.0 | 323.3 |
| 311 | 251.6 | 182.8 | 371 | 300.2 | 218.1 | 431 | 348.7 | 253.3 | 491 | 397.3 | 288.6 | 551 | 445.8 | 323.8 |
| 312 | 252.4 | 183.4 | 372 | 301.0 | 218.7 | 432 | 349.5 | 253.9 | 492 | 398.1 | 289.2 | 552 | 446.6 | 324.4 |
| 313 | 253.2 | 184.0 | 373 | 301.8 | 219.3 | 433 | 350.3 | 254.5 | 493 | 398.9 | 289.8 | 553 | 447.4 | 325.0 |
| 314 | 254.0 | 184.6 | 374 | 302.6 | 219.8 | 434 | 351.1 | 255.1 | 494 | 399.7 | 290.3 | 554 | 448.2 | 325.6 |
| 315 | 254.9 | 185.2 | 375 | 303.4 | 220.4 | 435 | 351.9 | 255.7 | 495 | 400.5 | 290.9 | 555 | 449.0 | 326.2 |
| 316 | 255.7 | 185.8 | 376 | 304.2 | 221.0 | 436 | 352.7 | 256.3 | 496 | 401.3 | 291.5 | 556 | 449.8 | 326.8 |
| 317 | 256.5 | 186.4 | 377 | 305.0 | 221.6 | 437 | 353.6 | 256.9 | 497 | 402.1 | 292.1 | 557 | 450.7 | 327.4 |
| 318 | 257.3 | 186.9 | 378 | 305.8 | 222.2 | 438 | 354.4 | 257.5 | 498 | 402.9 | 292.7 | 558 | 451.5 | 328.0 |
| 319 | 258.1 | 187.5 | 379 | 306.6 | 222.8 | 439 | 355.2 | 258.0 | 499 | 403.7 | 293.3 | 559 | 452.3 | 328.5 |
| 320 | 258.9 | 188.1 | 380 | 307.4 | 223.4 | 440 | 356.0 | 258.6 | 500 | 404.5 | 293.9 | 560 | 453.1 | 329.1 |
| 321 | 259.7 | 188.7 | 381 | 308.2 | 224.0 | 441 | 356.8 | 259.2 | 501 | 405.3 | 294.5 | 561 | 453.9 | 329.7 |
| 322 | 260.5 | 189.3 | 382 | 309.1 | 224.5 | 442 | 357.6 | 259.8 | 502 | 406.1 | 295.0 | 562 | 454.7 | 330.3 |
| 323 | 261.3 | 189.9 | 383 | 309.9 | 225.1 | 443 | 358.4 | 260.4 | 503 | 407.0 | 295.6 | 563 | 455.5 | 330.9 |
| 324 | 262.1 | 190.5 | 384 | 310.7 | 225.7 | 444 | 359.2 | 261.0 | 504 | 407.8 | 296.2 | 564 | 456.3 | 331.5 |
| 325 | 262.9 | 191.0 | 385 | 311.5 | 226.3 | 445 | 360.0 | 261.6 | 505 | 408.6 | 296.8 | 565 | 457.1 | 332.1 |
| 326 | 263.7 | 191.6 | 386 | 312.3 | 226.9 | 446 | 360.8 | 262.2 | 506 | 409.4 | 297.4 | 566 | 457.9 | 332.7 |
| 327 | 264.6 | 192.2 | 387 | 313.1 | 227.5 | 447 | 361.6 | 262.8 | 507 | 410.2 | 298.0 | 567 | 458.7 | 333.3 |
| 328 | 265.4 | 192.8 | 388 | 313.9 | 228.1 | 448 | 362.4 | 263.3 | 508 | 411.0 | 298.6 | 568 | 459.5 | 333.8 |
| 329 | 266.2 | 193.4 | 389 | 314.7 | 228.7 | 449 | 363.3 | 263.9 | 509 | 411.8 | 299.2 | 569 | 460.3 | 334.4 |
| 330 | 267.0 | 194.0 | 390 | 315.5 | 229.2 | 450 | 364.1 | 264.5 | 510 | 412.6 | 299.8 | 570 | 461.1 | 335.0 |
| 331 | 267.8 | 194.6 | 391 | 316.3 | 229.8 | 451 | 364.9 | 265.1 | 511 | 413.4 | 300.3 | 571 | 462.0 | 335.6 |
| 332 | 268.6 | 195.2 | 392 | 317.1 | 230.4 | 452 | 365.7 | 265.7 | 512 | 414.2 | 300.9 | 572 | 462.8 | 336.2 |
| 333 | 269.4 | 195.7 | 393 | 318.0 | 231.0 | 453 | 366.5 | 266.3 | 513 | 415.1 | 301.5 | 573 | 463.6 | 336.8 |
| 334 | 270.2 | 196.3 | 394 | 318.8 | 231.6 | 454 | 367.3 | 266.9 | 514 | 415.9 | 302.1 | 574 | 464.4 | 337.4 |
| 335 | 271.0 | 196.9 | 395 | 319.6 | 232.2 | 455 | 368.1 | 267.5 | 515 | 416.7 | 302.7 | 575 | 465.2 | 338.0 |
| 336 | 271.8 | 197.5 | 396 | 320.4 | 232.8 | 456 | 368.9 | 268.0 | 516 | 417.5 | 303.3 | 576 | 466.0 | 338.5 |
| 337 | 272.6 | 198.1 | 397 | 321.2 | 233.4 | 457 | 369.7 | 268.6 | 517 | 418.3 | 303.9 | 577 | 466.8 | 339.1 |
| 338 | 273.5 | 198.7 | 398 | 322.0 | 233.9 | 458 | 370.5 | 269.2 | 518 | 419.1 | 304.4 | 578 | 467.6 | 339.7 |
| 339 | 274.3 | 199.3 | 399 | 322.8 | 234.5 | 459 | 371.3 | 269.8 | 519 | 419.9 | 305.0 | 579 | 468.4 | 340.3 |
| 340 | 275.1 | 199.9 | 400 | 323.6 | 235.1 | 460 | 372.2 | 270.4 | 520 | 420.7 | 305.6 | 580 | 469.3 | 340.9 |
| 341 | 275.9 | 200.4 | 401 | 324.4 | 235.7 | 461 | 373.0 | 271.0 | 521 | 421.5 | 306.2 | 581 | 470.1 | 341.5 |
| 342 | 276.7 | 201.0 | 402 | 325.2 | 236.3 | 462 | 373.8 | 271.6 | 522 | 422.3 | 306.8 | 582 | 470.9 | 342.1 |
| 343 | 277.5 | 201.6 | 403 | 326.0 | 236.9 | 463 | 374.6 | 272.2 | 523 | 423.1 | 307.4 | 583 | 471.7 | 342.7 |
| 344 | 278.3 | 202.2 | 404 | 326.9 | 237.5 | 464 | 375.4 | 272.7 | 524 | 423.9 | 308.0 | 584 | 472.5 | 343.2 |
| 345 | 279.1 | 202.8 | 405 | 327.7 | 238.1 | 465 | 376.2 | 273.3 | 525 | 424.7 | 308.6 | 585 | 473.3 | 343.8 |
| 346 | 279.9 | 203.4 | 406 | 328.5 | 238.7 | 466 | 377.0 | 273.9 | 526 | 425.5 | 309.2 | 586 | 474.1 | 344.4 |
| 347 | 280.7 | 204.0 | 407 | 329.3 | 239.2 | 467 | 377.8 | 274.5 | 527 | 426.4 | 309.7 | 587 | 474.9 | 345.0 |
| 348 | 281.5 | 204.6 | 408 | 330.1 | 239.8 | 468 | 378.6 | 275.1 | 528 | 427.2 | 310.3 | 588 | 475.7 | 345.6 |
| 349 | 282.4 | 205.1 | 409 | 330.9 | 240.4 | 469 | 379.4 | 275.7 | 529 | 428.0 | 310.9 | 589 | 476.5 | 346.2 |
| 350 | 283.2 | 205.7 | 410 | 331.7 | 241.0 | 470 | 380.2 | 276.3 | 530 | 428.8 | 311.5 | 590 | 477.3 | 346.8 |
| 351 | 284.0 | 206.3 | 411 | 332.5 | 241.6 | 471 | 381.1 | 276.9 | 531 | 429.6 | 312.1 | 591 | 478.2 | 347.4 |
| 352 | 284.8 | 206.9 | 412 | 333.3 | 242.2 | 472 | 381.9 | 277.4 | 532 | 430.4 | 312.7 | 592 | 479.0 | 347.9 |
| 353 | 285.6 | 207.5 | 413 | 334.1 | 242.8 | 473 | 382.7 | 278.0 | 533 | 431.2 | 313.3 | 593 | 479.8 | 348.5 |
| 354 | 286.4 | 208.1 | 414 | 334.9 | 243.4 | 474 | 383.5 | 278.6 | 534 | 432.0 | 313.9 | 594 | 480.6 | 349.1 |
| 355 | 287.2 | 208.7 | 415 | 335.8 | 243.9 | 475 | 384.3 | 279.2 | 535 | 432.9 | 314.4 | 595 | 481.4 | 349.7 |
| 356 | 288.0 | 209.3 | 416 | 336.6 | 244.5 | 476 | 385.1 | 279.8 | 536 | 433.7 | 315.0 | 596 | 482.2 | 350.3 |
| 357 | 288.8 | 209.8 | 417 | 337.4 | 245.1 | 477 | 385.9 | 280.4 | 537 | 434.5 | 315.6 | 597 | 483.0 | 350.9 |
| 358 | 289.6 | 210.4 | 418 | 338.2 | 245.7 | 478 | 386.7 | 281.0 | 538 | 435.3 | 316.2 | 598 | 483.8 | 351.5 |
| 359 | 290.4 | 211.0 | 419 | 339.0 | 246.3 | 479 | 387.5 | 281.6 | 539 | 436.1 | 316.8 | 599 | 484.6 | 352.1 |
| 360 | 291.3 | 211.6 | 420 | 339.8 | 246.9 | 480 | 388.3 | 282.1 | 540 | 436.9 | 317.4 | 600 | 485.4 | 352.7 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

54° — $3^h\ 36^m$

## TRAVERSE TABLE TO DEGREES

37° 2h 28m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0·8 | 0·6 | 61 | 48·7 | 36·7 | 121 | 96·6 | 72·8 | 181 | 144·6 | 108·9 | 241 | 192·5 | 145·0 |
| 2 | 1·6 | 1·2 | 62 | 49·5 | 37·3 | 122 | 97·4 | 73·4 | 182 | 145·4 | 109·5 | 242 | 193·3 | 145·6 |
| 3 | 2·4 | 1·8 | 63 | 50·3 | 37·9 | 123 | 98·2 | 74·0 | 183 | 146·2 | 110·1 | 243 | 194·1 | 146·2 |
| 4 | 3·2 | 2·4 | 64 | 51·1 | 38·5 | 124 | 99·0 | 74·6 | 184 | 146·9 | 110·7 | 244 | 194·9 | 146·8 |
| 5 | 4·0 | 3·0 | 65 | 51·9 | 39·1 | 125 | 99·8 | 75·2 | 185 | 147·7 | 111·3 | 245 | 195·7 | 147·4 |
| 6 | 4·8 | 3·6 | 66 | 52·7 | 39·7 | 126 | 100·6 | 75·8 | 186 | 148·5 | 111·9 | 246 | 196·5 | 148·0 |
| 7 | 5·6 | 4·2 | 67 | 53·5 | 40·3 | 127 | 101·4 | 76·4 | 187 | 149·3 | 112·5 | 247 | 197·3 | 148·6 |
| 8 | 6·4 | 4·8 | 68 | 54·3 | 40·9 | 128 | 102·2 | 77·0 | 188 | 150·1 | 113·1 | 248 | 198·1 | 149·3 |
| 9 | 7·2 | 5·4 | 69 | 55·1 | 41·5 | 129 | 103·0 | 77·6 | 189 | 150·9 | 113·7 | 249 | 198·9 | 149·9 |
| 10 | 8·0 | 6·0 | 70 | 55·9 | 42·1 | 130 | 103·8 | 78·2 | 190 | 151·7 | 114·3 | 250 | 199·7 | 150·5 |
| 11 | 8·8 | 6·6 | 71 | 56·7 | 42·7 | 131 | 104·6 | 78·8 | 191 | 152·5 | 114·9 | 251 | 200·5 | 151·1 |
| 12 | 9·6 | 7·2 | 72 | 57·5 | 43·3 | 132 | 105·4 | 79·4 | 192 | 153·3 | 115·5 | 252 | 201·3 | 151·7 |
| 13 | 10·4 | 7·8 | 73 | 58·3 | 43·9 | 133 | 106·2 | 80·0 | 193 | 154·1 | 116·2 | 253 | 202·1 | 152·3 |
| 14 | 11·2 | 8·4 | 74 | 59·1 | 44·5 | 134 | 107·0 | 80·6 | 194 | 154·9 | 116·8 | 254 | 202·9 | 152·9 |
| 15 | 12·0 | 9·0 | 75 | 59·9 | 45·1 | 135 | 107·8 | 81·2 | 195 | 155·7 | 117·4 | 255 | 203·7 | 153·5 |
| 16 | 12·8 | 9·6 | 76 | 60·7 | 45·7 | 136 | 108·6 | 81·8 | 196 | 156·5 | 118·0 | 256 | 204·5 | 154·1 |
| 17 | 13·6 | 10·2 | 77 | 61·5 | 46·3 | 137 | 109·4 | 82·4 | 197 | 157·3 | 118·6 | 257 | 205·2 | 154·7 |
| 18 | 14·4 | 10·8 | 78 | 62·3 | 46·9 | 138 | 110·2 | 83·1 | 198 | 158·1 | 119·2 | 258 | 206·0 | 155·3 |
| 19 | 15·2 | 11·4 | 79 | 63·1 | 47·5 | 139 | 111·0 | 83·7 | 199 | 158·9 | 119·8 | 259 | 206·8 | 155·9 |
| 20 | 16·0 | 12·0 | 80 | 63·9 | 48·1 | 140 | 111·8 | 84·3 | 200 | 159·7 | 120·4 | 260 | 207·6 | 156·5 |
| 21 | 16·8 | 12·6 | 81 | 64·7 | 48·7 | 141 | 112·6 | 84·9 | 201 | 160·5 | 121·0 | 261 | 208·4 | 157·1 |
| 22 | 17·6 | 13·2 | 82 | 65·5 | 49·3 | 142 | 113·4 | 85·5 | 202 | 161·3 | 121·6 | 262 | 209·2 | 157·7 |
| 23 | 18·4 | 13·8 | 83 | 66·3 | 50·0 | 143 | 114·2 | 86·1 | 203 | 162·1 | 122·2 | 263 | 210·0 | 158·3 |
| 24 | 19·2 | 14·4 | 84 | 67·1 | 50·6 | 144 | 115·0 | 86·7 | 204 | 162·9 | 122·8 | 264 | 210·8 | 158·9 |
| 25 | 20·0 | 15·0 | 85 | 67·9 | 51·2 | 145 | 115·8 | 87·3 | 205 | 163·7 | 123·4 | 265 | 211·6 | 159·5 |
| 26 | 20·8 | 15·6 | 86 | 68·7 | 51·8 | 146 | 116·6 | 87·9 | 206 | 164·5 | 124·0 | 266 | 212·4 | 160·1 |
| 27 | 21·6 | 16·2 | 87 | 69·5 | 52·4 | 147 | 117·4 | 88·5 | 207 | 165·3 | 124·6 | 267 | 213·2 | 160·7 |
| 28 | 22·4 | 16·9 | 88 | 70·3 | 53·0 | 148 | 118·2 | 89·1 | 208 | 166·1 | 125·2 | 268 | 214·0 | 161·3 |
| 29 | 23·2 | 17·5 | 89 | 71·1 | 53·6 | 149 | 119·0 | 89·7 | 209 | 166·9 | 125·8 | 269 | 214·8 | 161·9 |
| 30 | 24·0 | 18·1 | 90 | 71·9 | 54·2 | 150 | 119·8 | 90·3 | 210 | 167·7 | 126·4 | 270 | 215·6 | 162·5 |
| 31 | 24·8 | 18·7 | 91 | 72·7 | 54·8 | 151 | 120·6 | 90·9 | 211 | 168·5 | 127·0 | 271 | 216·4 | 163·1 |
| 32 | 25·6 | 19·3 | 92 | 73·5 | 55·4 | 152 | 121·4 | 91·5 | 212 | 169·3 | 127·6 | 272 | 217·2 | 163·7 |
| 33 | 26·4 | 19·9 | 93 | 74·3 | 56·0 | 153 | 122·2 | 92·1 | 213 | 170·1 | 128·2 | 273 | 218·0 | 164·3 |
| 34 | 27·2 | 20·5 | 94 | 75·1 | 56·6 | 154 | 123·0 | 92·7 | 214 | 170·9 | 128·8 | 274 | 218·8 | 164·9 |
| 35 | 28·0 | 21·1 | 95 | 75·9 | 57·2 | 155 | 123·8 | 93·3 | 215 | 171·7 | 129·4 | 275 | 219·6 | 165·5 |
| 36 | 28·8 | 21·7 | 96 | 76·7 | 57·8 | 156 | 124·6 | 93·9 | 216 | 172·5 | 130·0 | 276 | 220·4 | 166·1 |
| 37 | 29·5 | 22·3 | 97 | 77·5 | 58·4 | 157 | 125·4 | 94·5 | 217 | 173·3 | 130·6 | 277 | 221·2 | 166·7 |
| 38 | 30·3 | 22·9 | 98 | 78·3 | 59·0 | 158 | 126·2 | 95·1 | 218 | 174·1 | 131·2 | 278 | 222·0 | 167·3 |
| 39 | 31·1 | 23·5 | 99 | 79·1 | 59·6 | 159 | 127·0 | 95·7 | 219 | 174·9 | 131·8 | 279 | 222·8 | 167·9 |
| 40 | 31·9 | 24·1 | 100 | 79·9 | 60·2 | 160 | 127·8 | 96·3 | 220 | 175·7 | 132·4 | 280 | 223·6 | 168·5 |
| 41 | 32·7 | 24·7 | 101 | 80·7 | 60·8 | 161 | 128·6 | 96·9 | 221 | 176·5 | 133·0 | 281 | 224·4 | 169·1 |
| 42 | 33·5 | 25·3 | 102 | 81·5 | 61·4 | 162 | 129·4 | 97·5 | 222 | 177·3 | 133·6 | 282 | 225·2 | 169·7 |
| 43 | 34·3 | 25·9 | 103 | 82·3 | 62·0 | 163 | 130·2 | 98·1 | 223 | 178·1 | 134·2 | 283 | 226·0 | 170·3 |
| 44 | 35·1 | 26·5 | 104 | 83·1 | 62·6 | 164 | 131·0 | 98·7 | 224 | 178·9 | 134·8 | 284 | 226·8 | 170·9 |
| 45 | 35·9 | 27·1 | 105 | 83·9 | 63·2 | 165 | 131·8 | 99·3 | 225 | 179·7 | 135·4 | 285 | 227·6 | 171·5 |
| 46 | 36·7 | 27·7 | 106 | 84·7 | 63·8 | 166 | 132·6 | 99·9 | 226 | 180·5 | 136·0 | 286 | 228·4 | 172·1 |
| 47 | 37·5 | 28·3 | 107 | 85·5 | 64·4 | 167 | 133·4 | 100·5 | 227 | 181·3 | 136·6 | 287 | 229·2 | 172·7 |
| 48 | 38·3 | 28·9 | 108 | 86·3 | 65·0 | 168 | 134·2 | 101·1 | 228 | 182·1 | 137·2 | 288 | 230·0 | 173·3 |
| 49 | 39·1 | 29·5 | 109 | 87·1 | 65·6 | 169 | 135·0 | 101·7 | 229 | 182·9 | 137·8 | 289 | 230·8 | 173·9 |
| 50 | 39·9 | 30·1 | 110 | 87·8 | 66·2 | 170 | 135·8 | 102·3 | 230 | 183·7 | 138·4 | 290 | 231·6 | 174·5 |
| 51 | 40·7 | 30·7 | 111 | 88·6 | 66·8 | 171 | 136·6 | 102·9 | 231 | 184·5 | 139·0 | 291 | 232·4 | 175·1 |
| 52 | 41·5 | 31·3 | 112 | 89·4 | 67·4 | 172 | 137·4 | 103·5 | 232 | 185·3 | 139·6 | 292 | 233·2 | 175·7 |
| 53 | 42·3 | 31·9 | 113 | 90·2 | 68·0 | 173 | 138·2 | 104·1 | 233 | 186·1 | 140·2 | 293 | 234·0 | 176·3 |
| 54 | 43·1 | 32·5 | 114 | 91·0 | 68·6 | 174 | 139·0 | 104·7 | 234 | 186·9 | 140·8 | 294 | 234·8 | 176·9 |
| 55 | 43·9 | 33·1 | 115 | 91·8 | 69·2 | 175 | 139·8 | 105·3 | 235 | 187·7 | 141·4 | 295 | 235·6 | 177·5 |
| 56 | 44·7 | 33·7 | 116 | 92·6 | 69·8 | 176 | 140·6 | 105·9 | 236 | 188·5 | 142·0 | 296 | 236·4 | 178·1 |
| 57 | 45·5 | 34·3 | 117 | 93·4 | 70·4 | 177 | 141·4 | 106·5 | 237 | 189·3 | 142·6 | 297 | 237·2 | 178·7 |
| 58 | 46·3 | 34·9 | 118 | 94·2 | 71·0 | 178 | 142·2 | 107·1 | 238 | 190·1 | 143·2 | 298 | 238·0 | 179·3 |
| 59 | 47·1 | 35·5 | 119 | 95·0 | 71·6 | 179 | 143·0 | 107·7 | 239 | 190·9 | 143·8 | 299 | 238·8 | 179·9 |
| 60 | 47·9 | 36·1 | 120 | 95·8 | 72·2 | 180 | 143·8 | 108·3 | 240 | 191·7 | 144·4 | 300 | 239·6 | 180·5 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

53° 3h 32m

## TRAVERSE TABLE TO DEGREES

37° — 2h 28m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 240·4 | 181·1 | 361 | 288·3 | 217·3 | 421 | 336·2 | 253·4 | 481 | 384·1 | 289·5 | 541 | 432·0 | 325·6 |
| 302 | 241·2 | 181·7 | 362 | 289·1 | 217·9 | 422 | 337·0 | 254·0 | 482 | 384·9 | 290·0 | 542 | 432·8 | 326·2 |
| 303 | 242·0 | 182·4 | 363 | 289·9 | 218·5 | 423 | 337·8 | 254·6 | 483 | 385·7 | 290·6 | 543 | 433·6 | 326·8 |
| 304 | 242·7 | 183·0 | 364 | 290·7 | 219·1 | 424 | 338·6 | 255·2 | 484 | 386·5 | 291·2 | 544 | 434·4 | 327·3 |
| 305 | 243·5 | 183·6 | 365 | 291·5 | 219·7 | 425 | 339·4 | 255·8 | 485 | 387·3 | 291·8 | 545 | 435·2 | 327·9 |
| 306 | 244·3 | 184·2 | 366 | 292·3 | 220·3 | 426 | 340·2 | 256·4 | 486 | 388·1 | 292·4 | 546 | 436·0 | 328·5 |
| 307 | 245·1 | 184·8 | 367 | 293·1 | 220·9 | 427 | 341·0 | 257·0 | 487 | 388·9 | 293·0 | 547 | 436·8 | 329·1 |
| 308 | 245·9 | 185·4 | 368 | 293·9 | 221·5 | 428 | 341·8 | 257·6 | 488 | 389·7 | 293·6 | 548 | 437·6 | 329·7 |
| 309 | 246·7 | 186·0 | 369 | 294·7 | 222·1 | 429 | 342·6 | 258·2 | 489 | 390·5 | 294·2 | 549 | 438·4 | 330·3 |
| 310 | 247·5 | 186·6 | 370 | 295·5 | 222·7 | 430 | 343·4 | 258·8 | 490 | 391·3 | 294·8 | 550 | 439·2 | 330·9 |
| 311 | 248·3 | 187·2 | 371 | 296·3 | 223·3 | 431 | 344·2 | 259·4 | 491 | 392·1 | 295·4 | 551 | 440·0 | 331·5 |
| 312 | 249·1 | 187·8 | 372 | 297·1 | 223·9 | 432 | 345·0 | 260·0 | 492 | 392·9 | 296·0 | 552 | 440·8 | 332·1 |
| 313 | 249·9 | 188·4 | 373 | 297·9 | 224·5 | 433 | 345·8 | 260·6 | 493 | 393·7 | 296·6 | 553 | 441·6 | 332·7 |
| 314 | 250·7 | 189·0 | 374 | 298·7 | 225·1 | 434 | 346·6 | 261·2 | 494 | 394·5 | 297·2 | 554 | 442·4 | 333·3 |
| 315 | 251·5 | 189·6 | 375 | 299·5 | 225·7 | 435 | 347·4 | 261·8 | 495 | 395·3 | 297·8 | 555 | 443·2 | 333·9 |
| 316 | 252·3 | 190·2 | 376 | 300·3 | 226·3 | 436 | 348·2 | 262·4 | 496 | 396·1 | 298·5 | 556 | 444·0 | 334·6 |
| 317 | 253·1 | 190·8 | 377 | 301·1 | 226·9 | 437 | 349·0 | 263·0 | 497 | 396·9 | 299·1 | 557 | 444·8 | 335·2 |
| 318 | 253·9 | 191·4 | 378 | 301·8 | 227·5 | 438 | 349·8 | 263·6 | 498 | 397·7 | 299·7 | 558 | 445·6 | 335·8 |
| 319 | 254·7 | 192·0 | 379 | 302·6 | 228·1 | 439 | 350·6 | 264·2 | 499 | 398·5 | 300·3 | 559 | 446·4 | 336·4 |
| 320 | 255·5 | 192·6 | 380 | 303·4 | 228·7 | 440 | 351·4 | 264·8 | 500 | 399·3 | 300·9 | 560 | 447·2 | 337·0 |
| 321 | 256·3 | 193·2 | 381 | 304·2 | 229·3 | 441 | 352·2 | 265·4 | 501 | 400·1 | 301·5 | 561 | 448·0 | 337·6 |
| 322 | 257·1 | 193·8 | 382 | 305·0 | 229·9 | 442 | 353·0 | 266·0 | 502 | 400·9 | 302·1 | 562 | 448·8 | 338·2 |
| 323 | 257·9 | 194·4 | 383 | 305·8 | 230·5 | 443 | 353·8 | 266·6 | 503 | 401·7 | 302·7 | 563 | 449·6 | 338·8 |
| 324 | 258·7 | 195·0 | 384 | 306·6 | 231·1 | 444 | 354·6 | 267·2 | 504 | 402·5 | 303·3 | 564 | 450·4 | 339·4 |
| 325 | 259·5 | 195·6 | 385 | 307·4 | 231·7 | 445 | 355·4 | 267·8 | 505 | 403·3 | 303·9 | 565 | 451·2 | 340·0 |
| 326 | 260·3 | 196·2 | 386 | 308·2 | 232·3 | 446 | 356·2 | 268·4 | 506 | 404·1 | 304·5 | 566 | 452·0 | 340·6 |
| 327 | 261·1 | 196·8 | 387 | 309·0 | 232·9 | 447 | 357·0 | 269·0 | 507 | 404·9 | 305·1 | 567 | 452·8 | 341·2 |
| 328 | 261·9 | 197·4 | 388 | 309·8 | 233·5 | 448 | 357·8 | 269·6 | 508 | 405·7 | 305·7 | 568 | 453·6 | 341·8 |
| 329 | 262·7 | 198·0 | 389 | 310·6 | 234·1 | 449 | 358·6 | 270·2 | 509 | 406·5 | 306·3 | 569 | 454·4 | 342·4 |
| 330 | 263·5 | 198·6 | 390 | 311·4 | 234·7 | 450 | 359·4 | 270·8 | 510 | 407·3 | 306·9 | 570 | 455·2 | 343·0 |
| 331 | 264·3 | 199·2 | 391 | 312·2 | 235·3 | 451 | 360·1 | 271·4 | 511 | 408·1 | 307·5 | 571 | 456·0 | 343·6 |
| 332 | 265·1 | 199·8 | 392 | 313·0 | 235·9 | 452 | 360·9 | 272·0 | 512 | 408·9 | 308·2 | 572 | 456·8 | 344·3 |
| 333 | 265·9 | 200·4 | 393 | 313·8 | 236·5 | 453 | 361·7 | 272·6 | 513 | 409·7 | 308·8 | 573 | 457·6 | 344·9 |
| 334 | 266·7 | 201·0 | 394 | 314·6 | 237·1 | 454 | 362·5 | 273·2 | 514 | 410·5 | 309·4 | 574 | 458·4 | 345·5 |
| 335 | 267·5 | 201·6 | 395 | 315·4 | 237·7 | 455 | 363·3 | 273·8 | 515 | 411·3 | 310·0 | 575 | 459·2 | 346·1 |
| 336 | 268·3 | 202·2 | 396 | 316·2 | 238·3 | 456 | 364·1 | 274·4 | 516 | 412·1 | 310·6 | 576 | 460·0 | 346·7 |
| 337 | 269·1 | 202·8 | 397 | 317·0 | 238·9 | 457 | 364·9 | 275·0 | 517 | 412·9 | 311·2 | 577 | 460·8 | 347·3 |
| 338 | 269·9 | 203·4 | 398 | 317·8 | 239·5 | 458 | 365·7 | 275·6 | 518 | 413·7 | 311·8 | 578 | 461·6 | 347·9 |
| 339 | 270·7 | 204·0 | 399 | 318·6 | 240·1 | 459 | 366·5 | 276·2 | 519 | 414·5 | 312·4 | 579 | 462·4 | 348·5 |
| 340 | 271·5 | 204·6 | 400 | 319·4 | 240·7 | 460 | 367·3 | 276·8 | 520 | 415·3 | 313·0 | 580 | 463·2 | 349·1 |
| 341 | 272·3 | 205·2 | 401 | 320·2 | 241·3 | 461 | 368·1 | 277·4 | 521 | 416·1 | 313·6 | 581 | 464·0 | 349·7 |
| 342 | 273·1 | 205·8 | 402 | 321·0 | 241·9 | 462 | 368·9 | 278·0 | 522 | 416·9 | 314·2 | 582 | 464·8 | 350·3 |
| 343 | 273·9 | 206·4 | 403 | 321·8 | 242·5 | 463 | 369·7 | 278·6 | 523 | 417·7 | 314·8 | 583 | 465·6 | 350·9 |
| 344 | 274·7 | 207·0 | 404 | 322·6 | 243·1 | 464 | 370·5 | 279·2 | 524 | 418·5 | 315·4 | 584 | 466·4 | 351·5 |
| 345 | 275·5 | 207·6 | 405 | 323·4 | 243·7 | 465 | 371·3 | 279·8 | 525 | 419·3 | 316·0 | 585 | 467·2 | 352·1 |
| 346 | 276·3 | 208·2 | 406 | 324·2 | 244·3 | 466 | 372·1 | 280·4 | 526 | 420·1 | 316·6 | 586 | 468·0 | 352·7 |
| 347 | 277·1 | 208·8 | 407 | 325·0 | 244·9 | 467 | 372·9 | 281·0 | 527 | 420·9 | 317·2 | 587 | 468·8 | 353·3 |
| 348 | 277·9 | 209·4 | 408 | 325·8 | 245·5 | 468 | 373·7 | 281·6 | 528 | 421·7 | 317·8 | 588 | 469·6 | 353·9 |
| 349 | 278·7 | 210·0 | 409 | 326·6 | 246·1 | 469 | 374·5 | 282·3 | 529 | 422·5 | 318·4 | 589 | 470·4 | 354·5 |
| 350 | 279·5 | 210·6 | 410 | 327·4 | 246·7 | 470 | 375·3 | 282·9 | 530 | 423·3 | 319·0 | 590 | 471·2 | 355·1 |
| 351 | 280·3 | 211·2 | 411 | 328·2 | 247·3 | 471 | 376·1 | 283·5 | 531 | 424·1 | 319·6 | 591 | 472·0 | 355·7 |
| 352 | 281·1 | 211·8 | 412 | 329·0 | 247·9 | 472 | 376·9 | 284·1 | 532 | 424·9 | 320·2 | 592 | 472·8 | 356·3 |
| 353 | 281·9 | 212·4 | 413 | 329·8 | 248·5 | 473 | 377·7 | 284·7 | 533 | 425·7 | 320·8 | 593 | 473·6 | 356·9 |
| 354 | 282·7 | 213·0 | 414 | 330·6 | 249·2 | 474 | 378·5 | 285·3 | 534 | 426·5 | 321·4 | 594 | 474·4 | 357·5 |
| 355 | 283·5 | 213·6 | 415 | 331·4 | 249·8 | 475 | 379·3 | 285·9 | 535 | 427·3 | 322·0 | 595 | 475·2 | 358·1 |
| 356 | 284·3 | 214·2 | 416 | 332·2 | 250·4 | 476 | 380·1 | 286·5 | 536 | 428·1 | 322·6 | 596 | 476·0 | 358·7 |
| 357 | 285·1 | 214·8 | 417 | 333·0 | 251·0 | 477 | 380·9 | 287·1 | 537 | 428·9 | 323·2 | 597 | 476·8 | 359·3 |
| 358 | 285·9 | 215·4 | 418 | 333·8 | 251·6 | 478 | 381·7 | 287·7 | 538 | 429·7 | 323·8 | 598 | 477·6 | 359·9 |
| 359 | 286·7 | 216·1 | 419 | 334·6 | 252·2 | 479 | 382·5 | 288·3 | 539 | 430·5 | 324·4 | 599 | 478·4 | 360·5 |
| 360 | 287·5 | 216·7 | 420 | 335·4 | 252·8 | 480 | 383·3 | 288·9 | 540 | 431·3 | 325·0 | 600 | 479·2 | 361·1 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

53° — 3h 32m

## TRAVERSE TABLE TO DEGREES

38° — 2h 32m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0·8 | 0·6 | 61 | 48·1 | 37·6 | 121 | 95·3 | 74·5 | 181 | 142·6 | 111·4 | 241 | 189·9 | 148·4 |
| 2 | 1·6 | 1·2 | 62 | 48·9 | 38·2 | 122 | 96·1 | 75·1 | 182 | 143·4 | 112·1 | 242 | 190·7 | 149·0 |
| 3 | 2·4 | 1·8 | 63 | 49·6 | 38·8 | 123 | 96·9 | 75·7 | 183 | 144·2 | 112·7 | 243 | 191·5 | 149·6 |
| 4 | 3·2 | 2·5 | 64 | 50·4 | 39·4 | 124 | 97·7 | 76·3 | 184 | 145·0 | 113·3 | 244 | 192·3 | 150·2 |
| 5 | 3·9 | 3·1 | 65 | 51·2 | 40·0 | 125 | 98·5 | 77·0 | 185 | 145·8 | 113·9 | 245 | 193·1 | 150·8 |
| 6 | 4·7 | 3·7 | 66 | 52·0 | 40·6 | 126 | 99·3 | 77·6 | 186 | 146·6 | 114·5 | 246 | 193·9 | 151·5 |
| 7 | 5·5 | 4·3 | 67 | 52·8 | 41·2 | 127 | 100·1 | 78·2 | 187 | 147·4 | 115·1 | 247 | 194·6 | 152·1 |
| 8 | 6·3 | 4·9 | 68 | 53·6 | 41·9 | 128 | 100·9 | 78·8 | 188 | 148·1 | 115·7 | 248 | 195·4 | 152·7 |
| 9 | 7·1 | 5·5 | 69 | 54·4 | 42·5 | 129 | 101·7 | 79·4 | 189 | 148·9 | 116·4 | 249 | 196·2 | 153·3 |
| 10 | 7·9 | 6·2 | 70 | 55·2 | 43·1 | 130 | 102·4 | 80·0 | 190 | 149·7 | 117·0 | 250 | 197·0 | 153·9 |
| 11 | 8·7 | 6·8 | 71 | 55·9 | 43·7 | 131 | 103·2 | 80·7 | 191 | 150·5 | 117·6 | 251 | 197·8 | 154·5 |
| 12 | 9·5 | 7·4 | 72 | 56·7 | 44·3 | 132 | 104·0 | 81·3 | 192 | 151·3 | 118·2 | 252 | 198·6 | 155·1 |
| 13 | 10·2 | 8·0 | 73 | 57·5 | 44·9 | 133 | 104·8 | 81·9 | 193 | 152·1 | 118·8 | 253 | 199·4 | 155·8 |
| 14 | 11·0 | 8·6 | 74 | 58·3 | 45·6 | 134 | 105·6 | 82·5 | 194 | 152·9 | 119·4 | 254 | 200·2 | 156·4 |
| 15 | 11·8 | 9·2 | 75 | 59·1 | 46·2 | 135 | 106·4 | 83·1 | 195 | 153·7 | 120·1 | 255 | 200·9 | 157·0 |
| 16 | 12·6 | 9·9 | 76 | 59·9 | 46·8 | 136 | 107·2 | 83·7 | 196 | 154·5 | 120·7 | 256 | 201·7 | 157·6 |
| 17 | 13·4 | 10·5 | 77 | 60·7 | 47·4 | 137 | 108·0 | 84·3 | 197 | 155·2 | 121·3 | 257 | 202·5 | 158·2 |
| 18 | 14·2 | 11·1 | 78 | 61·5 | 48·0 | 138 | 108·7 | 85·0 | 198 | 156·0 | 121·9 | 258 | 203·3 | 158·8 |
| 19 | 15·0 | 11·7 | 79 | 62·3 | 48·6 | 139 | 109·5 | 85·6 | 199 | 156·8 | 122·5 | 259 | 204·1 | 159·5 |
| 20 | 15·8 | 12·3 | 80 | 63·0 | 49·3 | 140 | 110·3 | 86·2 | 200 | 157·6 | 123·1 | 260 | 204·9 | 160·1 |
| 21 | 16·5 | 12·9 | 81 | 63·8 | 49·9 | 141 | 111·1 | 86·8 | 201 | 158·4 | 123·7 | 261 | 205·7 | 160·7 |
| 22 | 17·3 | 13·5 | 82 | 64·6 | 50·5 | 142 | 111·9 | 87·4 | 202 | 159·2 | 124·4 | 262 | 206·5 | 161·3 |
| 23 | 18·1 | 14·2 | 83 | 65·4 | 51·1 | 143 | 112·7 | 88·0 | 203 | 160·0 | 125·0 | 263 | 207·2 | 161·9 |
| 24 | 18·9 | 14·8 | 84 | 66·2 | 51·7 | 144 | 113·5 | 88·7 | 204 | 160·8 | 125·6 | 264 | 208·0 | 162·5 |
| 25 | 19·7 | 15·4 | 85 | 67·0 | 52·3 | 145 | 114·3 | 89·3 | 205 | 161·5 | 126·2 | 265 | 208·8 | 163·2 |
| 26 | 20·5 | 16·0 | 86 | 67·8 | 52·9 | 146 | 115·0 | 89·9 | 206 | 162·3 | 126·8 | 266 | 209·6 | 163·8 |
| 27 | 21·3 | 16·6 | 87 | 68·6 | 53·6 | 147 | 115·8 | 90·5 | 207 | 163·1 | 127·4 | 267 | 210·4 | 164·4 |
| 28 | 22·1 | 17·2 | 88 | 69·3 | 54·2 | 148 | 116·6 | 91·1 | 208 | 163·9 | 128·1 | 268 | 211·2 | 165·0 |
| 29 | 22·9 | 17·9 | 89 | 70·1 | 54·8 | 149 | 117·4 | 91·7 | 209 | 164·7 | 128·7 | 269 | 212·0 | 165·6 |
| 30 | 23·6 | 18·5 | 90 | 70·9 | 55·4 | 150 | 118·2 | 92·3 | 210 | 165·5 | 129·3 | 270 | 212·8 | 166·2 |
| 31 | 24·4 | 19·1 | 91 | 71·7 | 56·0 | 151 | 119·0 | 93·0 | 211 | 166·3 | 129·9 | 271 | 213·6 | 166·8 |
| 32 | 25·2 | 19·7 | 92 | 72·5 | 56·6 | 152 | 119·8 | 93·6 | 212 | 167·1 | 130·5 | 272 | 214·3 | 167·5 |
| 33 | 26·0 | 20·3 | 93 | 73·3 | 57·3 | 153 | 120·6 | 94·2 | 213 | 167·8 | 131·1 | 273 | 215·1 | 168·1 |
| 34 | 26·8 | 20·9 | 94 | 74·1 | 57·9 | 154 | 121·4 | 94·8 | 214 | 168·6 | 131·8 | 274 | 215·9 | 168·7 |
| 35 | 27·6 | 21·5 | 95 | 74·9 | 58·5 | 155 | 122·1 | 95·4 | 215 | 169·4 | 132·4 | 275 | 216·7 | 169·3 |
| 36 | 28·4 | 22·2 | 96 | 75·6 | 59·1 | 156 | 122·9 | 96·0 | 216 | 170·2 | 133·0 | 276 | 217·5 | 169·9 |
| 37 | 29·2 | 22·8 | 97 | 76·4 | 59·7 | 157 | 123·7 | 96·7 | 217 | 171·0 | 133·6 | 277 | 218·3 | 170·5 |
| 38 | 29·9 | 23·4 | 98 | 77·2 | 60·3 | 158 | 124·5 | 97·3 | 218 | 171·8 | 134·2 | 278 | 219·1 | 171·2 |
| 39 | 30·7 | 24·0 | 99 | 78·0 | 61·0 | 159 | 125·3 | 97·9 | 219 | 172·6 | 134·8 | 279 | 219·9 | 171·8 |
| 40 | 31·5 | 24·6 | 100 | 78·8 | 61·6 | 160 | 126·1 | 98·5 | 220 | 173·4 | 135·4 | 280 | 220·6 | 172·4 |
| 41 | 32·3 | 25·2 | 101 | 79·6 | 62·2 | 161 | 126·9 | 99·1 | 221 | 174·2 | 136·1 | 281 | 221·4 | 173·0 |
| 42 | 33·1 | 25·9 | 102 | 80·4 | 62·8 | 162 | 127·7 | 99·7 | 222 | 174·9 | 136·7 | 282 | 222·2 | 173·6 |
| 43 | 33·9 | 26·5 | 103 | 81·2 | 63·4 | 163 | 128·4 | 100·4 | 223 | 175·7 | 137·3 | 283 | 223·0 | 174·2 |
| 44 | 34·7 | 27·1 | 104 | 82·0 | 64·0 | 164 | 129·2 | 101·0 | 224 | 176·5 | 137·9 | 284 | 223·8 | 174·8 |
| 45 | 35·5 | 27·7 | 105 | 82·7 | 64·6 | 165 | 130·0 | 101·6 | 225 | 177·3 | 138·5 | 285 | 224·6 | 175·5 |
| 46 | 36·2 | 28·3 | 106 | 83·5 | 65·3 | 166 | 130·8 | 102·2 | 226 | 178·1 | 139·1 | 286 | 225·4 | 176·1 |
| 47 | 37·0 | 28·9 | 107 | 84·3 | 65·9 | 167 | 131·6 | 102·8 | 227 | 178·9 | 139·8 | 287 | 226·2 | 176·7 |
| 48 | 37·8 | 29·6 | 108 | 85·1 | 66·5 | 168 | 132·4 | 103·4 | 228 | 179·7 | 140·4 | 288 | 226·9 | 177·3 |
| 49 | 38·6 | 30·2 | 109 | 85·9 | 67·1 | 169 | 133·2 | 104·0 | 229 | 180·5 | 141·0 | 289 | 227·7 | 177·9 |
| 50 | 39·4 | 30·8 | 110 | 86·7 | 67·7 | 170 | 134·0 | 104·7 | 230 | 181·2 | 141·6 | 290 | 228·5 | 178·5 |
| 51 | 40·2 | 31·4 | 111 | 87·5 | 68·3 | 171 | 134·7 | 105·3 | 231 | 182·0 | 142·2 | 291 | 229·3 | 179·2 |
| 52 | 41·0 | 32·0 | 112 | 88·3 | 69·0 | 172 | 135·5 | 105·9 | 232 | 182·8 | 142·8 | 292 | 230·1 | 179·8 |
| 53 | 41·8 | 32·6 | 113 | 89·0 | 69·6 | 173 | 136·3 | 106·5 | 233 | 183·6 | 143·4 | 293 | 230·9 | 180·4 |
| 54 | 42·6 | 33·2 | 114 | 89·8 | 70·2 | 174 | 137·1 | 107·1 | 234 | 184·4 | 144·1 | 294 | 231·7 | 181·0 |
| 55 | 43·3 | 33·9 | 115 | 90·6 | 70·8 | 175 | 137·9 | 107·7 | 235 | 185·2 | 144·7 | 295 | 232·5 | 181·6 |
| 56 | 44·1 | 34·5 | 116 | 91·4 | 71·4 | 176 | 138·7 | 108·4 | 236 | 186·0 | 145·3 | 296 | 233·3 | 182·2 |
| 57 | 44·9 | 35·1 | 117 | 92·2 | 72·0 | 177 | 139·5 | 109·0 | 237 | 186·8 | 145·9 | 297 | 234·0 | 182·9 |
| 58 | 45·7 | 35·7 | 118 | 93·0 | 72·6 | 178 | 140·3 | 109·6 | 238 | 187·5 | 146·5 | 298 | 234·8 | 183·5 |
| 59 | 46·5 | 36·3 | 119 | 93·8 | 73·3 | 179 | 141·1 | 110·2 | 239 | 188·3 | 147·1 | 299 | 235·6 | 184·1 |
| 60 | 47·3 | 36·9 | 120 | 94·6 | 73·9 | 180 | 141·8 | 110·8 | 240 | 189·1 | 147·8 | 300 | 236·4 | 184·7 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

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## TRAVERSE TABLE TO DEGREES

38° 2h 32m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 237.2 | 185.3 | 361 | 284.5 | 222.3 | 421 | 331.8 | 259.2 | 481 | 379.0 | 296.2 | 541 | 426.3 | 333.1 |
| 302 | 238.0 | 185.9 | 362 | 285.3 | 222.9 | 422 | 332.5 | 259.8 | 482 | 379.8 | 296.8 | 542 | 427.1 | 333.7 |
| 303 | 238.8 | 186.6 | 363 | 286.0 | 223.5 | 423 | 333.3 | 260.4 | 483 | 380.6 | 297.4 | 543 | 427.9 | 334.3 |
| 304 | 239.6 | 187.2 | 364 | 286.8 | 224.1 | 424 | 334.1 | 261.0 | 484 | 381.4 | 298.0 | 544 | 428.7 | 335.0 |
| 305 | 240.3 | 187.8 | 365 | 287.6 | 224.7 | 425 | 334.9 | 261.7 | 485 | 382.2 | 298.6 | 545 | 429.5 | 335.6 |
| 306 | 241.1 | 188.4 | 366 | 288.4 | 225.3 | 426 | 335.7 | 262.3 | 486 | 383.0 | 299.2 | 546 | 430.3 | 336.2 |
| 307 | 241.9 | 189.0 | 367 | 289.2 | 226.0 | 427 | 336.5 | 262.9 | 487 | 383.8 | 299.8 | 547 | 431.0 | 336.8 |
| 308 | 242.7 | 189.6 | 368 | 290.0 | 226.6 | 428 | 337.3 | 263.5 | 488 | 384.5 | 300.4 | 548 | 431.8 | 337.4 |
| 309 | 243.5 | 190.2 | 369 | 290.8 | 227.2 | 429 | 338.1 | 264.1 | 489 | 385.3 | 301.1 | 549 | 432.6 | 338.0 |
| 310 | 244.3 | 190.9 | 370 | 291.6 | 227.8 | 430 | 338.8 | 264.7 | 490 | 386.1 | 301.7 | 550 | 433.4 | 338.6 |
| 311 | 245.1 | 191.5 | 371 | 292.4 | 228.4 | 431 | 339.6 | 265.4 | 491 | 386.9 | 302.3 | 551 | 434.2 | 339.3 |
| 312 | 245.9 | 192.1 | 372 | 293.1 | 229.0 | 432 | 340.4 | 266.0 | 492 | 387.7 | 302.9 | 552 | 435.0 | 339.9 |
| 313 | 246.6 | 192.7 | 373 | 293.9 | 229.6 | 433 | 341.2 | 266.6 | 493 | 388.5 | 303.5 | 553 | 435.8 | 340.5 |
| 314 | 247.4 | 193.3 | 374 | 294.7 | 230.3 | 434 | 342.0 | 267.2 | 494 | 389.3 | 304.2 | 554 | 436.6 | 341.1 |
| 315 | 248.2 | 193.9 | 375 | 295.5 | 230.9 | 435 | 342.8 | 267.8 | 495 | 390.1 | 304.8 | 555 | 437.4 | 341.7 |
| 316 | 249.0 | 194.6 | 376 | 296.3 | 231.5 | 436 | 343.6 | 268.4 | 496 | 390.9 | 305.4 | 556 | 438.1 | 342.3 |
| 317 | 249.8 | 195.2 | 377 | 297.1 | 232.1 | 437 | 344.4 | 269.1 | 497 | 391.6 | 306.0 | 557 | 438.9 | 343.0 |
| 318 | 250.6 | 195.8 | 378 | 297.9 | 232.7 | 438 | 345.2 | 269.7 | 498 | 392.4 | 306.6 | 558 | 439.7 | 343.6 |
| 319 | 251.4 | 196.4 | 379 | 298.7 | 233.3 | 439 | 345.9 | 270.3 | 499 | 393.2 | 307.2 | 559 | 440.5 | 344.2 |
| 320 | 252.2 | 197.0 | 380 | 299.4 | 234.0 | 440 | 346.7 | 270.9 | 500 | 394.0 | 307.8 | 560 | 441.3 | 344.8 |
| 321 | 253.0 | 197.6 | 381 | 300.2 | 234.6 | 441 | 347.5 | 271.5 | 501 | 394.8 | 308.4 | 561 | 442.1 | 345.4 |
| 322 | 253.7 | 198.2 | 382 | 301.0 | 235.2 | 442 | 348.3 | 272.1 | 502 | 395.6 | 309.1 | 562 | 442.9 | 346.0 |
| 323 | 254.5 | 198.9 | 383 | 301.8 | 235.8 | 443 | 349.1 | 272.7 | 503 | 396.4 | 309.7 | 563 | 443.7 | 346.6 |
| 324 | 255.3 | 199.5 | 384 | 302.6 | 236.4 | 444 | 349.9 | 273.4 | 504 | 397.2 | 310.3 | 564 | 444.4 | 347.2 |
| 325 | 256.1 | 200.1 | 385 | 303.4 | 237.0 | 445 | 350.7 | 274.0 | 505 | 397.9 | 310.9 | 565 | 445.2 | 347.8 |
| 326 | 256.9 | 200.7 | 386 | 304.2 | 237.7 | 446 | 351.5 | 274.6 | 506 | 398.7 | 311.6 | 566 | 446.0 | 348.5 |
| 327 | 257.7 | 201.3 | 387 | 305.0 | 238.3 | 447 | 352.2 | 275.2 | 507 | 399.5 | 312.2 | 567 | 446.8 | 349.1 |
| 328 | 258.5 | 201.9 | 388 | 305.7 | 238.9 | 448 | 353.0 | 275.8 | 508 | 400.3 | 312.8 | 568 | 447.6 | 349.7 |
| 329 | 259.3 | 202.6 | 389 | 306.5 | 239.5 | 449 | 353.8 | 276.4 | 509 | 401.1 | 313.4 | 569 | 448.4 | 350.3 |
| 330 | 260.0 | 203.2 | 390 | 307.3 | 240.1 | 450 | 354.6 | 277.1 | 510 | 401.9 | 314.0 | 570 | 449.2 | 350.9 |
| 331 | 260.8 | 203.8 | 391 | 308.1 | 240.7 | 451 | 355.4 | 277.7 | 511 | 402.7 | 314.6 | 571 | 450.0 | 351.6 |
| 332 | 261.6 | 204.4 | 392 | 308.9 | 241.3 | 452 | 356.2 | 278.3 | 512 | 403.5 | 315.2 | 572 | 450.7 | 352.2 |
| 333 | 262.4 | 205.0 | 393 | 309.7 | 242.0 | 453 | 357.0 | 278.9 | 513 | 404.2 | 315.8 | 573 | 451.5 | 352.8 |
| 334 | 263.2 | 205.6 | 394 | 310.5 | 242.6 | 454 | 357.8 | 279.5 | 514 | 405.0 | 316.4 | 574 | 452.3 | 353.4 |
| 335 | 264.0 | 206.3 | 395 | 311.3 | 243.2 | 455 | 358.5 | 280.1 | 515 | 405.8 | 317.1 | 575 | 453.1 | 354.0 |
| 336 | 264.8 | 206.9 | 396 | 312.1 | 243.8 | 456 | 359.3 | 280.7 | 516 | 406.6 | 317.7 | 576 | 453.9 | 354.6 |
| 337 | 265.6 | 207.5 | 397 | 312.8 | 244.4 | 457 | 360.1 | 281.4 | 517 | 407.4 | 318.3 | 577 | 454.7 | 355.2 |
| 338 | 266.3 | 208.1 | 398 | 313.6 | 245.0 | 458 | 360.9 | 282.0 | 518 | 408.2 | 318.9 | 578 | 455.5 | 355.8 |
| 339 | 267.1 | 208.7 | 399 | 314.4 | 245.7 | 459 | 361.7 | 282.6 | 519 | 409.0 | 319.5 | 579 | 456.3 | 356.4 |
| 340 | 267.9 | 209.3 | 400 | 315.2 | 246.3 | 460 | 362.5 | 283.2 | 520 | 409.8 | 320.2 | 580 | 457.1 | 357.1 |
| 341 | 268.7 | 209.9 | 401 | 316.0 | 246.9 | 461 | 363.3 | 283.8 | 521 | 410.6 | 320.8 | 581 | 457.8 | 357.7 |
| 342 | 269.5 | 210.6 | 402 | 316.8 | 247.5 | 462 | 364.1 | 284.4 | 522 | 411.3 | 321.4 | 582 | 458.6 | 358.3 |
| 343 | 270.3 | 211.2 | 403 | 317.6 | 248.1 | 463 | 364.9 | 285.1 | 523 | 412.1 | 322.0 | 583 | 459.4 | 358.9 |
| 344 | 271.1 | 211.8 | 404 | 318.4 | 248.7 | 464 | 365.6 | 285.7 | 524 | 412.9 | 322.6 | 584 | 460.2 | 359.5 |
| 345 | 271.9 | 212.4 | 405 | 319.1 | 249.3 | 465 | 366.4 | 286.3 | 525 | 413.7 | 323.2 | 585 | 461.0 | 360.2 |
| 346 | 272.7 | 213.0 | 406 | 319.9 | 250.0 | 466 | 367.2 | 286.9 | 526 | 414.5 | 323.8 | 586 | 461.8 | 360.8 |
| 347 | 273.4 | 213.6 | 407 | 320.7 | 250.6 | 467 | 368.0 | 287.5 | 527 | 415.3 | 324.5 | 587 | 462.6 | 361.4 |
| 348 | 274.2 | 214.3 | 408 | 321.5 | 251.2 | 468 | 368.8 | 288.1 | 528 | 416.1 | 325.1 | 588 | 463.3 | 362.0 |
| 349 | 275.0 | 214.9 | 409 | 322.3 | 251.8 | 469 | 369.6 | 288.7 | 529 | 416.9 | 325.7 | 589 | 464.1 | 362.6 |
| 350 | 275.8 | 215.5 | 410 | 323.1 | 252.4 | 470 | 370.4 | 289.3 | 530 | 417.6 | 326.3 | 590 | 464.9 | 363.2 |
| 351 | 276.6 | 216.1 | 411 | 323.9 | 253.0 | 471 | 371.2 | 290.0 | 531 | 418.4 | 326.9 | 591 | 465.7 | 363.8 |
| 352 | 277.4 | 216.7 | 412 | 324.7 | 253.7 | 472 | 371.9 | 290.6 | 532 | 419.2 | 327.5 | 592 | 466.5 | 364.4 |
| 353 | 278.2 | 217.3 | 413 | 325.5 | 254.3 | 473 | 372.7 | 291.2 | 533 | 420.0 | 328.2 | 593 | 467.3 | 365.1 |
| 354 | 279.0 | 218.0 | 414 | 326.2 | 254.9 | 474 | 373.5 | 291.8 | 534 | 420.8 | 328.8 | 594 | 468.1 | 365.7 |
| 355 | 279.7 | 218.6 | 415 | 327.0 | 255.5 | 475 | 374.3 | 292.4 | 535 | 421.6 | 329.4 | 595 | 468.9 | 366.3 |
| 356 | 280.5 | 219.2 | 416 | 327.8 | 256.1 | 476 | 375.1 | 293.1 | 536 | 422.4 | 330.0 | 596 | 469.7 | 366.9 |
| 357 | 281.3 | 219.8 | 417 | 328.6 | 256.7 | 477 | 375.9 | 293.7 | 537 | 423.2 | 330.6 | 597 | 470.5 | 367.5 |
| 358 | 282.1 | 220.4 | 418 | 329.4 | 257.4 | 478 | 376.7 | 294.3 | 538 | 424.0 | 331.2 | 598 | 471.2 | 368.1 |
| 359 | 282.9 | 221.0 | 419 | 330.2 | 258.0 | 479 | 377.5 | 294.9 | 539 | 424.7 | 331.8 | 599 | 472.0 | 368.7 |
| 360 | 283.7 | 221.6 | 420 | 331.0 | 258.6 | 480 | 378.2 | 295.5 | 540 | 425.5 | 332.5 | 600 | 472.8 | 369.4 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

52° 3h 28m

## TRAVERSE TABLE TO DEGREES

39° 2h 36m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.8 | 0.6 | 61 | 47.4 | 38.4 | 121 | 94.0 | 76.1 | 181 | 140.7 | 113.9 | 241 | 187.3 | 151.7 |
| 2 | 1.6 | 1.3 | 62 | 48.2 | 39.0 | 122 | 94.8 | 76.8 | 182 | 141.4 | 114.5 | 242 | 188.1 | 152.3 |
| 3 | 2.3 | 1.9 | 63 | 49.0 | 39.6 | 123 | 95.6 | 77.4 | 183 | 142.2 | 115.2 | 243 | 188.8 | 152.9 |
| 4 | 3.1 | 2.5 | 64 | 49.7 | 40.3 | 124 | 96.4 | 78.0 | 184 | 143.0 | 115.8 | 244 | 189.6 | 153.6 |
| 5 | 3.9 | 3.1 | 65 | 50.5 | 40.9 | 125 | 97.1 | 78.7 | 185 | 143.8 | 116.4 | 245 | 190.4 | 154.2 |
| 6 | 4.7 | 3.8 | 66 | 51.3 | 41.5 | 126 | 97.9 | 79.3 | 186 | 144.5 | 117.1 | 246 | 191.2 | 154.8 |
| 7 | 5.4 | 4.4 | 67 | 52.1 | 42.2 | 127 | 98.7 | 79.9 | 187 | 145.3 | 117.7 | 247 | 192.0 | 155.4 |
| 8 | 6.2 | 5.0 | 68 | 52.8 | 42.8 | 128 | 99.5 | 80.6 | 188 | 146.1 | 118.3 | 248 | 192.7 | 156.1 |
| 9 | 7.0 | 5.7 | 69 | 53.6 | 43.4 | 129 | 100.3 | 81.2 | 189 | 146.9 | 118.9 | 249 | 193.5 | 156.7 |
| 10 | 7.8 | 6.3 | 70 | 54.4 | 44.1 | 130 | 101.0 | 81.8 | 190 | 147.7 | 119.6 | 250 | 194.3 | 157.3 |
| 11 | 8.5 | 6.9 | 71 | 55.2 | 44.7 | 131 | 101.8 | 82.4 | 191 | 148.4 | 120.2 | 251 | 195.1 | 158.0 |
| 12 | 9.3 | 7.6 | 72 | 56.0 | 45.3 | 132 | 102.6 | 83.1 | 192 | 149.2 | 120.8 | 252 | 195.8 | 158.6 |
| 13 | 10.1 | 8.2 | 73 | 56.7 | 45.9 | 133 | 103.4 | 83.7 | 193 | 150.0 | 121.5 | 253 | 196.6 | 159.2 |
| 14 | 10.9 | 8.8 | 74 | 57.5 | 46.6 | 134 | 104.1 | 84.3 | 194 | 150.8 | 122.1 | 254 | 197.4 | 159.8 |
| 15 | 11.7 | 9.4 | 75 | 58.3 | 47.2 | 135 | 104.9 | 85.0 | 195 | 151.5 | 122.7 | 255 | 198.2 | 160.5 |
| 16 | 12.4 | 10.1 | 76 | 59.1 | 47.8 | 136 | 105.7 | 85.6 | 196 | 152.3 | 123.3 | 256 | 198.9 | 161.1 |
| 17 | 13.2 | 10.7 | 77 | 59.8 | 48.5 | 137 | 106.5 | 86.2 | 197 | 153.1 | 124.0 | 257 | 199.7 | 161.7 |
| 18 | 14.0 | 11.3 | 78 | 60.6 | 49.1 | 138 | 107.2 | 86.8 | 198 | 153.9 | 124.6 | 258 | 200.5 | 162.4 |
| 19 | 14.8 | 12.0 | 79 | 61.4 | 49.7 | 139 | 108.0 | 87.5 | 199 | 154.7 | 125.2 | 259 | 201.3 | 163.0 |
| 20 | 15.5 | 12.6 | 80 | 62.2 | 50.3 | 140 | 108.8 | 88.1 | 200 | 155.4 | 125.9 | 260 | 202.1 | 163.6 |
| 21 | 16.3 | 13.2 | 81 | 62.9 | 51.0 | 141 | 109.6 | 88.7 | 201 | 156.2 | 126.5 | 261 | 202.8 | 164.3 |
| 22 | 17.1 | 13.8 | 82 | 63.7 | 51.6 | 142 | 110.4 | 89.4 | 202 | 157.0 | 127.1 | 262 | 203.6 | 164.9 |
| 23 | 17.9 | 14.5 | 83 | 64.5 | 52.2 | 143 | 111.1 | 90.0 | 203 | 157.8 | 127.8 | 263 | 204.4 | 165.5 |
| 24 | 18.7 | 15.1 | 84 | 65.3 | 52.9 | 144 | 111.9 | 90.6 | 204 | 158.5 | 128.4 | 264 | 205.2 | 166.1 |
| 25 | 19.4 | 15.7 | 85 | 66.1 | 53.5 | 145 | 112.7 | 91.3 | 205 | 159.3 | 129.0 | 265 | 205.9 | 166.8 |
| 26 | 20.2 | 16.4 | 86 | 66.8 | 54.1 | 146 | 113.5 | 91.9 | 206 | 160.1 | 129.6 | 266 | 206.7 | 167.4 |
| 27 | 21.0 | 17.0 | 87 | 67.6 | 54.8 | 147 | 114.2 | 92.5 | 207 | 160.9 | 130.3 | 267 | 207.5 | 168.0 |
| 28 | 21.8 | 17.6 | 88 | 68.4 | 55.4 | 148 | 115.0 | 93.1 | 208 | 161.6 | 130.9 | 268 | 208.3 | 168.7 |
| 29 | 22.5 | 18.3 | 89 | 69.2 | 56.0 | 149 | 115.8 | 93.8 | 209 | 162.4 | 131.5 | 269 | 209.1 | 169.3 |
| 30 | 23.3 | 18.9 | 90 | 69.9 | 56.6 | 150 | 116.6 | 94.4 | 210 | 163.2 | 132.2 | 270 | 209.8 | 169.9 |
| 31 | 24.1 | 19.5 | 91 | 70.7 | 57.3 | 151 | 117.3 | 95.0 | 211 | 164.0 | 132.8 | 271 | 210.6 | 170.5 |
| 32 | 24.9 | 20.1 | 92 | 71.5 | 57.9 | 152 | 118.1 | 95.7 | 212 | 164.8 | 133.4 | 272 | 211.4 | 171.2 |
| 33 | 25.6 | 20.8 | 93 | 72.3 | 58.5 | 153 | 118.9 | 96.3 | 213 | 165.5 | 134.0 | 273 | 212.2 | 171.8 |
| 34 | 26.4 | 21.4 | 94 | 73.1 | 59.2 | 154 | 119.7 | 96.9 | 214 | 166.3 | 134.7 | 274 | 212.9 | 172.4 |
| 35 | 27.2 | 22.0 | 95 | 73.8 | 59.8 | 155 | 120.5 | 97.5 | 215 | 167.1 | 135.3 | 275 | 213.7 | 173.1 |
| 36 | 28.0 | 22.7 | 96 | 74.6 | 60.4 | 156 | 121.2 | 98.2 | 216 | 167.9 | 135.9 | 276 | 214.5 | 173.7 |
| 37 | 28.8 | 23.3 | 97 | 75.4 | 61.0 | 157 | 122.0 | 98.8 | 217 | 168.6 | 136.6 | 277 | 215.3 | 174.3 |
| 38 | 29.5 | 23.9 | 98 | 76.2 | 61.7 | 158 | 122.8 | 99.4 | 218 | 169.4 | 137.2 | 278 | 216.0 | 175.0 |
| 39 | 30.3 | 24.5 | 99 | 76.9 | 62.3 | 159 | 123.6 | 100.1 | 219 | 170.2 | 137.8 | 279 | 216.8 | 175.6 |
| 40 | 31.1 | 25.2 | 100 | 77.7 | 62.9 | 160 | 124.3 | 100.7 | 220 | 171.0 | 138.5 | 280 | 217.6 | 176.2 |
| 41 | 31.9 | 25.8 | 101 | 78.5 | 63.6 | 161 | 125.1 | 101.3 | 221 | 171.7 | 139.1 | 281 | 218.4 | 176.8 |
| 42 | 32.6 | 26.4 | 102 | 79.3 | 64.2 | 162 | 125.9 | 101.9 | 222 | 172.5 | 139.7 | 282 | 219.2 | 177.5 |
| 43 | 33.4 | 27.1 | 103 | 80.0 | 64.8 | 163 | 126.7 | 102.6 | 223 | 173.3 | 140.3 | 283 | 219.9 | 178.1 |
| 44 | 34.2 | 27.7 | 104 | 80.8 | 65.4 | 164 | 127.5 | 103.2 | 224 | 174.1 | 141.0 | 284 | 220.7 | 178.7 |
| 45 | 35.0 | 28.3 | 105 | 81.6 | 66.1 | 165 | 128.2 | 103.8 | 225 | 174.9 | 141.6 | 285 | 221.5 | 179.4 |
| 46 | 35.7 | 28.9 | 106 | 82.4 | 66.7 | 166 | 129.0 | 104.5 | 226 | 175.6 | 142.2 | 286 | 222.3 | 180.0 |
| 47 | 36.5 | 29.6 | 107 | 83.2 | 67.3 | 167 | 129.8 | 105.1 | 227 | 176.4 | 142.9 | 287 | 223.0 | 180.6 |
| 48 | 37.3 | 30.2 | 108 | 83.9 | 68.0 | 168 | 130.6 | 105.7 | 228 | 177.2 | 143.5 | 288 | 223.8 | 181.2 |
| 49 | 38.1 | 30.8 | 109 | 84.7 | 68.6 | 169 | 131.3 | 106.4 | 229 | 178.0 | 144.1 | 289 | 224.6 | 181.9 |
| 50 | 38.9 | 31.5 | 110 | 85.5 | 69.2 | 170 | 132.1 | 107.0 | 230 | 178.7 | 144.7 | 290 | 225.4 | 182.5 |
| 51 | 39.6 | 32.1 | 111 | 86.3 | 69.9 | 171 | 132.9 | 107.6 | 231 | 179.5 | 145.4 | 291 | 226.1 | 183.1 |
| 52 | 40.4 | 32.7 | 112 | 87.0 | 70.5 | 172 | 133.7 | 108.2 | 232 | 180.3 | 146.0 | 292 | 226.9 | 183.8 |
| 53 | 41.2 | 33.4 | 113 | 87.8 | 71.1 | 173 | 134.4 | 108.9 | 233 | 181.1 | 146.6 | 293 | 227.7 | 184.4 |
| 54 | 42.0 | 34.0 | 114 | 88.6 | 71.7 | 174 | 135.2 | 109.5 | 234 | 181.9 | 147.3 | 294 | 228.5 | 185.0 |
| 55 | 42.7 | 34.6 | 115 | 89.4 | 72.4 | 175 | 136.0 | 110.1 | 235 | 182.6 | 147.9 | 295 | 229.3 | 185.6 |
| 56 | 43.5 | 35.2 | 116 | 90.1 | 73.0 | 176 | 136.8 | 110.8 | 236 | 183.4 | 148.5 | 296 | 230.0 | 186.3 |
| 57 | 44.3 | 35.9 | 117 | 90.9 | 73.6 | 177 | 137.6 | 111.4 | 237 | 184.2 | 149.1 | 297 | 230.8 | 186.9 |
| 58 | 45.1 | 36.5 | 118 | 91.7 | 74.3 | 178 | 138.3 | 112.0 | 238 | 185.0 | 149.8 | 298 | 231.6 | 187.5 |
| 59 | 45.9 | 37.1 | 119 | 92.5 | 74.9 | 179 | 139.1 | 112.6 | 239 | 185.7 | 150.4 | 299 | 232.4 | 188.2 |
| 60 | 46.6 | 37.8 | 120 | 93.3 | 75.5 | 180 | 139.9 | 113.3 | 240 | 186.5 | 151.0 | 300 | 233.1 | 188.8 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

51° 3h 24m

## TRAVERSE TABLE TO DEGREES

39° 2h 36m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 233.9 | 189.4 | 361 | 280.6 | 227.1 | 421 | 327.2 | 264.9 | 481 | 373.8 | 302.6 | 541 | 420.4 | 340.4 |
| 302 | 234.7 | 190.0 | 362 | 281.3 | 227.8 | 422 | 328.0 | 265.5 | 482 | 374.6 | 303.3 | 542 | 421.2 | 341.0 |
| 303 | 235.5 | 190.6 | 363 | 282.1 | 228.4 | 423 | 328.7 | 266.2 | 483 | 375.4 | 303.9 | 543 | 422.0 | 341.7 |
| 304 | 236.3 | 191.3 | 364 | 282.9 | 229.0 | 424 | 329.5 | 266.8 | 484 | 376.1 | 304.5 | 544 | 422.7 | 342.3 |
| 305 | 237.0 | 191.9 | 365 | 283.7 | 229.7 | 425 | 330.3 | 267.4 | 485 | 376.9 | 305.2 | 545 | 423.5 | 342.9 |
| 306 | 237.8 | 192.5 | 366 | 284.4 | 230.3 | 426 | 331.1 | 268.0 | 486 | 377.7 | 305.8 | 546 | 424.3 | 343.6 |
| 307 | 238.6 | 193.2 | 367 | 285.2 | 230.9 | 427 | 331.9 | 268.7 | 487 | 378.5 | 306.4 | 547 | 425.1 | 344.2 |
| 308 | 239.4 | 193.8 | 368 | 286.0 | 231.5 | 428 | 332.6 | 269.3 | 488 | 379.3 | 307.1 | 548 | 425.9 | 344.8 |
| 309 | 240.1 | 194.4 | 369 | 286.8 | 232.2 | 429 | 333.4 | 269.9 | 489 | 380.0 | 307.7 | 549 | 426.6 | 345.5 |
| 310 | 240.9 | 195.0 | 370 | 287.6 | 232.8 | 430 | 334.2 | 270.6 | 490 | 380.8 | 308.3 | 550 | 427.4 | 346.1 |
| 311 | 241.7 | 195.7 | 371 | 288.3 | 233.4 | 431 | 335.0 | 271.2 | 491 | 381.6 | 308.9 | 551 | 428.2 | 346.7 |
| 312 | 242.5 | 196.3 | 372 | 289.1 | 234.1 | 432 | 335.7 | 271.8 | 492 | 382.4 | 309.6 | 552 | 429.0 | 347.4 |
| 313 | 243.3 | 196.9 | 373 | 289.9 | 234.7 | 433 | 336.5 | 272.5 | 493 | 383.1 | 310.2 | 553 | 429.7 | 348.0 |
| 314 | 244.0 | 197.6 | 374 | 290.7 | 235.3 | 434 | 337.3 | 273.1 | 494 | 383.9 | 310.8 | 554 | 430.5 | 348.6 |
| 315 | 244.8 | 198.2 | 375 | 291.4 | 236.0 | 435 | 338.1 | 273.7 | 495 | 384.7 | 311.5 | 555 | 431.3 | 349.2 |
| 316 | 245.6 | 198.8 | 376 | 292.2 | 236.6 | 436 | 338.8 | 274.3 | 496 | 385.5 | 312.1 | 556 | 432.1 | 349.9 |
| 317 | 246.4 | 199.5 | 377 | 293.0 | 237.2 | 437 | 339.6 | 275.0 | 497 | 386.2 | 312.7 | 557 | 432.8 | 350.5 |
| 318 | 247.1 | 200.1 | 378 | 293.8 | 237.8 | 438 | 340.4 | 275.6 | 498 | 387.0 | 313.3 | 558 | 433.6 | 351.1 |
| 319 | 247.9 | 200.7 | 379 | 294.5 | 238.5 | 439 | 341.2 | 276.2 | 499 | 387.8 | 314.0 | 559 | 434.4 | 351.7 |
| 320 | 248.7 | 201.3 | 380 | 295.3 | 239.1 | 440 | 342.0 | 276.9 | 500 | 388.6 | 314.7 | 560 | 435.2 | 352.4 |
| 321 | 249.5 | 202.0 | 381 | 296.1 | 239.7 | 441 | 342.7 | 277.5 | 501 | 389.4 | 315.3 | 561 | 435.9 | 353.0 |
| 322 | 250.3 | 202.6 | 382 | 296.9 | 240.4 | 442 | 343.5 | 278.1 | 502 | 390.1 | 315.9 | 562 | 436.7 | 353.6 |
| 323 | 251.0 | 203.2 | 383 | 297.7 | 241.0 | 443 | 344.3 | 278.7 | 503 | 390.9 | 316.5 | 563 | 437.5 | 354.3 |
| 324 | 251.8 | 203.9 | 384 | 298.4 | 241.6 | 444 | 345.1 | 279.4 | 504 | 391.7 | 317.1 | 564 | 438.3 | 354.9 |
| 325 | 252.6 | 204.5 | 385 | 299.2 | 242.2 | 445 | 345.8 | 280.0 | 505 | 392.5 | 317.8 | 565 | 439.1 | 355.5 |
| 326 | 253.4 | 205.1 | 386 | 300.0 | 242.9 | 446 | 346.6 | 280.6 | 506 | 393.2 | 318.4 | 566 | 439.8 | 356.2 |
| 327 | 254.1 | 205.7 | 387 | 300.8 | 243.5 | 447 | 347.4 | 281.3 | 507 | 394.0 | 319.0 | 567 | 440.6 | 356.8 |
| 328 | 254.9 | 206.4 | 388 | 301.5 | 244.1 | 448 | 348.2 | 281.9 | 508 | 394.8 | 319.6 | 568 | 441.4 | 357.4 |
| 329 | 255.7 | 207.0 | 389 | 302.3 | 244.8 | 449 | 349.0 | 282.5 | 509 | 395.6 | 320.3 | 569 | 442.2 | 358.1 |
| 330 | 256.5 | 207.6 | 390 | 303.1 | 245.4 | 450 | 349.7 | 283.2 | 510 | 396.3 | 320.9 | 570 | 443.0 | 358.7 |
| 331 | 257.2 | 208.3 | 391 | 303.9 | 246.0 | 451 | 350.5 | 283.8 | 511 | 397.1 | 321.6 | 571 | 443.7 | 359.3 |
| 332 | 258.0 | 208.9 | 392 | 304.7 | 246.7 | 452 | 351.3 | 284.4 | 512 | 397.9 | 322.2 | 572 | 444.5 | 359.9 |
| 333 | 258.8 | 209.5 | 393 | 305.4 | 247.3 | 453 | 352.1 | 285.0 | 513 | 398.7 | 322.8 | 573 | 445.3 | 360.6 |
| 334 | 259.6 | 210.2 | 394 | 306.2 | 247.9 | 454 | 352.8 | 285.7 | 514 | 399.4 | 323.4 | 574 | 446.1 | 361.2 |
| 335 | 260.4 | 210.8 | 395 | 307.0 | 248.5 | 455 | 353.6 | 286.3 | 515 | 400.2 | 324.1 | 575 | 446.9 | 361.8 |
| 336 | 261.1 | 211.4 | 396 | 307.8 | 249.2 | 456 | 354.4 | 286.9 | 516 | 401.0 | 324.7 | 576 | 447.6 | 362.4 |
| 337 | 261.9 | 212.0 | 397 | 308.5 | 249.8 | 457 | 355.2 | 287.6 | 517 | 401.8 | 325.3 | 577 | 448.4 | 363.1 |
| 338 | 262.7 | 212.7 | 398 | 309.3 | 250.4 | 458 | 355.9 | 288.2 | 518 | 402.5 | 325.9 | 578 | 449.2 | 363.7 |
| 339 | 263.5 | 213.3 | 399 | 310.1 | 251.1 | 459 | 356.7 | 288.8 | 519 | 403.3 | 326.6 | 579 | 450.0 | 364.3 |
| 340 | 264.2 | 213.9 | 400 | 310.9 | 251.7 | 460 | 357.5 | 289.4 | 520 | 404.1 | 327.2 | 580 | 450.7 | 365.0 |
| 341 | 265.0 | 214.6 | 401 | 311.6 | 252.3 | 461 | 358.3 | 290.1 | 521 | 404.9 | 327.8 | 581 | 451.5 | 365.6 |
| 342 | 265.8 | 215.2 | 402 | 312.4 | 252.9 | 462 | 359.1 | 290.7 | 522 | 405.7 | 328.5 | 582 | 452.3 | 366.2 |
| 343 | 266.6 | 215.8 | 403 | 313.2 | 253.6 | 463 | 359.8 | 291.3 | 523 | 406.4 | 329.1 | 583 | 453.1 | 366.9 |
| 344 | 267.3 | 216.4 | 404 | 314.0 | 254.2 | 464 | 360.6 | 292.0 | 524 | 407.2 | 329.7 | 584 | 453.9 | 367.5 |
| 345 | 268.1 | 217.1 | 405 | 314.8 | 254.8 | 465 | 361.4 | 292.6 | 525 | 408.0 | 330.4 | 585 | 454.6 | 368.1 |
| 346 | 268.9 | 217.7 | 406 | 315.5 | 255.5 | 466 | 362.2 | 293.2 | 526 | 408.8 | 331.0 | 586 | 455.4 | 368.8 |
| 347 | 269.7 | 218.3 | 407 | 316.3 | 256.1 | 467 | 362.9 | 293.8 | 527 | 409.5 | 331.6 | 587 | 456.2 | 369.4 |
| 348 | 270.5 | 219.0 | 408 | 317.1 | 256.7 | 468 | 363.7 | 294.5 | 528 | 410.3 | 332.3 | 588 | 457.0 | 370.0 |
| 349 | 271.2 | 219.6 | 409 | 317.9 | 257.3 | 469 | 364.5 | 295.1 | 529 | 411.1 | 332.9 | 589 | 457.8 | 370.6 |
| 350 | 272.0 | 220.2 | 410 | 318.6 | 258.0 | 470 | 365.3 | 295.7 | 530 | 411.9 | 333.5 | 590 | 458.5 | 371.3 |
| 351 | 272.8 | 220.8 | 411 | 319.4 | 258.6 | 471 | 366.0 | 296.4 | 531 | 412.6 | 334.1 | 591 | 459.3 | 371.9 |
| 352 | 273.6 | 221.5 | 412 | 320.2 | 259.2 | 472 | 366.8 | 297.0 | 532 | 413.4 | 334.8 | 592 | 460.1 | 372.5 |
| 353 | 274.3 | 222.1 | 413 | 321.0 | 259.9 | 473 | 367.6 | 297.6 | 533 | 414.2 | 335.4 | 593 | 460.9 | 373.2 |
| 354 | 275.1 | 222.7 | 414 | 321.8 | 260.5 | 474 | 368.4 | 298.3 | 534 | 415.0 | 336.1 | 594 | 461.6 | 373.8 |
| 355 | 275.9 | 223.4 | 415 | 322.5 | 261.1 | 475 | 369.2 | 298.9 | 535 | 415.8 | 336.7 | 595 | 462.4 | 374.4 |
| 356 | 276.7 | 224.0 | 416 | 323.3 | 261.8 | 476 | 369.9 | 299.5 | 536 | 416.5 | 337.3 | 596 | 463.2 | 375.1 |
| 357 | 277.5 | 224.6 | 417 | 324.1 | 262.4 | 477 | 370.7 | 300.1 | 537 | 417.3 | 337.9 | 597 | 464.0 | 375.7 |
| 358 | 278.2 | 225.3 | 418 | 324.9 | 263.0 | 478 | 371.5 | 300.8 | 538 | 418.1 | 338.5 | 598 | 464.8 | 376.3 |
| 359 | 279.0 | 225.9 | 419 | 325.6 | 263.6 | 479 | 372.3 | 301.4 | 539 | 418.9 | 339.1 | 599 | 465.5 | 376.9 |
| 360 | 279.8 | 226.5 | 420 | 326.4 | 264.3 | 480 | 373.0 | 302.0 | 540 | 419.6 | 339.8 | 600 | 466.3 | 377.6 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

51° 3h 24m

## TRAVERSE TABLE TO DEGREES.

40° — 2h 40m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.8 | 0.6 | 61 | 46.7 | 39.2 | 121 | 92.7 | 77.8 | 181 | 138.7 | 116.3 | 241 | 184.6 | 154.9 |
| 2 | 1.5 | 1.3 | 62 | 47.5 | 39.9 | 122 | 93.5 | 78.4 | 182 | 139.4 | 117.0 | 242 | 185.4 | 155.6 |
| 3 | 2.3 | 1.9 | 63 | 48.3 | 40.5 | 123 | 94.2 | 79.1 | 183 | 140.2 | 117.6 | 243 | 186.1 | 156.2 |
| 4 | 3.1 | 2.6 | 64 | 49.0 | 41.1 | 124 | 95.0 | 79.7 | 184 | 141.0 | 118.3 | 244 | 186.9 | 156.8 |
| 5 | 3.8 | 3.2 | 65 | 49.8 | 41.8 | 125 | 95.8 | 80.3 | 185 | 141.7 | 118.9 | 245 | 187.7 | 157.5 |
| 6 | 4.6 | 3.9 | 66 | 50.6 | 42.4 | 126 | 96.5 | 81.0 | 186 | 142.5 | 119.6 | 246 | 188.4 | 158.1 |
| 7 | 5.4 | 4.5 | 67 | 51.3 | 43.1 | 127 | 97.3 | 81.6 | 187 | 143.3 | 120.2 | 247 | 189.2 | 158.8 |
| 8 | 6.1 | 5.1 | 68 | 52.1 | 43.7 | 128 | 98.1 | 82.3 | 188 | 144.0 | 120.8 | 248 | 190.0 | 159.4 |
| 9 | 6.9 | 5.8 | 69 | 52.9 | 44.4 | 129 | 98.8 | 82.9 | 189 | 144.8 | 121.5 | 249 | 190.7 | 160.1 |
| 10 | 7.7 | 6.4 | 70 | 53.6 | 45.0 | 130 | 99.6 | 83.6 | 190 | 145.5 | 122.1 | 250 | 191.5 | 160.7 |
| 11 | 8.4 | 7.1 | 71 | 54.4 | 45.6 | 131 | 100.4 | 84.2 | 191 | 146.3 | 122.8 | 251 | 192.3 | 161.3 |
| 12 | 9.2 | 7.7 | 72 | 55.2 | 46.3 | 132 | 101.1 | 84.8 | 192 | 147.1 | 123.4 | 252 | 193.0 | 162.0 |
| 13 | 10.0 | 8.4 | 73 | 55.9 | 46.9 | 133 | 101.9 | 85.5 | 193 | 147.8 | 124.1 | 253 | 193.8 | 162.6 |
| 14 | 10.7 | 9.0 | 74 | 56.7 | 47.6 | 134 | 102.6 | 86.1 | 194 | 148.6 | 124.7 | 254 | 194.6 | 163.3 |
| 15 | 11.5 | 9.6 | 75 | 57.5 | 48.2 | 135 | 103.4 | 86.8 | 195 | 149.4 | 125.3 | 255 | 195.3 | 163.9 |
| 16 | 12.3 | 10.3 | 76 | 58.2 | 48.9 | 136 | 104.2 | 87.4 | 196 | 150.1 | 126.0 | 256 | 196.1 | 164.6 |
| 17 | 13.0 | 10.9 | 77 | 59.0 | 49.5 | 137 | 104.9 | 88.1 | 197 | 150.9 | 126.6 | 257 | 196.9 | 165.2 |
| 18 | 13.8 | 11.6 | 78 | 59.8 | 50.1 | 138 | 105.7 | 88.7 | 198 | 151.7 | 127.3 | 258 | 197.6 | 165.8 |
| 19 | 14.6 | 12.2 | 79 | 60.5 | 50.8 | 139 | 106.5 | 89.3 | 199 | 152.4 | 127.9 | 259 | 198.4 | 166.5 |
| 20 | 15.3 | 12.9 | 80 | 61.3 | 51.4 | 140 | 107.2 | 90.0 | 200 | 153.2 | 128.6 | 260 | 199.2 | 167.1 |
| 21 | 16.1 | 13.5 | 81 | 62.0 | 52.1 | 141 | 108.0 | 90.6 | 201 | 154.0 | 129.2 | 261 | 199.9 | 167.8 |
| 22 | 16.9 | 14.1 | 82 | 62.8 | 52.7 | 142 | 108.8 | 91.3 | 202 | 154.7 | 129.8 | 262 | 200.7 | 168.4 |
| 23 | 17.6 | 14.8 | 83 | 63.6 | 53.4 | 143 | 109.5 | 91.9 | 203 | 155.5 | 130.5 | 263 | 201.5 | 169.1 |
| 24 | 18.4 | 15.4 | 84 | 64.3 | 54.0 | 144 | 110.3 | 92.6 | 204 | 156.3 | 131.1 | 264 | 202.2 | 169.7 |
| 25 | 19.2 | 16.1 | 85 | 65.1 | 54.6 | 145 | 111.1 | 93.2 | 205 | 157.0 | 131.8 | 265 | 203.0 | 170.3 |
| 26 | 19.9 | 16.7 | 86 | 65.9 | 55.3 | 146 | 111.8 | 93.8 | 206 | 157.8 | 132.4 | 266 | 203.8 | 171.0 |
| 27 | 20.7 | 17.4 | 87 | 66.6 | 55.9 | 147 | 112.6 | 94.5 | 207 | 158.6 | 133.1 | 267 | 204.5 | 171.6 |
| 28 | 21.4 | 18.0 | 88 | 67.4 | 56.6 | 148 | 113.4 | 95.1 | 208 | 159.3 | 133.7 | 268 | 205.3 | 172.3 |
| 29 | 22.2 | 18.6 | 89 | 68.2 | 57.2 | 149 | 114.1 | 95.8 | 209 | 160.1 | 134.3 | 269 | 206.1 | 172.9 |
| 30 | 23.0 | 19.3 | 90 | 68.9 | 57.9 | 150 | 114.9 | 96.4 | 210 | 160.9 | 135.0 | 270 | 206.8 | 173.6 |
| 31 | 23.7 | 19.9 | 91 | 69.7 | 58.5 | 151 | 115.7 | 97.1 | 211 | 161.6 | 135.6 | 271 | 207.6 | 174.2 |
| 32 | 24.5 | 20.6 | 92 | 70.5 | 59.1 | 152 | 116.4 | 97.7 | 212 | 162.4 | 136.3 | 272 | 208.4 | 174.8 |
| 33 | 25.3 | 21.2 | 93 | 71.2 | 59.8 | 153 | 117.2 | 98.3 | 213 | 163.2 | 136.9 | 273 | 209.1 | 175.5 |
| 34 | 26.0 | 21.9 | 94 | 72.0 | 60.4 | 154 | 118.0 | 99.0 | 214 | 163.9 | 137.6 | 274 | 209.9 | 176.1 |
| 35 | 26.8 | 22.5 | 95 | 72.8 | 61.1 | 155 | 118.7 | 99.6 | 215 | 164.7 | 138.2 | 275 | 210.7 | 176.8 |
| 36 | 27.6 | 23.1 | 96 | 73.5 | 61.7 | 156 | 119.5 | 100.3 | 216 | 165.5 | 138.8 | 276 | 211.4 | 177.4 |
| 37 | 28.3 | 23.8 | 97 | 74.3 | 62.4 | 157 | 120.3 | 100.9 | 217 | 166.2 | 139.5 | 277 | 212.2 | 178.1 |
| 38 | 29.1 | 24.4 | 98 | 75.1 | 63.0 | 158 | 121.0 | 101.6 | 218 | 167.0 | 140.1 | 278 | 213.0 | 178.7 |
| 39 | 29.9 | 25.1 | 99 | 75.8 | 63.6 | 159 | 121.8 | 102.2 | 219 | 167.8 | 140.8 | 279 | 213.7 | 179.3 |
| 40 | 30.6 | 25.7 | 100 | 76.6 | 64.3 | 160 | 122.6 | 102.8 | 220 | 168.5 | 141.4 | 280 | 214.5 | 180.0 |
| 41 | 31.4 | 26.4 | 101 | 77.4 | 64.9 | 161 | 123.3 | 103.5 | 221 | 169.3 | 142.1 | 281 | 215.3 | 180.6 |
| 42 | 32.2 | 27.0 | 102 | 78.1 | 65.6 | 162 | 124.1 | 104.1 | 222 | 170.1 | 142.7 | 282 | 216.0 | 181.3 |
| 43 | 32.9 | 27.6 | 103 | 78.9 | 66.2 | 163 | 124.9 | 104.8 | 223 | 170.8 | 143.3 | 283 | 216.8 | 181.9 |
| 44 | 33.7 | 28.3 | 104 | 79.7 | 66.8 | 164 | 125.6 | 105.4 | 224 | 171.6 | 144.0 | 284 | 217.6 | 182.6 |
| 45 | 34.5 | 28.9 | 105 | 80.4 | 67.5 | 165 | 126.4 | 106.1 | 225 | 172.4 | 144.6 | 285 | 218.3 | 183.2 |
| 46 | 35.2 | 29.6 | 106 | 81.2 | 68.1 | 166 | 127.2 | 106.7 | 226 | 173.1 | 145.3 | 286 | 219.1 | 183.8 |
| 47 | 36.0 | 30.2 | 107 | 82.0 | 68.8 | 167 | 127.9 | 107.3 | 227 | 173.9 | 145.9 | 287 | 219.9 | 184.5 |
| 48 | 36.8 | 30.9 | 108 | 82.7 | 69.4 | 168 | 128.7 | 108.0 | 228 | 174.7 | 146.6 | 288 | 220.6 | 185.1 |
| 49 | 37.5 | 31.5 | 109 | 83.5 | 70.1 | 169 | 129.5 | 108.6 | 229 | 175.4 | 147.2 | 289 | 221.4 | 185.8 |
| 50 | 38.3 | 32.1 | 110 | 84.3 | 70.7 | 170 | 130.2 | 109.3 | 230 | 176.2 | 147.8 | 290 | 222.2 | 186.4 |
| 51 | 39.1 | 32.8 | 111 | 85.0 | 71.3 | 171 | 131.0 | 109.9 | 231 | 177.0 | 148.5 | 291 | 222.9 | 187.1 |
| 52 | 39.8 | 33.4 | 112 | 85.8 | 72.0 | 172 | 131.8 | 110.6 | 232 | 177.7 | 149.1 | 292 | 223.7 | 187.7 |
| 53 | 40.6 | 34.1 | 113 | 86.6 | 72.6 | 173 | 132.5 | 111.2 | 233 | 178.5 | 149.8 | 293 | 224.5 | 188.3 |
| 54 | 41.4 | 34.7 | 114 | 87.3 | 73.3 | 174 | 133.3 | 111.8 | 234 | 179.3 | 150.4 | 294 | 225.2 | 189.0 |
| 55 | 42.1 | 35.4 | 115 | 88.1 | 73.9 | 175 | 134.1 | 112.5 | 235 | 180.0 | 151.1 | 295 | 226.0 | 189.6 |
| 56 | 42.9 | 36.0 | 116 | 88.9 | 74.6 | 176 | 134.8 | 113.1 | 236 | 180.8 | 151.7 | 296 | 226.7 | 190.3 |
| 57 | 43.7 | 36.6 | 117 | 89.6 | 75.2 | 177 | 135.6 | 113.8 | 237 | 181.6 | 152.3 | 297 | 227.5 | 190.9 |
| 58 | 44.4 | 37.3 | 118 | 90.4 | 75.8 | 178 | 136.4 | 114.4 | 238 | 182.3 | 153.0 | 298 | 228.3 | 191.6 |
| 59 | 45.2 | 37.9 | 119 | 91.2 | 76.5 | 179 | 137.1 | 115.1 | 239 | 183.1 | 153.6 | 299 | 229.0 | 192.2 |
| 60 | 46.0 | 38.6 | 120 | 91.9 | 77.1 | 180 | 137.9 | 115.7 | 240 | 183.9 | 154.3 | 300 | 229.8 | 192.8 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

50° — 3h 20m

## TRAVERSE TABLE TO DEGREES

| 40° | | | | | | | | | | | | | | 2h 40m |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
| 301 | 230·6 | 193·5 | 361 | 276·5 | 232·1 | 421 | 322·5 | 270·6 | 481 | 368·5 | 309·2 | 541 | 414·4 | 347·7 |
| 302 | 231·3 | 194·1 | 362 | 277·3 | 232·7 | 422 | 323·3 | 271·3 | 482 | 369·2 | 309·8 | 542 | 415·2 | 348·4 |
| 303 | 232·1 | 194·8 | 363 | 278·1 | 233·3 | 423 | 324·0 | 271·9 | 483 | 370·0 | 310·5 | 543 | 416·0 | 349·0 |
| 304 | 232·9 | 195·4 | 364 | 278·8 | 234·0 | 424 | 324·8 | 272·6 | 484 | 370·8 | 311·1 | 544 | 416·7 | 349·7 |
| 305 | 233·6 | 196·1 | 365 | 279·6 | 234·6 | 425 | 325·6 | 273·2 | 485 | 371·5 | 311·7 | 545 | 417·5 | 350·3 |
| 306 | 234·4 | 196·7 | 366 | 280·4 | 235·3 | 426 | 326·3 | 273·8 | 486 | 372·3 | 312·4 | 546 | 418·3 | 351·0 |
| 307 | 235·2 | 197·3 | 367 | 281·1 | 235·9 | 427 | 327·1 | 274·5 | 487 | 373·1 | 313·0 | 547 | 419·0 | 351·6 |
| 308 | 235·9 | 198·0 | 368 | 281·9 | 236·6 | 428 | 327·9 | 275·1 | 488 | 373·8 | 313·6 | 548 | 419·8 | 352·2 |
| 309 | 236·7 | 198·6 | 369 | 282·7 | 237·2 | 429 | 328·6 | 275·8 | 489 | 374·6 | 314·3 | 549 | 420·6 | 352·9 |
| 310 | 237·5 | 199·3 | 370 | 283·4 | 237·8 | 430 | 329·4 | 276·4 | 490 | 375·4 | 314·9 | 550 | 421·3 | 353·5 |
| 311 | 238·2 | 199·9 | 371 | 284·2 | 238·5 | 431 | 330·2 | 277·1 | 491 | 376·1 | 315·6 | 551 | 422·1 | 354·2 |
| 312 | 239·0 | 200·6 | 372 | 285·0 | 239·1 | 432 | 330·9 | 277·7 | 492 | 376·9 | 316·2 | 552 | 422·9 | 354·8 |
| 313 | 239·8 | 201·2 | 373 | 285·7 | 239·7 | 433 | 331·7 | 278·3 | 493 | 377·7 | 316·9 | 553 | 423·6 | 355·5 |
| 314 | 240·5 | 201·8 | 374 | 286·5 | 240·4 | 434 | 332·5 | 279·0 | 494 | 378·4 | 317·5 | 554 | 424·4 | 356·1 |
| 315 | 241·3 | 202·5 | 375 | 287·3 | 241·0 | 435 | 333·2 | 279·6 | 495 | 379·2 | 318·2 | 555 | 425·2 | 356·8 |
| 316 | 242·1 | 203·1 | 376 | 288·0 | 241·7 | 436 | 334·0 | 280·3 | 496 | 380·0 | 318·8 | 556 | 425·9 | 357·4 |
| 317 | 242·8 | 203·8 | 377 | 288·8 | 242·3 | 437 | 334·8 | 280·9 | 497 | 380·7 | 319·5 | 557 | 426·7 | 358·0 |
| 318 | 243·6 | 204·4 | 378 | 289·6 | 243·0 | 438 | 335·5 | 281·6 | 498 | 381·5 | 320·1 | 558 | 427·5 | 358·7 |
| 319 | 244·4 | 205·1 | 379 | 290·3 | 243·6 | 439 | 336·3 | 282·2 | 499 | 382·3 | 320·8 | 559 | 428·2 | 359·3 |
| 320 | 245·1 | 205·7 | 380 | 291·1 | 244·3 | 440 | 337·1 | 282·8 | 500 | 383·0 | 321·4 | 560 | 429·0 | 360·0 |
| 321 | 245·9 | 206·3 | 381 | 291·9 | 244·9 | 441 | 337·8 | 283·5 | 501 | 383·8 | 322·0 | 561 | 429·8 | 360·6 |
| 322 | 246·7 | 207·0 | 382 | 292·6 | 245·6 | 442 | 338·6 | 284·1 | 502 | 384·6 | 322·7 | 562 | 430·5 | 361·2 |
| 323 | 247·4 | 207·6 | 383 | 293·4 | 246·2 | 443 | 339·4 | 284·8 | 503 | 385·3 | 323·3 | 563 | 431·3 | 361·9 |
| 324 | 248·2 | 208·3 | 384 | 294·2 | 246·8 | 444 | 340·1 | 285·4 | 504 | 386·1 | 324·0 | 564 | 432·1 | 362·5 |
| 325 | 249·0 | 208·9 | 385 | 294·9 | 247·5 | 445 | 340·9 | 286·0 | 505 | 386·8 | 324·6 | 565 | 432·8 | 363·2 |
| 326 | 249·7 | 209·6 | 386 | 295·7 | 248·1 | 446 | 341·7 | 286·7 | 506 | 387·6 | 325·2 | 566 | 433·6 | 363·8 |
| 327 | 250·5 | 210·2 | 387 | 296·5 | 248·8 | 447 | 342·4 | 287·3 | 507 | 388·4 | 325·9 | 567 | 434·3 | 364·5 |
| 328 | 251·3 | 210·8 | 388 | 297·2 | 249·4 | 448 | 343·2 | 288·0 | 508 | 389·2 | 326·5 | 568 | 435·1 | 365·1 |
| 329 | 252·0 | 211·5 | 389 | 298·0 | 250·1 | 449 | 344·0 | 288·6 | 509 | 389·9 | 327·1 | 569 | 435·9 | 365·8 |
| 330 | 252·8 | 212·1 | 390 | 298·8 | 250·7 | 450 | 344·7 | 289·3 | 510 | 390·7 | 327·8 | 570 | 436·6 | 366·4 |
| 331 | 253·6 | 212·8 | 391 | 299·5 | 251·3 | 451 | 345·5 | 289·9 | 511 | 391·5 | 328·4 | 571 | 437·4 | 367·0 |
| 332 | 254·3 | 213·4 | 392 | 300·3 | 252·0 | 452 | 346·3 | 290·5 | 512 | 392·2 | 329·1 | 572 | 438·2 | 367·7 |
| 333 | 255·1 | 214·1 | 393 | 301·1 | 252·6 | 453 | 347·0 | 291·2 | 513 | 393·0 | 329·7 | 573 | 438·9 | 368·3 |
| 334 | 255·9 | 214·7 | 394 | 301·8 | 253·3 | 454 | 347·8 | 291·8 | 514 | 393·8 | 330·4 | 574 | 439·7 | 369·0 |
| 335 | 256·6 | 215·3 | 395 | 302·6 | 253·9 | 455 | 348·6 | 292·5 | 515 | 394·5 | 331·0 | 575 | 440·5 | 369·6 |
| 336 | 257·4 | 216·0 | 396 | 303·4 | 254·6 | 456 | 349·3 | 293·1 | 516 | 395·3 | 331·6 | 576 | 441·2 | 370·2 |
| 337 | 258·2 | 216·6 | 397 | 304·1 | 255·2 | 457 | 350·1 | 293·8 | 517 | 396·1 | 332·3 | 577 | 442·0 | 370·9 |
| 338 | 258·9 | 217·3 | 398 | 304·9 | 255·8 | 458 | 350·8 | 294·4 | 518 | 396·8 | 332·9 | 578 | 442·8 | 371·5 |
| 339 | 259·7 | 217·9 | 399 | 305·7 | 256·5 | 459 | 351·6 | 295·0 | 519 | 397·6 | 333·6 | 579 | 443·5 | 372·2 |
| 340 | 260·5 | 218·6 | 400 | 306·4 | 257·1 | 460 | 352·4 | 295·7 | 520 | 398·3 | 334·2 | 580 | 444·3 | 372·8 |
| 341 | 261·2 | 219·2 | 401 | 307·2 | 257·8 | 461 | 353·1 | 296·3 | 521 | 399·1 | 334·9 | 581 | 445·1 | 373·5 |
| 342 | 262·0 | 219·8 | 402 | 308·0 | 258·4 | 462 | 353·9 | 297·0 | 522 | 399·9 | 335·5 | 582 | 445·8 | 374·1 |
| 343 | 262·8 | 220·5 | 403 | 308·7 | 259·1 | 463 | 354·7 | 297·6 | 523 | 400·6 | 336·1 | 583 | 446·6 | 374·8 |
| 344 | 263·5 | 221·1 | 404 | 309·5 | 259·7 | 464 | 355·4 | 298·3 | 524 | 401·4 | 336·8 | 584 | 447·4 | 375·4 |
| 345 | 264·3 | 221·8 | 405 | 310·2 | 260·3 | 465 | 356·2 | 298·9 | 525 | 402·2 | 337·4 | 585 | 448·1 | 376·0 |
| 346 | 265·1 | 222·4 | 406 | 311·0 | 261·0 | 466 | 357·0 | 299·5 | 526 | 402·9 | 338·1 | 586 | 448·9 | 376·7 |
| 347 | 265·8 | 223·1 | 407 | 311·8 | 261·6 | 467 | 357·7 | 300·2 | 527 | 403·7 | 338·7 | 587 | 449·7 | 377·3 |
| 348 | 266·6 | 223·7 | 408 | 312·5 | 262·3 | 468 | 358·5 | 300·8 | 528 | 404·5 | 339·4 | 588 | 450·4 | 378·0 |
| 349 | 267·4 | 224·3 | 409 | 313·3 | 262·9 | 469 | 359·3 | 301·5 | 529 | 405·2 | 340·0 | 589 | 451·2 | 378·6 |
| 350 | 268·1 | 225·0 | 410 | 314·1 | 263·6 | 470 | 360·0 | 302·1 | 530 | 406·0 | 340·6 | 590 | 452·0 | 379·2 |
| 351 | 268·9 | 225·6 | 411 | 314·8 | 264·2 | 471 | 360·8 | 302·8 | 531 | 406·8 | 341·3 | 591 | 452·7 | 379·9 |
| 352 | 269·6 | 226·3 | 412 | 315·6 | 264·8 | 472 | 361·6 | 303·4 | 532 | 407·5 | 341·9 | 592 | 453·5 | 380·5 |
| 353 | 270·4 | 226·9 | 413 | 316·4 | 265·5 | 473 | 362·3 | 304·0 | 533 | 408·3 | 342·6 | 593 | 454·3 | 381·2 |
| 354 | 271·2 | 227·6 | 414 | 317·1 | 266·1 | 474 | 363·1 | 304·7 | 534 | 409·1 | 343·2 | 594 | 455·0 | 381·8 |
| 355 | 271·9 | 228·2 | 415 | 317·9 | 266·8 | 475 | 363·9 | 305·3 | 535 | 409·8 | 343·9 | 595 | 455·8 | 382·4 |
| 356 | 272·7 | 228·8 | 416 | 318·7 | 267·4 | 476 | 364·6 | 306·0 | 536 | 410·6 | 344·5 | 596 | 456·6 | 383·1 |
| 357 | 273·5 | 229·5 | 417 | 319·4 | 268·1 | 477 | 365·4 | 306·6 | 537 | 411·4 | 345·2 | 597 | 457·3 | 383·7 |
| 358 | 274·2 | 230·1 | 418 | 320·2 | 268·7 | 478 | 366·2 | 307·3 | 538 | 412·1 | 345·8 | 598 | 458·1 | 384·4 |
| 359 | 275·0 | 230·8 | 419 | 321·0 | 269·3 | 479 | 366·9 | 307·9 | 539 | 412·9 | 346·4 | 599 | 458·9 | 385·0 |
| 360 | 275·8 | 231·4 | 420 | 321·7 | 270·0 | 480 | 367·7 | 308·5 | 540 | 413·7 | 347·1 | 600 | 459·6 | 385·7 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |
| 50° | | | | | | | | | | | | | | 3h 20m |

## TRAVERSE TABLE TO DEGREES

41° $2^h 44^m$

| Dist. | D.Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.8 | 0.7 | 61 | 46.0 | 40.0 | 121 | 91.3 | 79.4 | 181 | 136.6 | 118.7 | 241 | 181.9 | 158.1 |
| 2 | 1.5 | 1.3 | 62 | 46.8 | 40.7 | 122 | 92.1 | 80.0 | 182 | 137.4 | 119.4 | 242 | 182.6 | 158.8 |
| 3 | 2.3 | 2.0 | 63 | 47.5 | 41.3 | 123 | 92.8 | 80.7 | 183 | 138.1 | 120.1 | 243 | 183.4 | 159.4 |
| 4 | 3.0 | 2.6 | 64 | 48.3 | 42.0 | 124 | 93.6 | 81.4 | 184 | 138.9 | 120.7 | 244 | 184.1 | 160.1 |
| 5 | 3.8 | 3.3 | 65 | 49.1 | 42.6 | 125 | 94.3 | 82.0 | 185 | 139.6 | 121.4 | 245 | 184.9 | 160.7 |
| 6 | 4.5 | 3.9 | 66 | 49.8 | 43.3 | 126 | 95.1 | 82.7 | 186 | 140.4 | 122.0 | 246 | 185.7 | 161.4 |
| 7 | 5.3 | 4.6 | 67 | 50.6 | 44.0 | 127 | 95.8 | 83.3 | 187 | 141.1 | 122.7 | 247 | 186.4 | 162.0 |
| 8 | 6.0 | 5.2 | 68 | 51.3 | 44.6 | 128 | 96.6 | 84.0 | 188 | 141.9 | 123.3 | 248 | 187.2 | 162.7 |
| 9 | 6.8 | 5.9 | 69 | 52.1 | 45.3 | 129 | 97.4 | 84.6 | 189 | 142.6 | 124.0 | 249 | 187.9 | 163.4 |
| 10 | 7.5 | 6.6 | 70 | 52.8 | 45.9 | 130 | 98.1 | 85.3 | 190 | 143.4 | 124.7 | 250 | 188.7 | 164.0 |
| 11 | 8.3 | 7.2 | 71 | 53.6 | 46.6 | 131 | 98.9 | 85.9 | 191 | 144.1 | 125.3 | 251 | 189.4 | 164.7 |
| 12 | 9.1 | 7.9 | 72 | 54.3 | 47.2 | 132 | 99.6 | 86.6 | 192 | 144.9 | 126.0 | 252 | 190.2 | 165.3 |
| 13 | 9.8 | 8.5 | 73 | 55.1 | 47.9 | 133 | 100.4 | 87.3 | 193 | 145.7 | 126.6 | 253 | 190.9 | 166.0 |
| 14 | 10.6 | 9.2 | 74 | 55.8 | 48.5 | 134 | 101.1 | 87.9 | 194 | 146.4 | 127.3 | 254 | 191.7 | 166.6 |
| 15 | 11.3 | 9.8 | 75 | 56.6 | 49.2 | 135 | 101.9 | 88.6 | 195 | 147.2 | 127.9 | 255 | 192.5 | 167.3 |
| 16 | 12.1 | 10.5 | 76 | 57.4 | 49.9 | 136 | 102.6 | 89.2 | 196 | 147.9 | 128.6 | 256 | 193.2 | 168.0 |
| 17 | 12.8 | 11.2 | 77 | 58.1 | 50.5 | 137 | 103.4 | 89.9 | 197 | 148.7 | 129.2 | 257 | 194.0 | 168.6 |
| 18 | 13.6 | 11.8 | 78 | 58.9 | 51.2 | 138 | 104.1 | 90.5 | 198 | 149.4 | 129.9 | 258 | 194.7 | 169.3 |
| 19 | 14.3 | 12.5 | 79 | 59.6 | 51.8 | 139 | 104.9 | 91.2 | 199 | 150.2 | 130.6 | 259 | 195.5 | 169.9 |
| 20 | 15.1 | 13.1 | 80 | 60.4 | 52.5 | 140 | 105.7 | 91.8 | 200 | 150.9 | 131.2 | 260 | 196.2 | 170.6 |
| 21 | 15.8 | 13.8 | 81 | 61.1 | 53.1 | 141 | 106.4 | 92.5 | 201 | 151.7 | 131.9 | 261 | 197.0 | 171.2 |
| 22 | 16.6 | 14.4 | 82 | 61.9 | 53.8 | 142 | 107.2 | 93.2 | 202 | 152.5 | 132.5 | 262 | 197.7 | 171.9 |
| 23 | 17.4 | 15.1 | 83 | 62.6 | 54.5 | 143 | 107.9 | 93.8 | 203 | 153.2 | 133.2 | 263 | 198.5 | 172.5 |
| 24 | 18.1 | 15.7 | 84 | 63.4 | 55.1 | 144 | 108.7 | 94.5 | 204 | 154.0 | 133.8 | 264 | 199.2 | 173.2 |
| 25 | 18.9 | 16.4 | 85 | 64.2 | 55.8 | 145 | 109.4 | 95.1 | 205 | 154.7 | 134.5 | 265 | 200.0 | 173.9 |
| 26 | 19.6 | 17.1 | 86 | 64.9 | 56.4 | 146 | 110.2 | 95.8 | 206 | 155.5 | 135.1 | 266 | 200.8 | 174.5 |
| 27 | 20.4 | 17.7 | 87 | 65.7 | 57.1 | 147 | 110.9 | 96.4 | 207 | 156.2 | 135.8 | 267 | 201.5 | 175.2 |
| 28 | 21.1 | 18.4 | 88 | 66.4 | 57.7 | 148 | 111.7 | 97.1 | 208 | 157.0 | 136.5 | 268 | 202.3 | 175.8 |
| 29 | 21.9 | 19.0 | 89 | 67.2 | 58.4 | 149 | 112.5 | 97.8 | 209 | 157.7 | 137.1 | 269 | 203.0 | 176.5 |
| 30 | 22.6 | 19.7 | 90 | 67.9 | 59.0 | 150 | 113.2 | 98.4 | 210 | 158.5 | 137.8 | 270 | 203.8 | 177.1 |
| 31 | 23.4 | 20.3 | 91 | 68.7 | 59.7 | 151 | 114.0 | 99.1 | 211 | 159.2 | 138.4 | 271 | 204.5 | 177.8 |
| 32 | 24.2 | 21.0 | 92 | 69.4 | 60.4 | 152 | 114.7 | 99.7 | 212 | 160.0 | 139.1 | 272 | 205.3 | 178.4 |
| 33 | 24.9 | 21.6 | 93 | 70.2 | 61.0 | 153 | 115.5 | 100.4 | 213 | 160.8 | 139.7 | 273 | 206.0 | 179.1 |
| 34 | 25.7 | 22.3 | 94 | 70.9 | 61.7 | 154 | 116.2 | 101.0 | 214 | 161.5 | 140.4 | 274 | 206.8 | 179.8 |
| 35 | 26.4 | 23.0 | 95 | 71.7 | 62.3 | 155 | 117.0 | 101.7 | 215 | 162.3 | 141.1 | 275 | 207.5 | 180.4 |
| 36 | 27.2 | 23.6 | 96 | 72.5 | 63.0 | 156 | 117.7 | 102.3 | 216 | 163.0 | 141.7 | 276 | 208.3 | 181.1 |
| 37 | 27.9 | 24.3 | 97 | 73.2 | 63.6 | 157 | 118.5 | 103.0 | 217 | 163.8 | 142.4 | 277 | 209.1 | 181.7 |
| 38 | 28.7 | 24.9 | 98 | 74.0 | 64.3 | 158 | 119.2 | 103.7 | 218 | 164.5 | 143.0 | 278 | 209.8 | 182.4 |
| 39 | 29.4 | 25.6 | 99 | 74.7 | 64.9 | 159 | 120.0 | 104.3 | 219 | 165.3 | 143.7 | 279 | 210.6 | 183.0 |
| 40 | 30.2 | 26.2 | 100 | 75.5 | 65.6 | 160 | 120.8 | 105.0 | 220 | 166.0 | 144.3 | 280 | 211.3 | 183.7 |
| 41 | 30.9 | 26.9 | 101 | 76.2 | 66.3 | 161 | 121.5 | 105.6 | 221 | 166.8 | 145.0 | 281 | 212.1 | 184.4 |
| 42 | 31.7 | 27.6 | 102 | 77.0 | 66.9 | 162 | 122.3 | 106.3 | 222 | 167.5 | 145.6 | 282 | 212.8 | 185.0 |
| 43 | 32.5 | 28.2 | 103 | 77.7 | 67.6 | 163 | 123.0 | 106.9 | 223 | 168.3 | 146.3 | 283 | 213.6 | 185.7 |
| 44 | 33.2 | 28.9 | 104 | 78.5 | 68.2 | 164 | 123.8 | 107.6 | 224 | 169.1 | 147.0 | 284 | 214.3 | 186.3 |
| 45 | 34.0 | 29.5 | 105 | 79.2 | 68.9 | 165 | 124.5 | 108.2 | 225 | 169.8 | 147.6 | 285 | 215.1 | 187.0 |
| 46 | 34.7 | 30.2 | 106 | 80.0 | 69.5 | 166 | 125.3 | 108.9 | 226 | 170.6 | 148.3 | 286 | 215.8 | 187.6 |
| 47 | 35.5 | 30.8 | 107 | 80.8 | 70.2 | 167 | 126.0 | 109.6 | 227 | 171.3 | 148.9 | 287 | 216.6 | 188.3 |
| 48 | 36.2 | 31.5 | 108 | 81.5 | 70.9 | 168 | 126.8 | 110.2 | 228 | 172.1 | 149.6 | 288 | 217.4 | 188.9 |
| 49 | 37.0 | 32.1 | 109 | 82.3 | 71.5 | 169 | 127.5 | 110.9 | 229 | 172.8 | 150.2 | 289 | 218.1 | 189.6 |
| 50 | 37.7 | 32.8 | 110 | 83.0 | 72.2 | 170 | 128.3 | 111.5 | 230 | 173.6 | 150.9 | 290 | 218.9 | 190.3 |
| 51 | 38.5 | 33.5 | 111 | 83.8 | 72.8 | 171 | 129.1 | 112.2 | 231 | 174.3 | 151.5 | 291 | 219.6 | 190.9 |
| 52 | 39.2 | 34.1 | 112 | 84.5 | 73.5 | 172 | 129.8 | 112.8 | 232 | 175.1 | 152.2 | 292 | 220.4 | 191.6 |
| 53 | 40.0 | 34.8 | 113 | 85.3 | 74.1 | 173 | 130.6 | 113.5 | 233 | 175.8 | 152.9 | 293 | 221.1 | 192.2 |
| 54 | 40.8 | 35.4 | 114 | 86.0 | 74.8 | 174 | 131.3 | 114.2 | 234 | 176.6 | 153.5 | 294 | 221.9 | 192.9 |
| 55 | 41.5 | 36.1 | 115 | 86.8 | 75.4 | 175 | 132.1 | 114.8 | 235 | 177.4 | 154.2 | 295 | 222.6 | 193.5 |
| 56 | 42.3 | 36.7 | 116 | 87.5 | 76.1 | 176 | 132.8 | 115.5 | 236 | 178.1 | 154.8 | 296 | 223.4 | 194.2 |
| 57 | 43.0 | 37.4 | 117 | 88.3 | 76.8 | 177 | 133.6 | 116.1 | 237 | 178.9 | 155.5 | 297 | 224.1 | 194.8 |
| 58 | 43.8 | 38.1 | 118 | 89.1 | 77.4 | 178 | 134.3 | 116.8 | 238 | 179.6 | 156.1 | 298 | 224.9 | 195.5 |
| 59 | 44.5 | 38.7 | 119 | 89.8 | 78.1 | 179 | 135.1 | 117.4 | 239 | 180.4 | 156.8 | 299 | 225.7 | 196.2 |
| 60 | 45.3 | 39.4 | 120 | 90.6 | 78.7 | 180 | 135.8 | 118.1 | 240 | 181.1 | 157.5 | 300 | 226.4 | 196.8 |
| Dist. | Dep. | D.Lat. | Dist. | Dep. | D.Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

49° $3^h 16^m$

## TRAVERSE TABLE TO DEGREES

41° 2h 44m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 227·2 | 197·5 | 361 | 272·5 | 236·9 | 421 | 317·7 | 276·2 | 481 | 363·0 | 315·6 | 541 | 408·3 | 354·9 |
| 302 | 227·9 | 198·1 | 362 | 273·2 | 237·5 | 422 | 318·5 | 276·9 | 482 | 363·8 | 316·2 | 542 | 409·0 | 355·6 |
| 303 | 228·7 | 198·8 | 363 | 274·0 | 238·2 | 423 | 319·2 | 277·5 | 483 | 364·5 | 316·9 | 543 | 409·8 | 356·2 |
| 304 | 229·4 | 199·4 | 364 | 274·7 | 238·8 | 424 | 320·0 | 278·2 | 484 | 365·3 | 317·5 | 544 | 410·6 | 356·9 |
| 305 | 230·2 | 200·1 | 365 | 275·5 | 239·5 | 425 | 320·8 | 278·8 | 485 | 366·0 | 318·2 | 545 | 411·3 | 357·5 |
| 306 | 230·9 | 200·8 | 366 | 276·2 | 240·1 | 426 | 321·5 | 279·5 | 486 | 366·8 | 318·8 | 546 | 412·1 | 358·2 |
| 307 | 231·7 | 201·4 | 367 | 277·0 | 240·8 | 427 | 322·3 | 280·1 | 487 | 367·5 | 319·5 | 547 | 412·8 | 358·8 |
| 308 | 232·5 | 202·1 | 368 | 277·7 | 241·4 | 428 | 323·0 | 280·8 | 488 | 368·3 | 320·1 | 548 | 413·6 | 359·5 |
| 309 | 233·2 | 202·7 | 369 | 278·5 | 242·1 | 429 | 323·8 | 281·5 | 489 | 369·0 | 320·8 | 549 | 414·3 | 360·2 |
| 310 | 234·0 | 203·4 | 370 | 279·2 | 242·7 | 430 | 324·5 | 282·1 | 490 | 369·8 | 321·5 | 550 | 415·1 | 360·8 |
| 311 | 234·7 | 204·0 | 371 | 280·0 | 243·4 | 431 | 325·3 | 282·8 | 491 | 370·6 | 322·1 | 551 | 415·8 | 361·5 |
| 312 | 235·5 | 204·7 | 372 | 280·8 | 244·1 | 432 | 326·0 | 283·4 | 492 | 371·3 | 322·8 | 552 | 416·6 | 362·1 |
| 313 | 236·2 | 205·4 | 373 | 281·5 | 244·7 | 433 | 326·8 | 284·1 | 493 | 372·1 | 323·4 | 553 | 417·3 | 362·8 |
| 314 | 237·0 | 206·0 | 374 | 282·3 | 245·4 | 434 | 327·5 | 284·7 | 494 | 372·8 | 324·1 | 554 | 418·1 | 363·4 |
| 315 | 237·7 | 206·7 | 375 | 283·0 | 246·0 | 435 | 328·3 | 285·4 | 495 | 373·6 | 324·7 | 555 | 418·9 | 364·1 |
| 316 | 238·5 | 207·3 | 376 | 283·8 | 246·7 | 436 | 329·1 | 286·0 | 496 | 374·3 | 325·4 | 556 | 419·6 | 364·8 |
| 317 | 239·2 | 208·0 | 377 | 284·5 | 247·3 | 437 | 329·8 | 286·7 | 497 | 375·1 | 326·0 | 557 | 420·4 | 365·4 |
| 318 | 240·0 | 208·6 | 378 | 285·3 | 248·0 | 438 | 330·6 | 287·4 | 498 | 375·8 | 326·7 | 558 | 421·1 | 366·1 |
| 319 | 240·8 | 209·3 | 379 | 286·0 | 248·7 | 439 | 331·3 | 288·0 | 499 | 376·6 | 327·4 | 559 | 421·9 | 366·7 |
| 320 | 241·5 | 209·9 | 380 | 286·8 | 249·3 | 440 | 332·1 | 288·7 | 500 | 377·3 | 328·0 | 560 | 422·6 | 367·4 |
| 321 | 242·3 | 210·6 | 381 | 287·5 | 250·0 | 441 | 332·8 | 289·3 | 501 | 378·1 | 328·7 | 561 | 423·4 | 368·0 |
| 322 | 243·0 | 211·3 | 382 | 288·3 | 250·6 | 442 | 333·6 | 290·0 | 502 | 378·9 | 329·3 | 562 | 424·1 | 368·7 |
| 323 | 243·8 | 211·9 | 383 | 289·1 | 251·3 | 443 | 334·3 | 290·6 | 503 | 379·6 | 330·0 | 563 | 424·9 | 369·4 |
| 324 | 244·5 | 212·6 | 384 | 289·8 | 251·9 | 444 | 335·1 | 291·3 | 504 | 380·4 | 330·6 | 564 | 425·7 | 370·0 |
| 325 | 245·3 | 213·2 | 385 | 290·6 | 252·6 | 445 | 335·8 | 292·0 | 505 | 381·1 | 331·3 | 565 | 426·4 | 370·7 |
| 326 | 246·0 | 213·9 | 386 | 291·3 | 253·2 | 446 | 336·6 | 292·6 | 506 | 381·9 | 332·0 | 566 | 427·2 | 371·3 |
| 327 | 246·8 | 214·5 | 387 | 292·1 | 253·9 | 447 | 337·4 | 293·3 | 507 | 382·6 | 332·6 | 567 | 427·9 | 372·0 |
| 328 | 247·5 | 215·2 | 388 | 292·8 | 254·6 | 448 | 338·1 | 293·9 | 508 | 383·4 | 333·3 | 568 | 428·7 | 372·6 |
| 329 | 248·3 | 215·9 | 389 | 293·6 | 255·2 | 449 | 338·9 | 294·6 | 509 | 384·1 | 333·9 | 569 | 429·4 | 373·3 |
| 330 | 249·1 | 216·5 | 390 | 294·3 | 255·9 | 450 | 339·6 | 295·2 | 510 | 384·9 | 334·6 | 570 | 430·2 | 374·0 |
| 331 | 249·8 | 217·2 | 391 | 295·1 | 256·5 | 451 | 340·4 | 295·9 | 511 | 385·7 | 335·2 | 571 | 430·9 | 374·6 |
| 332 | 250·6 | 217·8 | 392 | 295·8 | 257·2 | 452 | 341·1 | 296·5 | 512 | 386·4 | 335·9 | 572 | 431·7 | 375·3 |
| 333 | 251·3 | 218·5 | 393 | 296·6 | 257·8 | 453 | 341·9 | 297·2 | 513 | 387·2 | 336·5 | 573 | 432·4 | 375·9 |
| 334 | 252·1 | 219·1 | 394 | 297·4 | 258·5 | 454 | 342·6 | 297·9 | 514 | 387·9 | 337·2 | 574 | 433·2 | 376·6 |
| 335 | 252·8 | 219·8 | 395 | 298·1 | 259·2 | 455 | 343·4 | 298·5 | 515 | 388·7 | 337·9 | 575 | 434·0 | 377·2 |
| 336 | 253·6 | 220·4 | 396 | 298·9 | 259·8 | 456 | 344·1 | 299·2 | 516 | 389·4 | 338·5 | 576 | 434·7 | 377·9 |
| 337 | 254·3 | 221·1 | 397 | 299·6 | 260·5 | 457 | 344·9 | 299·8 | 517 | 390·2 | 339·2 | 577 | 435·5 | 378·5 |
| 338 | 255·1 | 221·8 | 398 | 300·4 | 261·1 | 458 | 345·7 | 300·5 | 518 | 390·9 | 339·8 | 578 | 436·2 | 379·2 |
| 339 | 255·8 | 222·4 | 399 | 301·1 | 261·8 | 459 | 346·4 | 301·1 | 519 | 391·7 | 340·5 | 579 | 437·0 | 379·8 |
| 340 | 256·6 | 223·1 | 400 | 301·9 | 262·4 | 460 | 347·2 | 301·8 | 520 | 392·4 | 341·1 | 580 | 437·7 | 380·5 |
| 341 | 257·4 | 223·7 | 401 | 302·6 | 263·1 | 461 | 347·9 | 302·5 | 521 | 393·2 | 341·8 | 581 | 438·5 | 381·2 |
| 342 | 258·1 | 224·4 | 402 | 303·4 | 263·7 | 462 | 348·7 | 303·1 | 522 | 394·0 | 342·5 | 582 | 439·2 | 381·8 |
| 343 | 258·9 | 225·0 | 403 | 304·1 | 264·4 | 463 | 349·4 | 303·8 | 523 | 394·7 | 343·1 | 583 | 440·0 | 382·5 |
| 344 | 259·6 | 225·7 | 404 | 304·9 | 265·1 | 464 | 350·2 | 304·4 | 524 | 395·5 | 343·8 | 584 | 440·7 | 383·2 |
| 345 | 260·4 | 226·3 | 405 | 305·7 | 265·7 | 465 | 350·9 | 305·1 | 525 | 396·2 | 344·4 | 585 | 441·5 | 383·8 |
| 346 | 261·1 | 227·0 | 406 | 306·4 | 266·4 | 466 | 351·7 | 305·7 | 526 | 397·0 | 345·1 | 586 | 442·3 | 384·5 |
| 347 | 261·9 | 227·7 | 407 | 307·2 | 267·0 | 467 | 352·5 | 306·4 | 527 | 397·7 | 345·7 | 587 | 443·0 | 385·1 |
| 348 | 262·6 | 228·3 | 408 | 307·9 | 267·7 | 468 | 353·2 | 307·0 | 528 | 398·5 | 346·4 | 588 | 443·8 | 385·8 |
| 349 | 263·4 | 229·0 | 409 | 308·7 | 268·3 | 469 | 354·0 | 307·7 | 529 | 399·2 | 347·0 | 589 | 444·5 | 386·4 |
| 350 | 264·2 | 229·6 | 410 | 309·4 | 269·0 | 470 | 354·7 | 308·4 | 530 | 400·0 | 347·7 | 590 | 445·3 | 387·1 |
| 351 | 264·9 | 230·3 | 411 | 310·2 | 269·6 | 471 | 355·5 | 309·0 | 531 | 400·7 | 348·4 | 591 | 446·0 | 387·7 |
| 352 | 265·7 | 230·9 | 412 | 310·9 | 270·3 | 472 | 356·2 | 309·7 | 532 | 401·5 | 349·0 | 592 | 446·8 | 388·4 |
| 353 | 266·4 | 231·6 | 413 | 311·7 | 271·0 | 473 | 357·0 | 310·3 | 533 | 402·2 | 349·7 | 593 | 447·5 | 389·1 |
| 354 | 267·2 | 232·3 | 414 | 312·5 | 271·6 | 474 | 357·7 | 311·0 | 534 | 403·0 | 350·3 | 594 | 448·3 | 389·7 |
| 355 | 267·9 | 232·9 | 415 | 313·2 | 272·3 | 475 | 358·5 | 311·6 | 535 | 403·8 | 351·0 | 595 | 449·1 | 390·4 |
| 356 | 268·7 | 233·6 | 416 | 314·0 | 272·9 | 476 | 359·2 | 312·3 | 536 | 404·5 | 351·6 | 596 | 449·8 | 391·0 |
| 357 | 269·4 | 234·2 | 417 | 314·7 | 273·6 | 477 | 360·0 | 312·9 | 537 | 405·3 | 352·3 | 597 | 450·6 | 391·7 |
| 358 | 270·2 | 234·9 | 418 | 315·5 | 274·2 | 478 | 360·8 | 313·6 | 538 | 406·0 | 352·9 | 598 | 451·3 | 392·3 |
| 359 | 270·9 | 235·5 | 419 | 316·2 | 274·9 | 479 | 361·5 | 314·3 | 539 | 406·8 | 353·6 | 599 | 452·1 | 393·0 |
| 360 | 271·7 | 236·2 | 420 | 317·0 | 275·6 | 480 | 362·3 | 314·9 | 540 | 407·5 | 354·3 | 600 | 452·8 | 393·6 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

49° 3h 16m

## TRAVERSE TABLE TO DEGREES

42° — 2h 48m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.7 | 0.7 | 61 | 45.3 | 40.8 | 121 | 89.9 | 81.0 | 181 | 134.5 | 121.1 | 241 | 179.1 | 161.3 |
| 2 | 1.5 | 1.3 | 62 | 46.1 | 41.5 | 122 | 90.7 | 81.6 | 182 | 135.3 | 121.8 | 242 | 179.8 | 161.9 |
| 3 | 2.2 | 2.0 | 63 | 46.8 | 42.2 | 123 | 91.4 | 82.3 | 183 | 136.0 | 122.5 | 243 | 180.6 | 162.6 |
| 4 | 3.0 | 2.7 | 64 | 47.6 | 42.8 | 124 | 92.1 | 83.0 | 184 | 136.7 | 123.1 | 244 | 181.3 | 163.3 |
| 5 | 3.7 | 3.3 | 65 | 48.3 | 43.5 | 125 | 92.9 | 83.6 | 185 | 137.5 | 123.8 | 245 | 182.1 | 163.9 |
| 6 | 4.5 | 4.0 | 66 | 49.0 | 44.2 | 126 | 93.6 | 84.3 | 186 | 138.2 | 124.5 | 246 | 182.8 | 164.6 |
| 7 | 5.2 | 4.7 | 67 | 49.8 | 44.8 | 127 | 94.4 | 85.0 | 187 | 139.0 | 125.1 | 247 | 183.6 | 165.3 |
| 8 | 5.9 | 5.4 | 68 | 50.5 | 45.5 | 128 | 95.1 | 85.6 | 188 | 139.7 | 125.8 | 248 | 184.3 | 165.9 |
| 9 | 6.7 | 6.0 | 69 | 51.3 | 46.2 | 129 | 95.9 | 86.3 | 189 | 140.5 | 126.5 | 249 | 185.0 | 166.6 |
| 10 | 7.4 | 6.7 | 70 | 52.0 | 46.8 | 130 | 96.6 | 87.0 | 190 | 141.2 | 127.1 | 250 | 185.8 | 167.3 |
| 11 | 8.2 | 7.4 | 71 | 52.8 | 47.5 | 131 | 97.4 | 87.7 | 191 | 141.9 | 127.8 | 251 | 186.5 | 168.0 |
| 12 | 8.9 | 8.0 | 72 | 53.5 | 48.2 | 132 | 98.1 | 88.3 | 192 | 142.7 | 128.5 | 252 | 187.3 | 168.6 |
| 13 | 9.7 | 8.7 | 73 | 54.2 | 48.8 | 133 | 98.8 | 89.0 | 193 | 143.4 | 129.1 | 253 | 188.0 | 169.3 |
| 14 | 10.4 | 9.4 | 74 | 55.0 | 49.5 | 134 | 99.6 | 89.7 | 194 | 144.2 | 129.8 | 254 | 188.8 | 170.0 |
| 15 | 11.1 | 10.0 | 75 | 55.7 | 50.2 | 135 | 100.3 | 90.3 | 195 | 144.9 | 130.5 | 255 | 189.5 | 170.6 |
| 16 | 11.9 | 10.7 | 76 | 56.5 | 50.9 | 136 | 101.1 | 91.0 | 196 | 145.7 | 131.1 | 256 | 190.2 | 171.3 |
| 17 | 12.6 | 11.4 | 77 | 57.2 | 51.5 | 137 | 101.8 | 91.7 | 197 | 146.4 | 131.8 | 257 | 191.0 | 172.0 |
| 18 | 13.4 | 12.0 | 78 | 58.0 | 52.2 | 138 | 102.6 | 92.3 | 198 | 147.1 | 132.5 | 258 | 191.7 | 172.6 |
| 19 | 14.1 | 12.7 | 79 | 58.7 | 52.9 | 139 | 103.3 | 93.0 | 199 | 147.9 | 133.2 | 259 | 192.5 | 173.3 |
| 20 | 14.9 | 13.4 | 80 | 59.5 | 53.5 | 140 | 104.0 | 93.7 | 200 | 148.6 | 133.8 | 260 | 193.2 | 174.0 |
| 21 | 15.6 | 14.1 | 81 | 60.2 | 54.2 | 141 | 104.8 | 94.3 | 201 | 149.4 | 134.5 | 261 | 194.0 | 174.6 |
| 22 | 16.3 | 14.7 | 82 | 60.9 | 54.9 | 142 | 105.5 | 95.0 | 202 | 150.1 | 135.2 | 262 | 194.7 | 175.3 |
| 23 | 17.1 | 15.4 | 83 | 61.7 | 55.5 | 143 | 106.3 | 95.7 | 203 | 150.9 | 135.8 | 263 | 195.4 | 176.0 |
| 24 | 17.8 | 16.1 | 84 | 62.4 | 56.2 | 144 | 107.0 | 96.4 | 204 | 151.6 | 136.5 | 264 | 196.2 | 176.7 |
| 25 | 18.6 | 16.7 | 85 | 63.2 | 56.9 | 145 | 107.8 | 97.0 | 205 | 152.3 | 137.2 | 265 | 196.9 | 177.3 |
| 26 | 19.3 | 17.4 | 86 | 63.9 | 57.5 | 146 | 108.5 | 97.7 | 206 | 153.1 | 137.8 | 266 | 197.7 | 178.0 |
| 27 | 20.1 | 18.1 | 87 | 64.7 | 58.2 | 147 | 109.2 | 98.4 | 207 | 153.8 | 138.5 | 267 | 198.4 | 178.7 |
| 28 | 20.8 | 18.7 | 88 | 65.4 | 58.9 | 148 | 110.0 | 99.0 | 208 | 154.6 | 139.2 | 268 | 199.2 | 179.3 |
| 29 | 21.6 | 19.4 | 89 | 66.1 | 59.6 | 149 | 110.7 | 99.7 | 209 | 155.3 | 139.8 | 269 | 199.9 | 180.0 |
| 30 | 22.3 | 20.1 | 90 | 66.9 | 60.2 | 150 | 111.5 | 100.4 | 210 | 156.1 | 140.5 | 270 | 200.6 | 180.7 |
| 31 | 23.0 | 20.7 | 91 | 67.6 | 60.9 | 151 | 112.2 | 101.0 | 211 | 156.8 | 141.2 | 271 | 201.4 | 181.3 |
| 32 | 23.8 | 21.4 | 92 | 68.4 | 61.6 | 152 | 113.0 | 101.7 | 212 | 157.5 | 141.9 | 272 | 202.1 | 182.0 |
| 33 | 24.5 | 22.1 | 93 | 69.1 | 62.2 | 153 | 113.7 | 102.4 | 213 | 158.3 | 142.5 | 273 | 202.9 | 182.7 |
| 34 | 25.3 | 22.8 | 94 | 69.9 | 62.9 | 154 | 114.4 | 103.0 | 214 | 159.0 | 143.2 | 274 | 203.6 | 183.3 |
| 35 | 26.0 | 23.4 | 95 | 70.6 | 63.6 | 155 | 115.2 | 103.7 | 215 | 159.8 | 143.9 | 275 | 204.4 | 184.0 |
| 36 | 26.8 | 24.1 | 96 | 71.3 | 64.2 | 156 | 115.9 | 104.4 | 216 | 160.5 | 144.5 | 276 | 205.1 | 184.7 |
| 37 | 27.5 | 24.8 | 97 | 72.1 | 64.9 | 157 | 116.7 | 105.1 | 217 | 161.3 | 145.2 | 277 | 205.9 | 185.3 |
| 38 | 28.2 | 25.4 | 98 | 72.8 | 65.6 | 158 | 117.4 | 105.7 | 218 | 162.0 | 145.9 | 278 | 206.6 | 186.0 |
| 39 | 29.0 | 26.1 | 99 | 73.6 | 66.2 | 159 | 118.2 | 106.4 | 219 | 162.7 | 146.5 | 279 | 207.3 | 186.7 |
| 40 | 29.7 | 26.8 | 100 | 74.3 | 66.9 | 160 | 118.9 | 107.1 | 220 | 163.5 | 147.2 | 280 | 208.1 | 187.4 |
| 41 | 30.5 | 27.4 | 101 | 75.1 | 67.6 | 161 | 119.6 | 107.7 | 221 | 164.2 | 147.9 | 281 | 208.8 | 188.0 |
| 42 | 31.2 | 28.1 | 102 | 75.8 | 68.3 | 162 | 120.4 | 108.4 | 222 | 165.0 | 148.5 | 282 | 209.6 | 188.7 |
| 43 | 32.0 | 28.8 | 103 | 76.5 | 68.9 | 163 | 121.1 | 109.1 | 223 | 165.7 | 149.2 | 283 | 210.3 | 189.4 |
| 44 | 32.7 | 29.4 | 104 | 77.3 | 69.6 | 164 | 121.9 | 109.7 | 224 | 166.5 | 149.9 | 284 | 211.1 | 190.0 |
| 45 | 33.4 | 30.1 | 105 | 78.0 | 70.3 | 165 | 122.6 | 110.4 | 225 | 167.2 | 150.6 | 285 | 211.8 | 190.7 |
| 46 | 34.2 | 30.8 | 106 | 78.8 | 70.9 | 166 | 123.4 | 111.1 | 226 | 168.0 | 151.2 | 286 | 212.5 | 191.4 |
| 47 | 34.9 | 31.4 | 107 | 79.5 | 71.6 | 167 | 124.1 | 111.7 | 227 | 168.7 | 151.9 | 287 | 213.3 | 192.0 |
| 48 | 35.7 | 32.1 | 108 | 80.3 | 72.3 | 168 | 124.8 | 112.4 | 228 | 169.4 | 152.6 | 288 | 214.0 | 192.7 |
| 49 | 36.4 | 32.8 | 109 | 81.0 | 72.9 | 169 | 125.6 | 113.1 | 229 | 170.2 | 153.2 | 289 | 214.8 | 193.4 |
| 50 | 37.2 | 33.5 | 110 | 81.7 | 73.6 | 170 | 126.3 | 113.8 | 230 | 170.9 | 153.9 | 290 | 215.5 | 194.0 |
| 51 | 37.9 | 34.1 | 111 | 82.5 | 74.3 | 171 | 127.1 | 114.4 | 231 | 171.7 | 154.6 | 291 | 216.3 | 194.7 |
| 52 | 38.6 | 34.8 | 112 | 83.2 | 74.9 | 172 | 127.8 | 115.1 | 232 | 172.4 | 155.2 | 292 | 217.0 | 195.4 |
| 53 | 39.4 | 35.5 | 113 | 84.0 | 75.6 | 173 | 128.6 | 115.8 | 233 | 173.2 | 155.9 | 293 | 217.7 | 196.1 |
| 54 | 40.1 | 36.1 | 114 | 84.7 | 76.3 | 174 | 129.3 | 116.4 | 234 | 173.9 | 156.6 | 294 | 218.5 | 196.7 |
| 55 | 40.9 | 36.8 | 115 | 85.5 | 77.0 | 175 | 130.1 | 117.1 | 235 | 174.6 | 157.2 | 295 | 219.2 | 197.4 |
| 56 | 41.6 | 37.5 | 116 | 86.2 | 77.6 | 176 | 130.8 | 117.8 | 236 | 175.4 | 157.9 | 296 | 220.0 | 198.1 |
| 57 | 42.4 | 38.1 | 117 | 86.9 | 78.3 | 177 | 131.5 | 118.4 | 237 | 176.1 | 158.6 | 297 | 220.7 | 198.7 |
| 58 | 43.1 | 38.8 | 118 | 87.7 | 79.0 | 178 | 132.3 | 119.1 | 238 | 176.9 | 159.3 | 298 | 221.5 | 199.4 |
| 59 | 43.8 | 39.5 | 119 | 88.4 | 79.6 | 179 | 133.0 | 119.8 | 239 | 177.6 | 159.9 | 299 | 222.2 | 200.1 |
| 60 | 44.6 | 40.1 | 120 | 89.2 | 80.3 | 180 | 133.8 | 120.4 | 240 | 178.4 | 160.6 | 300 | 222.9 | 200.7 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

48° — 3h 12m

## TRAVERSE TABLE TO DEGREES

42° 2h 48m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 223·7 | 201·4 | 361 | 268·3 | 241·6 | 421 | 312·9 | 281·7 | 481 | 357·5 | 321·9 | 541 | 402·1 | 362·0 |
| 302 | 224·4 | 202·1 | 362 | 269·0 | 242·2 | 422 | 313·6 | 282·4 | 482 | 358·2 | 322·5 | 542 | 402·8 | 362·7 |
| 303 | 225·2 | 202·8 | 363 | 269·8 | 242·9 | 423 | 314·4 | 283·0 | 483 | 358·9 | 323·2 | 543 | 403·5 | 363·3 |
| 304 | 225·9 | 203·4 | 364 | 270·5 | 243·6 | 424 | 315·1 | 283·7 | 484 | 359·7 | 323·9 | 544 | 404·3 | 364·0 |
| 305 | 226·6 | 204·1 | 365 | 271·2 | 244·2 | 425 | 315·8 | 284·4 | 485 | 360·4 | 324·6 | 545 | 405·0 | 364·7 |
| 306 | 227·4 | 204·8 | 366 | 272·0 | 244·9 | 426 | 316·6 | 285·1 | 486 | 361·2 | 325·2 | 546 | 405·8 | 365·4 |
| 307 | 228·1 | 205·4 | 367 | 272·7 | 245·6 | 427 | 317·3 | 285·7 | 487 | 361·9 | 325·9 | 547 | 406·5 | 366·0 |
| 308 | 228·9 | 206·1 | 368 | 273·5 | 246·2 | 428 | 318·1 | 286·4 | 488 | 362·7 | 326·6 | 548 | 407·2 | 366·7 |
| 309 | 229·6 | 206·8 | 369 | 274·2 | 246·9 | 429 | 318·8 | 287·1 | 489 | 363·4 | 327·2 | 549 | 408·0 | 367·4 |
| 310 | 230·4 | 207·4 | 370 | 275·0 | 247·6 | 430 | 319·6 | 287·7 | 490 | 364·1 | 327·9 | 550 | 408·7 | 368·0 |
| 311 | 231·1 | 208·1 | 371 | 275·7 | 248·3 | 431 | 320·3 | 288·4 | 491 | 364·9 | 328·6 | 551 | 409·5 | 368·7 |
| 312 | 231·9 | 208·8 | 372 | 276·5 | 248·9 | 432 | 321·0 | 289·1 | 492 | 365·6 | 329·2 | 552 | 410·2 | 369·4 |
| 313 | 232·6 | 209·4 | 373 | 277·2 | 249·6 | 433 | 321·8 | 289·7 | 493 | 366·4 | 329·9 | 553 | 411·0 | 370·0 |
| 314 | 233·3 | 210·1 | 374 | 277·9 | 250·3 | 434 | 322·5 | 290·4 | 494 | 367·1 | 330·6 | 554 | 411·7 | 370·7 |
| 315 | 234·1 | 210·8 | 375 | 278·7 | 250·9 | 435 | 323·3 | 291·1 | 495 | 307·9 | 331·3 | 555 | 412·4 | 371·4 |
| 316 | 234·8 | 211·5 | 376 | 279·4 | 251·6 | 436 | 324·0 | 291·7 | 496 | 368·6 | 331·9 | 556 | 413·2 | 372·0 |
| 317 | 235·6 | 212·1 | 377 | 280·2 | 252·3 | 437 | 324·8 | 292·4 | 497 | 369·3 | 332·5 | 557 | 413·9 | 372·7 |
| 318 | 236·3 | 212·8 | 378 | 280·9 | 252·9 | 438 | 325·5 | 293·1 | 498 | 370·1 | 333·3 | 558 | 414·7 | 373·4 |
| 319 | 237·1 | 213·5 | 379 | 281·7 | 253·6 | 439 | 326·2 | 293·8 | 499 | 370·8 | 333·9 | 559 | 415·4 | 374·1 |
| 320 | 237·8 | 214·1 | 380 | 282·4 | 254·3 | 440 | 327·0 | 294·4 | 500 | 371·6 | 334·6 | 560 | 416·2 | 374·7 |
| 321 | 238·6 | 214·8 | 381 | 283·1 | 254·9 | 441 | 327·7 | 295·1 | 501 | 372·3 | 335·3 | 561 | 416·9 | 375·4 |
| 322 | 239·3 | 215·5 | 382 | 283·9 | 255·6 | 442 | 328·5 | 295·8 | 502 | 373·1 | 335·9 | 562 | 417·6 | 376·1 |
| 323 | 240·0 | 216·1 | 383 | 284·6 | 256·3 | 443 | 329·2 | 296·4 | 503 | 373·8 | 336·6 | 563 | 418·4 | 376·7 |
| 324 | 240·8 | 216·8 | 384 | 285·4 | 257·0 | 444 | 330·0 | 297·1 | 504 | 374·5 | 337·2 | 564 | 419·1 | 377·4 |
| 325 | 241·5 | 217·5 | 385 | 286·1 | 257·6 | 445 | 330·7 | 297·8 | 505 | 375·3 | 337·9 | 565 | 419·9 | 378·1 |
| 326 | 242·3 | 218·1 | 386 | 286·9 | 258·3 | 446 | 331·4 | 298·4 | 506 | 376·0 | 338·6 | 566 | 420·6 | 378·7 |
| 327 | 243·0 | 218·8 | 387 | 287·6 | 259·0 | 447 | 332·2 | 299·1 | 507 | 376·8 | 339·3 | 567 | 421·4 | 379·4 |
| 328 | 243·8 | 219·5 | 388 | 288·3 | 259·6 | 448 | 332·9 | 299·8 | 508 | 377·5 | 339·9 | 568 | 422·1 | 380·1 |
| 329 | 244·5 | 220·1 | 389 | 289·1 | 260·3 | 449 | 333·7 | 300·4 | 509 | 378·3 | 340·6 | 569 | 422·8 | 380·7 |
| 330 | 245·2 | 220·8 | 390 | 289·8 | 261·0 | 450 | 334·4 | 301·1 | 510 | 379·0 | 341·3 | 570 | 423·6 | 381·4 |
| 331 | 246·0 | 221·5 | 391 | 290·6 | 261·6 | 451 | 335·2 | 301·8 | 511 | 379·7 | 341·9 | 571 | 424·3 | 382·1 |
| 332 | 246·7 | 222·2 | 392 | 291·3 | 262·3 | 452 | 335·9 | 302·5 | 512 | 380·5 | 342·6 | 572 | 425·1 | 382·8 |
| 333 | 247·5 | 222·8 | 393 | 292·1 | 263·0 | 453 | 336·6 | 303·1 | 513 | 381·2 | 343·3 | 573 | 425·8 | 383·4 |
| 334 | 248·2 | 223·5 | 394 | 292·8 | 263·6 | 454 | 337·4 | 303·8 | 514 | 382·0 | 343·9 | 574 | 426·6 | 384·1 |
| 335 | 249·0 | 224·2 | 395 | 293·5 | 264·3 | 455 | 338·1 | 304·5 | 515 | 382·7 | 344·6 | 575 | 427·3 | 384·8 |
| 336 | 249·7 | 224·8 | 396 | 294·3 | 265·0 | 456 | 338·9 | 305·1 | 516 | 383·5 | 345·3 | 576 | 428·0 | 385·4 |
| 337 | 250·4 | 225·5 | 397 | 295·0 | 265·7 | 457 | 339·6 | 305·8 | 517 | 384·2 | 346·0 | 577 | 428·8 | 386·1 |
| 338 | 251·2 | 226·2 | 398 | 295·8 | 266·3 | 458 | 340·4 | 306·5 | 518 | 384·9 | 346·6 | 578 | 429·5 | 386·8 |
| 339 | 251·9 | 226·8 | 399 | 296·5 | 267·0 | 459 | 341·1 | 307·1 | 519 | 385·7 | 347·3 | 579 | 430·3 | 387·4 |
| 340 | 252·7 | 227·5 | 400 | 297·3 | 267·7 | 460 | 341·8 | 307·8 | 520 | 386·4 | 348·0 | 580 | 431·0 | 388·1 |
| 341 | 253·4 | 228·2 | 401 | 298·0 | 268·3 | 461 | 342·6 | 308·5 | 521 | 387·2 | 348·6 | 581 | 431·8 | 388·8 |
| 342 | 254·2 | 228·8 | 402 | 298·7 | 269·0 | 462 | 343·3 | 309·1 | 522 | 387·9 | 349·3 | 582 | 432·5 | 389·4 |
| 343 | 254·9 | 229·5 | 403 | 299·5 | 269·7 | 463 | 344·1 | 309·8 | 523 | 388·7 | 350·0 | 583 | 433·2 | 390·1 |
| 344 | 255·6 | 230·2 | 404 | 300·2 | 270·3 | 464 | 344·8 | 310·5 | 524 | 389·4 | 350·6 | 584 | 434·0 | 390·8 |
| 345 | 256·4 | 230·9 | 405 | 301·0 | 271·0 | 465 | 345·6 | 311·2 | 525 | 390·1 | 351·3 | 585 | 434·7 | 391·4 |
| 346 | 257·1 | 231·5 | 406 | 301·7 | 271·7 | 466 | 346·3 | 311·8 | 526 | 390·9 | 352·0 | 586 | 435·5 | 392·1 |
| 347 | 257·9 | 232·2 | 407 | 302·5 | 272·3 | 467 | 347·0 | 312·5 | 527 | 391·6 | 352·6 | 587 | 436·2 | 392·8 |
| 348 | 258·6 | 232·9 | 408 | 303·2 | 273·0 | 468 | 347·8 | 313·2 | 528 | 392·4 | 353·3 | 588 | 437·0 | 393·4 |
| 349 | 259·4 | 233·5 | 409 | 303·9 | 273·7 | 469 | 348·5 | 313·8 | 529 | 393·1 | 354·0 | 589 | 437·7 | 394·1 |
| 350 | 260·1 | 234·2 | 410 | 304·7 | 274·3 | 470 | 349·3 | 314·5 | 530 | 393·9 | 354·6 | 590 | 438·4 | 394·8 |
| 351 | 260·8 | 234·9 | 411 | 305·4 | 275·0 | 471 | 350·0 | 315·2 | 531 | 394·6 | 355·3 | 591 | 439·2 | 395·4 |
| 352 | 261·6 | 235·5 | 412 | 306·2 | 275·7 | 472 | 350·8 | 315·8 | 532 | 395·3 | 356·0 | 592 | 440·0 | 396·1 |
| 353 | 262·3 | 236·2 | 413 | 306·9 | 276·4 | 473 | 351·5 | 316·5 | 533 | 396·1 | 356·6 | 593 | 440·7 | 396·8 |
| 354 | 263·1 | 236·9 | 414 | 307·7 | 277·0 | 474 | 352·3 | 317·2 | 534 | 396·8 | 357·3 | 594 | 441·4 | 397·5 |
| 355 | 263·8 | 237·5 | 415 | 308·4 | 277·7 | 475 | 353·0 | 317·8 | 535 | 397·6 | 358·0 | 595 | 442·2 | 398·1 |
| 356 | 264·6 | 238·2 | 416 | 309·1 | 278·4 | 476 | 353·7 | 318·5 | 536 | 398·3 | 358·6 | 596 | 442·9 | 398·8 |
| 357 | 265·3 | 238·9 | 417 | 309·9 | 279·0 | 477 | 354·5 | 319·2 | 537 | 399·1 | 359·3 | 597 | 443·7 | 399·5 |
| 358 | 266·0 | 239·6 | 418 | 310·6 | 279·7 | 478 | 355·2 | 319·9 | 538 | 399·8 | 360·0 | 598 | 444·4 | 400·1 |
| 359 | 266·8 | 240·2 | 419 | 311·4 | 280·4 | 479 | 356·0 | 320·5 | 539 | 400·6 | 360·6 | 599 | 445·2 | 400·8 |
| 360 | 267·5 | 240·9 | 420 | 312·1 | 281·0 | 480 | 356·7 | 321·2 | 540 | 401·3 | 361·3 | 600 | 445·9 | 401·5 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

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## TRAVERSE TABLE TO DEGREES

43° — 2h 52m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0·7 | 0·7 | 61 | 44·6 | 41·6 | 121 | 88·5 | 82·5 | 181 | 132·4 | 123·4 | 241 | 176·3 | 164·4 |
| 2 | 1·5 | 1·4 | 62 | 45·3 | 42·3 | 122 | 89·2 | 83·2 | 182 | 133·1 | 124·1 | 242 | 177·0 | 165·0 |
| 3 | 2·2 | 2·0 | 63 | 46·1 | 43·0 | 123 | 90·0 | 83·9 | 183 | 133·8 | 124·8 | 243 | 177·7 | 165·7 |
| 4 | 2·9 | 2·7 | 64 | 46·8 | 43·6 | 124 | 90·7 | 84·6 | 184 | 134·6 | 125·5 | 244 | 178·5 | 166·4 |
| 5 | 3·7 | 3·4 | 65 | 47·5 | 44·3 | 125 | 91·4 | 85·2 | 185 | 135·3 | 126·2 | 245 | 179·2 | 167·1 |
| 6 | 4·4 | 4·1 | 66 | 48·3 | 45·0 | 126 | 92·2 | 85·9 | 186 | 136·0 | 126·9 | 246 | 179·9 | 167·8 |
| 7 | 5·1 | 4·8 | 67 | 49·0 | 45·7 | 127 | 92·9 | 86·6 | 187 | 136·8 | 127·5 | 247 | 180·6 | 168·5 |
| 8 | 5·9 | 5·5 | 68 | 49·7 | 46·4 | 128 | 93·6 | 87·3 | 188 | 137·5 | 128·2 | 248 | 181·4 | 169·1 |
| 9 | 6·6 | 6·1 | 69 | 50·5 | 47·1 | 129 | 94·3 | 88·0 | 189 | 138·2 | 128·9 | 249 | 182·1 | 169·8 |
| 10 | 7·3 | 6·8 | 70 | 51·2 | 47·7 | 130 | 95·1 | 88·7 | 190 | 139·0 | 129·6 | 250 | 182·8 | 170·5 |
| 11 | 8·0 | 7·5 | 71 | 51·9 | 48·4 | 131 | 95·8 | 89·3 | 191 | 139·7 | 130·3 | 251 | 183·6 | 171·2 |
| 12 | 8·8 | 8·2 | 72 | 52·7 | 49·1 | 132 | 96·5 | 90·0 | 192 | 140·4 | 130·9 | 252 | 184·3 | 171·9 |
| 13 | 9·5 | 8·9 | 73 | 53·4 | 49·8 | 133 | 97·3 | 90·7 | 193 | 141·2 | 131·6 | 253 | 185·0 | 172·5 |
| 14 | 10·2 | 9·5 | 74 | 54·1 | 50·5 | 134 | 98·0 | 91·4 | 194 | 141·9 | 132·3 | 254 | 185·8 | 173·2 |
| 15 | 11·0 | 10·2 | 75 | 54·9 | 51·1 | 135 | 98·7 | 92·1 | 195 | 142·6 | 133·0 | 255 | 186·5 | 173·9 |
| 16 | 11·7 | 10·9 | 76 | 55·6 | 51·8 | 136 | 99·5 | 92·8 | 196 | 143·3 | 133·7 | 256 | 187·2 | 174·6 |
| 17 | 12·4 | 11·6 | 77 | 56·3 | 52·5 | 137 | 100·2 | 93·4 | 197 | 144·1 | 134·4 | 257 | 188·0 | 175·3 |
| 18 | 13·2 | 12·3 | 78 | 57·0 | 53·2 | 138 | 100·9 | 94·1 | 198 | 144·8 | 135·0 | 258 | 188·7 | 176·0 |
| 19 | 13·9 | 13·0 | 79 | 57·8 | 53·9 | 139 | 101·7 | 94·8 | 199 | 145·5 | 135·7 | 259 | 189·4 | 176·6 |
| 20 | 14·6 | 13·6 | 80 | 58·5 | 54·6 | 140 | 102·4 | 95·5 | 200 | 146·3 | 136·4 | 260 | 190·2 | 177·3 |
| 21 | 15·4 | 14·3 | 81 | 59·2 | 55·2 | 141 | 103·1 | 96·2 | 201 | 147·0 | 137·1 | 261 | 190·9 | 178·0 |
| 22 | 16·1 | 15·0 | 82 | 60·0 | 55·9 | 142 | 103·9 | 96·8 | 202 | 147·7 | 137·8 | 262 | 191·6 | 178·7 |
| 23 | 16·8 | 15·7 | 83 | 60·7 | 56·6 | 143 | 104·6 | 97·5 | 203 | 148·5 | 138·4 | 263 | 192·3 | 179·4 |
| 24 | 17·6 | 16·4 | 84 | 61·4 | 57·3 | 144 | 105·3 | 98·2 | 204 | 149·2 | 139·1 | 264 | 193·1 | 180·0 |
| 25 | 18·3 | 17·0 | 85 | 62·2 | 58·0 | 145 | 106·0 | 98·9 | 205 | 149·9 | 139·8 | 265 | 193·8 | 180·7 |
| 26 | 19·0 | 17·7 | 86 | 62·9 | 58·7 | 146 | 106·8 | 99·6 | 206 | 150·7 | 140·5 | 266 | 194·5 | 181·4 |
| 27 | 19·7 | 18·4 | 87 | 63·6 | 59·3 | 147 | 107·5 | 100·3 | 207 | 151·4 | 141·2 | 267 | 195·3 | 182·1 |
| 28 | 20·5 | 19·1 | 88 | 64·4 | 60·0 | 148 | 108·2 | 100·9 | 208 | 152·1 | 141·9 | 268 | 196·0 | 182·8 |
| 29 | 21·2 | 19·8 | 89 | 65·1 | 60·7 | 149 | 109·0 | 101·6 | 209 | 152·9 | 142·5 | 269 | 196·7 | 183·5 |
| 30 | 21·9 | 20·5 | 90 | 65·8 | 61·4 | 150 | 109·7 | 102·3 | 210 | 153·6 | 143·2 | 270 | 197·5 | 184·1 |
| 31 | 22·7 | 21·1 | 91 | 66·6 | 62·1 | 151 | 110·4 | 103·0 | 211 | 154·3 | 143·9 | 271 | 198·2 | 184·8 |
| 32 | 23·4 | 21·8 | 92 | 67·3 | 62·7 | 152 | 111·2 | 103·7 | 212 | 155·0 | 144·6 | 272 | 198·9 | 185·5 |
| 33 | 24·1 | 22·5 | 93 | 68·0 | 63·4 | 153 | 111·9 | 104·3 | 213 | 155·8 | 145·3 | 273 | 199·7 | 186·2 |
| 34 | 24·9 | 23·2 | 94 | 68·7 | 64·1 | 154 | 112·6 | 105·0 | 214 | 156·5 | 145·9 | 274 | 200·4 | 186·9 |
| 35 | 25·6 | 23·9 | 95 | 69·5 | 64·8 | 155 | 113·4 | 105·7 | 215 | 157·2 | 146·6 | 275 | 201·1 | 187·5 |
| 36 | 26·3 | 24·6 | 96 | 70·2 | 65·5 | 156 | 114·1 | 106·4 | 216 | 158·0 | 147·3 | 276 | 201·9 | 188·2 |
| 37 | 27·1 | 25·2 | 97 | 70·9 | 66·2 | 157 | 114·8 | 107·1 | 217 | 158·7 | 148·0 | 277 | 202·6 | 188·9 |
| 38 | 27·8 | 25·9 | 98 | 71·7 | 66·8 | 158 | 115·6 | 107·8 | 218 | 159·4 | 148·7 | 278 | 203·3 | 189·6 |
| 39 | 28·5 | 26·6 | 99 | 72·4 | 67·5 | 159 | 116·3 | 108·4 | 219 | 160·2 | 149·4 | 279 | 204·0 | 190·3 |
| 40 | 29·3 | 27·3 | 100 | 73·1 | 68·2 | 160 | 117·0 | 109·1 | 220 | 160·9 | 150·0 | 280 | 204·8 | 191·0 |
| 41 | 30·0 | 28·0 | 101 | 73·9 | 68·9 | 161 | 117·7 | 109·8 | 221 | 161·6 | 150·7 | 281 | 205·5 | 191·6 |
| 42 | 30·7 | 28·6 | 102 | 74·6 | 69·6 | 162 | 118·5 | 110·5 | 222 | 162·4 | 151·4 | 282 | 206·2 | 192·3 |
| 43 | 31·4 | 29·3 | 103 | 75·3 | 70·2 | 163 | 119·2 | 111·2 | 223 | 163·1 | 152·1 | 283 | 207·0 | 193·0 |
| 44 | 32·2 | 30·0 | 104 | 76·1 | 70·9 | 164 | 119·9 | 111·8 | 224 | 163·8 | 152·8 | 284 | 207·7 | 193·7 |
| 45 | 32·9 | 30·7 | 105 | 76·8 | 71·6 | 165 | 120·7 | 112·5 | 225 | 164·6 | 153·4 | 285 | 208·4 | 194·4 |
| 46 | 33·6 | 31·4 | 106 | 77·5 | 72·3 | 166 | 121·4 | 113·2 | 226 | 165·3 | 154·1 | 286 | 209·2 | 195·1 |
| 47 | 34·4 | 32·1 | 107 | 78·3 | 73·0 | 167 | 122·1 | 113·9 | 227 | 166·0 | 154·8 | 287 | 209·9 | 195·7 |
| 48 | 35·1 | 32·7 | 108 | 79·0 | 73·7 | 168 | 122·9 | 114·6 | 228 | 166·7 | 155·5 | 288 | 210·6 | 196·4 |
| 49 | 35·8 | 33·4 | 109 | 79·7 | 74·3 | 169 | 123·6 | 115·3 | 229 | 167·5 | 156·2 | 289 | 211·4 | 197·1 |
| 50 | 36·6 | 34·1 | 110 | 80·4 | 75·0 | 170 | 124·3 | 115·9 | 230 | 168·2 | 156·9 | 290 | 212·1 | 197·8 |
| 51 | 37·3 | 34·8 | 111 | 81·2 | 75·7 | 171 | 125·1 | 116·6 | 231 | 168·9 | 157·5 | 291 | 212·8 | 198·5 |
| 52 | 38·0 | 35·5 | 112 | 81·9 | 76·4 | 172 | 125·8 | 117·3 | 232 | 169·7 | 158·2 | 292 | 213·6 | 199·1 |
| 53 | 38·8 | 36·1 | 113 | 82·6 | 77·1 | 173 | 126·5 | 118·0 | 233 | 170·4 | 158·9 | 293 | 214·3 | 199·8 |
| 54 | 39·5 | 36·8 | 114 | 83·4 | 77·7 | 174 | 127·3 | 118·7 | 234 | 171·1 | 159·6 | 294 | 215·0 | 200·5 |
| 55 | 40·2 | 37·5 | 115 | 84·1 | 78·4 | 175 | 128·0 | 119·3 | 235 | 171·9 | 160·3 | 295 | 215·7 | 201·2 |
| 56 | 41·0 | 38·2 | 116 | 84·8 | 79·1 | 176 | 128·7 | 120·0 | 236 | 172·6 | 161·0 | 296 | 216·5 | 201·9 |
| 57 | 41·7 | 38·9 | 117 | 85·6 | 79·8 | 177 | 129·4 | 120·7 | 237 | 173·3 | 161·6 | 297 | 217·2 | 202·6 |
| 58 | 42·4 | 39·6 | 118 | 86·3 | 80·5 | 178 | 130·2 | 121·4 | 238 | 174·1 | 162·3 | 298 | 217·9 | 203·2 |
| 59 | 43·1 | 40·2 | 119 | 87·0 | 81·2 | 179 | 130·9 | 122·1 | 239 | 174·8 | 163·0 | 299 | 218·7 | 203·9 |
| 60 | 43·9 | 40·9 | 120 | 87·8 | 81·8 | 180 | 131·6 | 122·8 | 240 | 175·5 | 163·7 | 300 | 219·4 | 204·6 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

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## TRAVERSE TABLE TO DEGREES

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| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 220.1 | 205.3 | 361 | 264.0 | 246.2 | 421 | 307.9 | 287.1 | 481 | 351.8 | 328.1 | 541 | 395.7 | 369.0 |
| 302 | 220.9 | 206.0 | 362 | 264.8 | 246.9 | 422 | 308.6 | 287.8 | 482 | 352.5 | 328.7 | 542 | 396.4 | 369.7 |
| 303 | 221.6 | 206.7 | 363 | 265.5 | 247.6 | 423 | 309.4 | 288.5 | 483 | 353.2 | 329.4 | 543 | 397.1 | 370.3 |
| 304 | 222.3 | 207.3 | 364 | 266.2 | 248.3 | 424 | 310.1 | 289.2 | 484 | 354.0 | 330.1 | 544 | 397.9 | 371.0 |
| 305 | 223.1 | 208.0 | 365 | 267.0 | 248.9 | 425 | 310.8 | 289.9 | 485 | 354.7 | 330.8 | 545 | 398.6 | 371.7 |
| 306 | 223.8 | 208.7 | 366 | 267.7 | 249.6 | 426 | 311.6 | 290.5 | 486 | 355.4 | 331.4 | 546 | 399.3 | 372.4 |
| 307 | 224.5 | 209.4 | 367 | 268.4 | 250.3 | 427 | 312.3 | 291.2 | 487 | 356.2 | 332.1 | 547 | 400.1 | 373.1 |
| 308 | 225.3 | 210.1 | 368 | 269.1 | 251.0 | 428 | 313.0 | 291.9 | 488 | 356.9 | 332.8 | 548 | 400.8 | 373.7 |
| 309 | 226.0 | 210.7 | 369 | 269.9 | 251.7 | 429 | 313.8 | 292.6 | 489 | 357.7 | 333.5 | 549 | 401.5 | 374.4 |
| 310 | 226.7 | 211.4 | 370 | 270.6 | 252.3 | 430 | 314.5 | 293.3 | 490 | 358.4 | 334.2 | 550 | 402.2 | 375.1 |
| 311 | 227.5 | 212.1 | 371 | 271.3 | 253.0 | 431 | 315.2 | 293.9 | 491 | 359.1 | 334.9 | 551 | 403.0 | 375.8 |
| 312 | 228.2 | 212.8 | 372 | 272.1 | 253.7 | 432 | 316.0 | 294.6 | 492 | 359.8 | 335.5 | 552 | 403.7 | 376.5 |
| 313 | 228.9 | 213.5 | 373 | 272.8 | 254.4 | 433 | 316.7 | 295.3 | 493 | 360.6 | 336.2 | 553 | 404.4 | 377.1 |
| 314 | 229.7 | 214.2 | 374 | 273.5 | 255.1 | 434 | 317.4 | 296.0 | 494 | 361.3 | 336.9 | 554 | 405.2 | 377.8 |
| 315 | 230.4 | 214.8 | 375 | 274.3 | 255.8 | 435 | 318.1 | 296.7 | 495 | 362.0 | 337.6 | 555 | 405.9 | 378.5 |
| 316 | 231.1 | 215.5 | 376 | 275.0 | 256.4 | 436 | 318.9 | 297.4 | 496 | 362.8 | 338.3 | 556 | 406.6 | 379.2 |
| 317 | 231.8 | 216.2 | 377 | 275.7 | 257.1 | 437 | 319.6 | 298.0 | 497 | 363.5 | 338.9 | 557 | 407.4 | 379.9 |
| 318 | 232.6 | 216.9 | 378 | 276.5 | 257.8 | 438 | 320.3 | 298.7 | 498 | 364.2 | 339.6 | 558 | 408.1 | 380.6 |
| 319 | 233.3 | 217.6 | 379 | 277.2 | 258.5 | 439 | 321.1 | 299.4 | 499 | 364.9 | 340.3 | 559 | 408.8 | 381.2 |
| 320 | 234.0 | 218.2 | 380 | 277.9 | 259.2 | 440 | 321.8 | 300.1 | 500 | 365.7 | 341.0 | 560 | 409.6 | 381.9 |
| 321 | 234.8 | 218.9 | 381 | 278.7 | 259.8 | 441 | 322.5 | 300.8 | 501 | 366.4 | 341.7 | 561 | 410.3 | 382.6 |
| 322 | 235.5 | 219.6 | 382 | 279.4 | 260.5 | 442 | 323.3 | 301.4 | 502 | 367.1 | 342.4 | 562 | 411.0 | 383.3 |
| 323 | 236.2 | 220.3 | 383 | 280.1 | 261.2 | 443 | 324.0 | 302.1 | 503 | 367.8 | 343.0 | 563 | 411.8 | 384.0 |
| 324 | 237.0 | 221.0 | 384 | 280.8 | 261.9 | 444 | 324.7 | 302.8 | 504 | 368.6 | 343.7 | 564 | 412.5 | 384.6 |
| 325 | 237.7 | 221.7 | 385 | 281.6 | 262.6 | 445 | 325.5 | 303.5 | 505 | 369.3 | 344.4 | 565 | 413.2 | 385.3 |
| 326 | 238.4 | 222.3 | 386 | 282.3 | 263.3 | 446 | 326.2 | 304.2 | 506 | 370.0 | 345.1 | 566 | 414.0 | 386.0 |
| 327 | 239.2 | 223.0 | 387 | 283.0 | 263.9 | 447 | 326.9 | 304.9 | 507 | 370.8 | 345.8 | 567 | 414.7 | 386.7 |
| 328 | 239.9 | 223.7 | 388 | 283.7 | 264.6 | 448 | 327.7 | 305.5 | 508 | 371.5 | 346.5 | 568 | 415.4 | 387.4 |
| 329 | 240.6 | 224.4 | 389 | 284.5 | 265.3 | 449 | 328.4 | 306.2 | 509 | 372.3 | 347.1 | 569 | 416.2 | 388.1 |
| 330 | 241.4 | 225.1 | 390 | 285.2 | 266.0 | 450 | 329.1 | 306.9 | 510 | 373.0 | 347.8 | 570 | 416.9 | 388.7 |
| 331 | 242.1 | 225.7 | 391 | 286.0 | 266.7 | 451 | 329.9 | 307.6 | 511 | 373.8 | 348.5 | 571 | 417.6 | 389.4 |
| 332 | 242.8 | 226.4 | 392 | 286.7 | 267.3 | 452 | 330.6 | 308.3 | 512 | 374.5 | 349.2 | 572 | 418.3 | 390.1 |
| 333 | 243.5 | 227.1 | 393 | 287.4 | 268.0 | 453 | 331.3 | 309.0 | 513 | 375.2 | 349.9 | 573 | 419.1 | 390.8 |
| 334 | 244.3 | 227.8 | 394 | 288.2 | 268.7 | 454 | 332.1 | 309.6 | 514 | 376.0 | 350.5 | 574 | 419.8 | 391.5 |
| 335 | 245.0 | 228.5 | 395 | 288.9 | 269.4 | 455 | 332.8 | 310.3 | 515 | 376.6 | 351.2 | 575 | 420.5 | 392.2 |
| 336 | 245.7 | 229.2 | 396 | 289.6 | 270.1 | 456 | 333.5 | 311.0 | 516 | 377.4 | 351.9 | 576 | 421.3 | 392.8 |
| 337 | 246.5 | 229.8 | 397 | 290.4 | 270.8 | 457 | 334.3 | 311.7 | 517 | 378.2 | 352.6 | 577 | 422.0 | 393.5 |
| 338 | 247.2 | 230.5 | 398 | 291.1 | 271.4 | 458 | 335.0 | 312.4 | 518 | 378.9 | 353.3 | 578 | 422.7 | 394.2 |
| 339 | 247.9 | 231.2 | 399 | 291.8 | 272.1 | 459 | 335.7 | 313.0 | 519 | 379.6 | 354.0 | 579 | 423.5 | 394.9 |
| 340 | 248.7 | 231.9 | 400 | 292.6 | 272.8 | 460 | 336.5 | 313.7 | 520 | 380.3 | 354.6 | 580 | 424.2 | 395.6 |
| 341 | 249.4 | 232.6 | 401 | 293.3 | 273.5 | 461 | 337.2 | 314.4 | 521 | 381.1 | 355.3 | 581 | 424.9 | 396.2 |
| 342 | 250.1 | 233.2 | 402 | 294.0 | 274.2 | 462 | 337.9 | 315.1 | 522 | 381.8 | 356.0 | 582 | 425.7 | 396.9 |
| 343 | 250.9 | 233.9 | 403 | 294.7 | 274.9 | 463 | 338.7 | 315.8 | 523 | 382.6 | 356.7 | 583 | 426.4 | 397.6 |
| 344 | 251.6 | 234.6 | 404 | 295.5 | 275.5 | 464 | 339.4 | 316.5 | 524 | 383.3 | 357.4 | 584 | 427.1 | 398.3 |
| 345 | 252.3 | 235.3 | 405 | 296.2 | 276.2 | 465 | 340.1 | 317.1 | 525 | 384.0 | 358.1 | 585 | 427.9 | 399.0 |
| 346 | 253.1 | 236.0 | 406 | 296.9 | 276.9 | 466 | 340.8 | 317.8 | 526 | 384.7 | 358.7 | 586 | 428.6 | 399.6 |
| 347 | 253.8 | 236.7 | 407 | 297.7 | 277.6 | 467 | 341.6 | 318.5 | 527 | 385.5 | 359.4 | 587 | 429.3 | 400.3 |
| 348 | 254.5 | 237.3 | 408 | 298.4 | 278.3 | 468 | 342.3 | 319.2 | 528 | 386.2 | 360.1 | 588 | 430.1 | 401.0 |
| 349 | 255.3 | 238.0 | 409 | 299.1 | 278.9 | 469 | 343.0 | 319.9 | 529 | 386.9 | 360.8 | 589 | 430.8 | 401.7 |
| 350 | 256.0 | 238.7 | 410 | 299.9 | 279.6 | 470 | 343.7 | 320.5 | 530 | 387.6 | 361.5 | 590 | 431.5 | 402.4 |
| 351 | 256.7 | 239.4 | 411 | 300.6 | 280.3 | 471 | 344.5 | 321.2 | 531 | 388.4 | 362.1 | 591 | 432.3 | 403.1 |
| 352 | 257.4 | 240.1 | 412 | 301.3 | 281.0 | 472 | 345.2 | 321.9 | 532 | 389.1 | 362.8 | 592 | 433.0 | 403.7 |
| 353 | 258.2 | 240.8 | 413 | 302.1 | 281.7 | 473 | 345.9 | 322.6 | 533 | 389.9 | 363.5 | 593 | 433.7 | 404.4 |
| 354 | 258.9 | 241.4 | 414 | 302.8 | 282.4 | 474 | 346.7 | 323.3 | 534 | 390.6 | 364.2 | 594 | 434.5 | 405.1 |
| 355 | 259.6 | 242.1 | 415 | 303.5 | 283.0 | 475 | 347.4 | 324.0 | 535 | 391.3 | 364.9 | 595 | 435.2 | 405.8 |
| 356 | 260.4 | 242.8 | 416 | 304.3 | 283.7 | 476 | 348.1 | 324.6 | 536 | 392.0 | 365.5 | 596 | 435.9 | 406.5 |
| 357 | 261.1 | 243.5 | 417 | 305.0 | 284.4 | 477 | 348.9 | 325.3 | 537 | 392.8 | 366.2 | 597 | 436.7 | 407.2 |
| 358 | 261.8 | 244.2 | 418 | 305.7 | 285.1 | 478 | 349.6 | 326.0 | 538 | 393.5 | 366.9 | 598 | 437.4 | 407.8 |
| 359 | 262.6 | 244.8 | 419 | 306.4 | 285.8 | 479 | 350.3 | 326.7 | 539 | 394.2 | 367.6 | 599 | 438.1 | 408.5 |
| 360 | 263.3 | 245.5 | 420 | 307.2 | 286.4 | 480 | 351.1 | 327.4 | 540 | 394.9 | 368.3 | 600 | 438.8 | 409.2 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

47° 3h 8m

## TRAVERSE TABLE TO DEGREES

| 44° | | | | | | | | | | | | | | 2h 56m |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
| 1 | 0·7 | 0·7 | 61 | 43·9 | 42·4 | 121 | 87·0 | 84·1 | 181 | 130·2 | 125·7 | 241 | 173·4 | 167·4 |
| 2 | 1·4 | 1·4 | 62 | 44·6 | 43·1 | 122 | 87·8 | 84·7 | 182 | 130·9 | 126·4 | 242 | 174·1 | 168·1 |
| 3 | 2·2 | 2·1 | 63 | 45·3 | 43·8 | 123 | 88·5 | 85·4 | 183 | 131·6 | 127·1 | 243 | 174·8 | 168·8 |
| 4 | 2·9 | 2·8 | 64 | 46·0 | 44·5 | 124 | 89·2 | 86·1 | 184 | 132·4 | 127·8 | 244 | 175·5 | 169·5 |
| 5 | 3·6 | 3·5 | 65 | 46·8 | 45·2 | 125 | 89·9 | 86·8 | 185 | 133·1 | 128·5 | 245 | 176·2 | 170·2 |
| 6 | 4·3 | 4·2 | 66 | 47·5 | 45·8 | 126 | 90·6 | 87·5 | 186 | 133·8 | 129·2 | 246 | 177·0 | 170·9 |
| 7 | 5·0 | 4·9 | 67 | 48·2 | 46·5 | 127 | 91·4 | 88·2 | 187 | 134·5 | 129·9 | 247 | 177·7 | 171·6 |
| 8 | 5·8 | 5·6 | 68 | 48·9 | 47·2 | 128 | 92·1 | 88·9 | 188 | 135·2 | 130·6 | 248 | 178·4 | 172·3 |
| 9 | 6·5 | 6·3 | 69 | 49·6 | 47·9 | 129 | 92·8 | 89·6 | 189 | 136·0 | 131·3 | 249 | 179·1 | 173·0 |
| 10 | 7·2 | 6·9 | 70 | 50·4 | 48·6 | 130 | 93·5 | 90·3 | 190 | 136·7 | 132·0 | 250 | 179·8 | 173·7 |
| 11 | 7·9 | 7·6 | 71 | 51·1 | 49·3 | 131 | 94·2 | 91·0 | 191 | 137·4 | 132·7 | 251 | 180·6 | 174·4 |
| 12 | 8·6 | 8·3 | 72 | 51·8 | 50·0 | 132 | 95·0 | 91·7 | 192 | 138·1 | 133·4 | 252 | 181·3 | 175·1 |
| 13 | 9·4 | 9·0 | 73 | 52·5 | 50·7 | 133 | 95·7 | 92·4 | 193 | 138·8 | 134·1 | 253 | 182·0 | 175·7 |
| 14 | 10·1 | 9·7 | 74 | 53·2 | 51·4 | 134 | 96·4 | 93·1 | 194 | 139·6 | 134·8 | 254 | 182·7 | 176·4 |
| 15 | 10·8 | 10·4 | 75 | 54·0 | 52·1 | 135 | 97·1 | 93·8 | 195 | 140·3 | 135·5 | 255 | 183·4 | 177·1 |
| 16 | 11·5 | 11·1 | 76 | 54·7 | 52·8 | 136 | 97·8 | 94·5 | 196 | 141·0 | 136·2 | 256 | 184·2 | 177·8 |
| 17 | 12·2 | 11·8 | 77 | 55·4 | 53·5 | 137 | 98·5 | 95·2 | 197 | 141·7 | 136·8 | 257 | 184·9 | 178·5 |
| 18 | 12·9 | 12·5 | 78 | 56·1 | 54·2 | 138 | 99·3 | 95·9 | 198 | 142·4 | 137·5 | 258 | 185·6 | 179·2 |
| 19 | 13·7 | 13·2 | 79 | 56·8 | 54·9 | 139 | 100·0 | 96·6 | 199 | 143·1 | 138·2 | 259 | 186·3 | 179·9 |
| 20 | 14·4 | 13·9 | 80 | 57·5 | 55·6 | 140 | 100·7 | 97·3 | 200 | 143·9 | 138·9 | 260 | 187·0 | 180·6 |
| 21 | 15·1 | 14·6 | 81 | 58·3 | 56·3 | 141 | 101·4 | 97·9 | 201 | 144·6 | 139·6 | 261 | 187·7 | 181·3 |
| 22 | 15·8 | 15·3 | 82 | 59·0 | 57·0 | 142 | 102·1 | 98·6 | 202 | 145·3 | 140·3 | 262 | 188·5 | 182·0 |
| 23 | 16·5 | 16·0 | 83 | 59·7 | 57·7 | 143 | 102·9 | 99·3 | 203 | 146·0 | 141·0 | 263 | 189·2 | 182·7 |
| 24 | 17·3 | 16·7 | 84 | 60·4 | 58·4 | 144 | 103·6 | 100·0 | 204 | 146·7 | 141·7 | 264 | 189·9 | 183·4 |
| 25 | 18·0 | 17·4 | 85 | 61·1 | 59·0 | 145 | 104·3 | 100·7 | 205 | 147·5 | 142·4 | 265 | 190·6 | 184·1 |
| 26 | 18·7 | 18·1 | 86 | 61·9 | 59·7 | 146 | 105·0 | 101·4 | 206 | 148·2 | 143·1 | 266 | 191·3 | 184·8 |
| 27 | 19·4 | 18·8 | 87 | 62·6 | 60·4 | 147 | 105·7 | 102·1 | 207 | 148·9 | 143·8 | 267 | 192·1 | 185·5 |
| 28 | 20·1 | 19·5 | 88 | 63·3 | 61·1 | 148 | 106·5 | 102·8 | 208 | 149·6 | 144·5 | 268 | 192·8 | 186·2 |
| 29 | 20·9 | 20·1 | 89 | 64·0 | 61·8 | 149 | 107·2 | 103·5 | 209 | 150·3 | 145·2 | 269 | 193·5 | 186·9 |
| 30 | 21·6 | 20·8 | 90 | 64·7 | 62·5 | 150 | 107·9 | 104·2 | 210 | 151·1 | 145·9 | 270 | 194·2 | 187·6 |
| 31 | 22·3 | 21·5 | 91 | 65·5 | 63·2 | 151 | 108·6 | 104·9 | 211 | 151·8 | 146·6 | 271 | 194·9 | 188·3 |
| 32 | 23·0 | 22·2 | 92 | 66·2 | 63·9 | 152 | 109·3 | 105·6 | 212 | 152·5 | 147·3 | 272 | 195·7 | 188·9 |
| 33 | 23·7 | 22·9 | 93 | 66·9 | 64·6 | 153 | 110·1 | 106·3 | 213 | 153·2 | 148·0 | 273 | 196·4 | 189·6 |
| 34 | 24·5 | 23·6 | 94 | 67·6 | 65·3 | 154 | 110·8 | 107·0 | 214 | 153·9 | 148·7 | 274 | 197·1 | 190·3 |
| 35 | 25·2 | 24·3 | 95 | 68·3 | 66·0 | 155 | 111·5 | 107·7 | 215 | 154·7 | 149·4 | 275 | 197·8 | 191·0 |
| 36 | 25·9 | 25·0 | 96 | 69·1 | 66·7 | 156 | 112·2 | 108·4 | 216 | 155·4 | 150·0 | 276 | 198·5 | 191·7 |
| 37 | 26·6 | 25·7 | 97 | 69·8 | 67·4 | 157 | 112·9 | 109·1 | 217 | 156·1 | 150·7 | 277 | 199·3 | 192·4 |
| 38 | 27·3 | 26·4 | 98 | 70·5 | 68·1 | 158 | 113·7 | 109·8 | 218 | 156·8 | 151·4 | 278 | 200·0 | 193·1 |
| 39 | 28·1 | 27·1 | 99 | 71·2 | 68·8 | 159 | 114·4 | 110·5 | 219 | 157·5 | 152·1 | 279 | 200·7 | 193·8 |
| 40 | 28·8 | 27·8 | 100 | 71·9 | 69·5 | 160 | 115·1 | 111·1 | 220 | 158·3 | 152·8 | 280 | 201·4 | 194·5 |
| 41 | 29·5 | 28·5 | 101 | 72·7 | 70·2 | 161 | 115·8 | 111·8 | 221 | 159·0 | 153·5 | 281 | 202·1 | 195·2 |
| 42 | 30·2 | 29·2 | 102 | 73·4 | 70·9 | 162 | 116·5 | 112·5 | 222 | 159·7 | 154·2 | 282 | 202·9 | 195·9 |
| 43 | 30·9 | 29·9 | 103 | 74·1 | 71·5 | 163 | 117·3 | 113·2 | 223 | 160·4 | 154·9 | 283 | 203·6 | 196·6 |
| 44 | 31·7 | 30·6 | 104 | 74·8 | 72·2 | 164 | 118·0 | 113·9 | 224 | 161·1 | 155·6 | 284 | 204·3 | 197·3 |
| 45 | 32·4 | 31·3 | 105 | 75·5 | 72·9 | 165 | 118·7 | 114·6 | 225 | 161·9 | 156·3 | 285 | 205·0 | 198·0 |
| 46 | 33·1 | 32·0 | 106 | 76·3 | 73·6 | 166 | 119·4 | 115·3 | 226 | 162·6 | 157·0 | 286 | 205·7 | 198·7 |
| 47 | 33·8 | 32·6 | 107 | 77·0 | 74·3 | 167 | 120·1 | 116·0 | 227 | 163·3 | 157·7 | 287 | 206·5 | 199·4 |
| 48 | 34·5 | 33·3 | 108 | 77·7 | 75·0 | 168 | 120·8 | 116·7 | 228 | 164·0 | 158·4 | 288 | 207·2 | 200·1 |
| 49 | 35·2 | 34·0 | 109 | 78·4 | 75·7 | 169 | 121·6 | 117·4 | 229 | 164·7 | 159·1 | 289 | 207·9 | 200·8 |
| 50 | 36·0 | 34·7 | 110 | 79·1 | 76·4 | 170 | 122·3 | 118·1 | 230 | 165·4 | 159·8 | 290 | 208·6 | 201·5 |
| 51 | 36·7 | 35·4 | 111 | 79·8 | 77·1 | 171 | 123·0 | 118·8 | 231 | 166·2 | 160·5 | 291 | 209·3 | 202·1 |
| 52 | 37·4 | 36·1 | 112 | 80·6 | 77·8 | 172 | 123·7 | 119·5 | 232 | 166·9 | 161·2 | 292 | 210·0 | 202·8 |
| 53 | 38·1 | 36·8 | 113 | 81·3 | 78·5 | 173 | 124·4 | 120·2 | 233 | 167·6 | 161·9 | 293 | 210·8 | 203·5 |
| 54 | 38·8 | 37·5 | 114 | 82·0 | 79·2 | 174 | 125·2 | 120·9 | 234 | 168·3 | 162·6 | 294 | 211·5 | 204·2 |
| 55 | 39·6 | 38·2 | 115 | 82·7 | 79·9 | 175 | 125·9 | 121·6 | 235 | 169·0 | 163·2 | 295 | 212·2 | 204·9 |
| 56 | 40·3 | 38·9 | 116 | 83·4 | 80·6 | 176 | 126·6 | 122·3 | 236 | 169·8 | 163·9 | 296 | 212·9 | 205·6 |
| 57 | 41·0 | 39·6 | 117 | 84·2 | 81·3 | 177 | 127·3 | 123·0 | 237 | 170·5 | 164·6 | 297 | 213·6 | 206·3 |
| 58 | 41·7 | 40·3 | 118 | 84·9 | 82·0 | 178 | 128·0 | 123·6 | 238 | 171·2 | 165·3 | 298 | 214·4 | 207·0 |
| 59 | 42·4 | 41·0 | 119 | 85·6 | 82·7 | 179 | 128·8 | 124·3 | 239 | 171·9 | 166·0 | 299 | 215·1 | 207·7 |
| 60 | 43·2 | 41·7 | 120 | 86·3 | 83·4 | 180 | 129·5 | 125·0 | 240 | 172·6 | 166·7 | 300 | 215·8 | 208·4 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |
| 46° | | | | | | | | | | | | | | 3h 4m |

TRAVERSE TABLE TO DEGREES

44° 2h 56m

| Dist. | D. Lat. | Dep | Dist. | D. Lat | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 216·5 | 209·1 | 361 | 259·7 | 250·8 | 421 | 302·8 | 292·5 | 481 | 346·0 | 334·1 | 541 | 389·2 | 375·8 |
| 302 | 217·2 | 209·8 | 362 | 260·4 | 251·5 | 422 | 303·6 | 293·2 | 482 | 346·7 | 334·8 | 542 | 389·9 | 376·5 |
| 303 | 218·0 | 210·5 | 363 | 261·1 | 252·2 | 423 | 304·3 | 293·8 | 483 | 347·4 | 335·5 | 543 | 390·6 | 377·2 |
| 304 | 218·7 | 211·2 | 364 | 261·8 | 252·9 | 424 | 305·0 | 294·5 | 484 | 348·2 | 336·2 | 544 | 391·3 | 377·9 |
| 305 | 219·4 | 211·9 | 365 | 262·6 | 253·6 | 425 | 305·7 | 295·2 | 485 | 348·9 | 336·9 | 545 | 392·0 | 378·6 |
| 306 | 220·1 | 212·6 | 366 | 263·3 | 254·3 | 426 | 306·4 | 295·9 | 486 | 349·6 | 337·6 | 546 | 392·8 | 379·3 |
| 307 | 220·8 | 213·3 | 367 | 264·0 | 254·9 | 427 | 307·2 | 296·6 | 487 | 350·3 | 338·3 | 547 | 393·5 | 380·0 |
| 308 | 221·6 | 214·0 | 368 | 264·7 | 255·6 | 428 | 307·9 | 297·3 | 488 | 351·0 | 339·0 | 548 | 394·2 | 380·7 |
| 309 | 222·3 | 214·7 | 369 | 265·4 | 256·3 | 429 | 308·6 | 298·0 | 489 | 351·7 | 339·7 | 549 | 394·9 | 381·4 |
| 310 | 223·0 | 215·4 | 370 | 266·2 | 257·0 | 430 | 309·3 | 298·7 | 490 | 352·5 | 340·4 | 550 | 395·6 | 382·1 |
| 311 | 223·7 | 216·0 | 371 | 266·9 | 257·7 | 431 | 310·0 | 299·4 | 491 | 353·2 | 341·1 | 551 | 396·4 | 382·7 |
| 312 | 224·4 | 216·7 | 372 | 267·6 | 258·4 | 432 | 310·8 | 300·1 | 492 | 353·9 | 341·8 | 552 | 397·1 | 383·4 |
| 313 | 225·2 | 217·4 | 373 | 268·3 | 259·1 | 433 | 311·5 | 300·8 | 493 | 354·6 | 342·5 | 553 | 397·8 | 384·1 |
| 314 | 225·9 | 218·1 | 374 | 269·0 | 259·8 | 434 | 312·2 | 301·5 | 494 | 355·3 | 343·2 | 554 | 398·5 | 384·8 |
| 315 | 226·6 | 218·8 | 375 | 269·8 | 260·5 | 435 | 312·9 | 302·2 | 495 | 356·1 | 343·9 | 555 | 399·2 | 385·5 |
| 316 | 227·3 | 219·5 | 376 | 270·5 | 261·2 | 436 | 313·6 | 302·9 | 496 | 356·8 | 344·6 | 556 | 400·0 | 386·2 |
| 317 | 228·0 | 220·2 | 377 | 271·2 | 261·9 | 437 | 314·4 | 303·6 | 497 | 357·5 | 345·2 | 557 | 400·7 | 386·9 |
| 318 | 228·8 | 220·9 | 378 | 271·9 | 262·6 | 438 | 315·1 | 304·3 | 498 | 358·2 | 345·9 | 558 | 401·4 | 387·6 |
| 319 | 229·5 | 221·6 | 379 | 272·6 | 263·3 | 439 | 315·8 | 305·0 | 499 | 358·9 | 346·6 | 559 | 402·1 | 388·3 |
| 320 | 230·2 | 222·3 | 380 | 273·4 | 264·0 | 440 | 316·5 | 305·7 | 500 | 359·7 | 347·3 | 560 | 402·8 | 389·0 |
| 321 | 230·9 | 223·0 | 381 | 274·1 | 264·7 | 441 | 317·2 | 306·4 | 501 | 360·4 | 348·0 | 561 | 403·6 | 389·7 |
| 322 | 231·6 | 223·7 | 382 | 274·8 | 265·4 | 442 | 318·0 | 307·0 | 502 | 361·1 | 348·7 | 562 | 404·3 | 390·4 |
| 323 | 232·3 | 224·4 | 383 | 275·5 | 266·1 | 443 | 318·7 | 307·7 | 503 | 361·8 | 349·4 | 563 | 405·0 | 391·1 |
| 324 | 233·1 | 225·1 | 384 | 276·2 | 266·8 | 444 | 319·4 | 308·4 | 504 | 362·5 | 350·1 | 564 | 405·7 | 391·8 |
| 325 | 233·8 | 225·8 | 385 | 276·9 | 267·5 | 445 | 320·1 | 309·1 | 505 | 363·3 | 350·8 | 565 | 406·4 | 392·5 |
| 326 | 234·5 | 226·5 | 386 | 277·7 | 268·1 | 446 | 320·8 | 309·8 | 506 | 364·0 | 351·5 | 566 | 407·2 | 393·2 |
| 327 | 235·2 | 227·2 | 387 | 278·4 | 268·8 | 447 | 321·5 | 310·5 | 507 | 364·7 | 352·2 | 567 | 407·9 | 393·9 |
| 328 | 235·9 | 227·9 | 388 | 279·1 | 269·5 | 448 | 322·3 | 311·2 | 508 | 365·4 | 352·9 | 568 | 408·6 | 394·6 |
| 329 | 236·7 | 228·6 | 389 | 279·8 | 270·2 | 449 | 323·0 | 311·9 | 509 | 366·1 | 353·6 | 569 | 409·3 | 395·3 |
| 330 | 237·4 | 229·2 | 390 | 280·5 | 270·9 | 450 | 323·7 | 312·6 | 510 | 366·9 | 354·3 | 570 | 410·0 | 396·0 |
| 331 | 238·1 | 229·9 | 391 | 281·3 | 271·6 | 451 | 324·4 | 313·3 | 511 | 367·6 | 355·0 | 571 | 410·7 | 396·7 |
| 332 | 238·8 | 230·6 | 392 | 282·0 | 272·3 | 452 | 325·2 | 314·0 | 512 | 368·3 | 355·7 | 572 | 411·5 | 397·3 |
| 333 | 239·5 | 231·3 | 393 | 282·7 | 273·0 | 453 | 325·9 | 314·7 | 513 | 369·0 | 356·4 | 573 | 412·2 | 398·0 |
| 334 | 240·3 | 232·0 | 394 | 283·4 | 273·7 | 454 | 326·6 | 315·4 | 514 | 369·7 | 357·1 | 574 | 412·9 | 398·7 |
| 335 | 241·0 | 232·7 | 395 | 284·1 | 274·4 | 455 | 327·3 | 316·1 | 515 | 370·5 | 357·8 | 575 | 413·6 | 399·4 |
| 336 | 241·7 | 233·4 | 396 | 284·9 | 275·1 | 456 | 328·0 | 316·8 | 516 | 371·2 | 358·4 | 576 | 414·3 | 400·1 |
| 337 | 242·4 | 234·1 | 397 | 285·6 | 275·8 | 457 | 328·7 | 317·5 | 517 | 371·9 | 359·1 | 577 | 415·1 | 400·8 |
| 338 | 243·1 | 234·8 | 398 | 286·3 | 276·5 | 458 | 329·5 | 318·2 | 518 | 372·6 | 359·8 | 578 | 415·8 | 401·5 |
| 339 | 243·9 | 235·5 | 399 | 287·0 | 277·2 | 459 | 330·2 | 318·9 | 519 | 373·3 | 360·5 | 579 | 416·5 | 402·2 |
| 340 | 244·6 | 236·2 | 400 | 287·7 | 277·9 | 460 | 330·9 | 319·6 | 520 | 374·1 | 361·2 | 580 | 417·2 | 402·9 |
| 341 | 245·3 | 236·9 | 401 | 288·5 | 278·6 | 461 | 331·6 | 320·2 | 521 | 374·8 | 361·9 | 581 | 417·9 | 403·6 |
| 342 | 246·0 | 237·6 | 402 | 289·2 | 279·3 | 462 | 332·3 | 320·9 | 522 | 375·5 | 362·6 | 582 | 418·7 | 404·3 |
| 343 | 246·7 | 238·3 | 403 | 289·9 | 280·0 | 463 | 333·1 | 321·6 | 523 | 376·2 | 363·3 | 583 | 419·4 | 405·0 |
| 344 | 247·5 | 239·0 | 404 | 290·6 | 280·7 | 464 | 333·8 | 322·3 | 524 | 376·9 | 364·0 | 584 | 420·1 | 405·7 |
| 345 | 248·2 | 239·7 | 405 | 291·3 | 281·3 | 465 | 334·5 | 323·0 | 525 | 377·7 | 364·7 | 585 | 420·8 | 406·4 |
| 346 | 248·9 | 240·4 | 406 | 292·1 | 282·0 | 466 | 335·2 | 323·7 | 526 | 378·4 | 365·4 | 586 | 421·5 | 407·1 |
| 347 | 249·6 | 241·1 | 407 | 292·8 | 282·7 | 467 | 335·9 | 324·4 | 527 | 379·1 | 366·1 | 587 | 422·3 | 407·8 |
| 348 | 250·3 | 241·7 | 408 | 293·5 | 283·4 | 468 | 336·7 | 325·1 | 528 | 379·8 | 366·8 | 588 | 423·0 | 408·5 |
| 349 | 251·1 | 242·4 | 409 | 294·2 | 284·1 | 469 | 337·4 | 325·8 | 529 | 380·5 | 367·5 | 589 | 423·7 | 409·1 |
| 350 | 251·8 | 243·1 | 410 | 294·9 | 284·8 | 470 | 338·1 | 326·5 | 530 | 381·2 | 368·2 | 590 | 424·4 | 409·9 |
| 351 | 252·5 | 243·8 | 411 | 295·7 | 285·5 | 471 | 338·8 | 327·2 | 531 | 382·0 | 368·9 | 591 | 425·1 | 410·5 |
| 352 | 253·2 | 244·5 | 412 | 296·4 | 286·2 | 472 | 339·5 | 327·9 | 532 | 382·7 | 369·6 | 592 | 425·9 | 411·2 |
| 353 | 253·9 | 245·2 | 413 | 297·1 | 286·9 | 473 | 340·3 | 328·6 | 533 | 383·4 | 370·3 | 593 | 426·6 | 411·9 |
| 354 | 254·6 | 245·9 | 414 | 297·8 | 287·6 | 474 | 341·0 | 329·3 | 534 | 384·1 | 371·0 | 594 | 427·3 | 412·6 |
| 355 | 255·4 | 246·6 | 415 | 298·5 | 288·3 | 475 | 341·7 | 330·0 | 535 | 384·8 | 371·7 | 595 | 428·0 | 413·3 |
| 356 | 256·1 | 247·3 | 416 | 299·2 | 289·0 | 476 | 342·4 | 330·7 | 536 | 385·6 | 372·4 | 596 | 428·7 | 414·0 |
| 357 | 256·8 | 248·0 | 417 | 300·0 | 289·7 | 477 | 343·1 | 331·4 | 537 | 386·3 | 373·1 | 597 | 429·5 | 414·7 |
| 358 | 257·5 | 248·7 | 418 | 300·7 | 290·4 | 478 | 343·8 | 332·1 | 538 | 387·0 | 373·7 | 598 | 430·2 | 415·4 |
| 359 | 258·2 | 249·4 | 419 | 301·4 | 291·1 | 479 | 344·6 | 332·7 | 539 | 387·7 | 374·4 | 599 | 430·9 | 416·1 |
| 360 | 259·0 | 250·1 | 420 | 302·1 | 291·8 | 480 | 345·3 | 333·4 | 540 | 388·4 | 375·1 | 600 | 431·6 | 416·8 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

46° 3h 4m

## TRAVERSE TABLE TO DEGREES

45° 3h 0m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.7 | 0.7 | 61 | 43.1 | 43.1 | 121 | 85.6 | 85.6 | 181 | 128.0 | 128.0 | 241 | 170.4 | 170.4 |
| 2 | 1.4 | 1.4 | 62 | 43.8 | 43.8 | 122 | 86.3 | 86.3 | 182 | 128.7 | 128.7 | 242 | 171.1 | 171.1 |
| 3 | 2.1 | 2.1 | 63 | 44.5 | 44.5 | 123 | 87.0 | 87.0 | 183 | 129.4 | 129.4 | 243 | 171.8 | 171.8 |
| 4 | 2.8 | 2.8 | 64 | 45.3 | 45.3 | 124 | 87.7 | 87.7 | 184 | 130.1 | 130.1 | 244 | 172.5 | 172.5 |
| 5 | 3.5 | 3.5 | 65 | 46.0 | 46.0 | 125 | 88.4 | 88.4 | 185 | 130.8 | 130.8 | 245 | 173.2 | 173.2 |
| 6 | 4.2 | 4.2 | 66 | 46.7 | 46.7 | 126 | 89.1 | 89.1 | 186 | 131.5 | 131.5 | 246 | 173.9 | 173.9 |
| 7 | 4.9 | 4.9 | 67 | 47.4 | 47.4 | 127 | 89.8 | 89.8 | 187 | 132.2 | 132.2 | 247 | 174.7 | 174.7 |
| 8 | 5.7 | 5.7 | 68 | 48.1 | 48.1 | 128 | 90.5 | 90.5 | 188 | 132.9 | 132.9 | 248 | 175.4 | 175.4 |
| 9 | 6.4 | 6.4 | 69 | 48.8 | 48.8 | 129 | 91.2 | 91.2 | 189 | 133.6 | 133.6 | 249 | 176.1 | 176.1 |
| 10 | 7.1 | 7.1 | 70 | 49.5 | 49.5 | 130 | 91.9 | 91.9 | 190 | 134.4 | 134.4 | 250 | 176.8 | 176.8 |
| 11 | 7.8 | 7.8 | 71 | 50.2 | 50.2 | 131 | 92.6 | 92.6 | 191 | 135.1 | 135.1 | 251 | 177.5 | 177.5 |
| 12 | 8.5 | 8.5 | 72 | 50.9 | 50.9 | 132 | 93.3 | 93.3 | 192 | 135.8 | 135.8 | 252 | 178.2 | 178.2 |
| 13 | 9.2 | 9.2 | 73 | 51.6 | 51.6 | 133 | 94.0 | 94.0 | 193 | 136.5 | 136.5 | 253 | 178.9 | 178.9 |
| 14 | 9.9 | 9.9 | 74 | 52.3 | 52.3 | 134 | 94.8 | 94.8 | 194 | 137.2 | 137.2 | 254 | 179.6 | 179.6 |
| 15 | 10.6 | 10.6 | 75 | 53.0 | 53.0 | 135 | 95.5 | 95.5 | 195 | 137.9 | 137.9 | 255 | 180.3 | 180.3 |
| 16 | 11.3 | 11.3 | 76 | 53.7 | 53.7 | 136 | 96.2 | 96.2 | 196 | 138.6 | 138.6 | 256 | 181.0 | 181.0 |
| 17 | 12.0 | 12.0 | 77 | 54.4 | 54.4 | 137 | 96.9 | 96.9 | 197 | 139.3 | 139.3 | 257 | 181.7 | 181.7 |
| 18 | 12.7 | 12.7 | 78 | 55.2 | 55.2 | 138 | 97.6 | 97.6 | 198 | 140.0 | 140.0 | 258 | 182.4 | 182.4 |
| 19 | 13.4 | 13.4 | 79 | 55.9 | 55.9 | 139 | 98.3 | 98.3 | 199 | 140.7 | 140.7 | 259 | 183.1 | 183.1 |
| 20 | 14.1 | 14.1 | 80 | 56.6 | 56.6 | 140 | 99.0 | 99.0 | 200 | 141.4 | 141.4 | 260 | 183.8 | 183.8 |
| 21 | 14.8 | 14.8 | 81 | 57.3 | 57.3 | 141 | 99.7 | 99.7 | 201 | 142.1 | 142.1 | 261 | 184.6 | 184.6 |
| 22 | 15.6 | 15.6 | 82 | 58.0 | 58.0 | 142 | 100.4 | 100.4 | 202 | 142.8 | 142.8 | 262 | 185.3 | 185.3 |
| 23 | 16.3 | 16.3 | 83 | 58.7 | 58.7 | 143 | 101.1 | 101.1 | 203 | 143.5 | 143.5 | 263 | 186.0 | 186.0 |
| 24 | 17.0 | 17.0 | 84 | 59.4 | 59.4 | 144 | 101.8 | 101.8 | 204 | 144.2 | 144.2 | 264 | 186.7 | 186.7 |
| 25 | 17.7 | 17.7 | 85 | 60.1 | 60.1 | 145 | 102.5 | 102.5 | 205 | 145.0 | 145.0 | 265 | 187.4 | 187.4 |
| 26 | 18.4 | 18.4 | 86 | 60.8 | 60.8 | 146 | 103.2 | 103.2 | 206 | 145.7 | 145.7 | 266 | 188.1 | 188.1 |
| 27 | 19.1 | 19.1 | 87 | 61.5 | 61.5 | 147 | 103.9 | 103.9 | 207 | 146.4 | 146.4 | 267 | 188.8 | 188.8 |
| 28 | 19.8 | 19.8 | 88 | 62.2 | 62.2 | 148 | 104.7 | 104.7 | 208 | 147.1 | 147.1 | 268 | 189.5 | 189.5 |
| 29 | 20.5 | 20.5 | 89 | 62.9 | 62.9 | 149 | 105.4 | 105.4 | 209 | 147.8 | 147.8 | 269 | 190.2 | 190.2 |
| 30 | 21.2 | 21.2 | 90 | 63.6 | 63.6 | 150 | 106.1 | 106.1 | 210 | 148.5 | 148.5 | 270 | 190.9 | 190.9 |
| 31 | 21.9 | 21.9 | 91 | 64.3 | 64.3 | 151 | 106.8 | 106.8 | 211 | 149.2 | 149.2 | 271 | 191.6 | 191.6 |
| 32 | 22.6 | 22.6 | 92 | 65.1 | 65.1 | 152 | 107.5 | 107.5 | 212 | 149.9 | 149.9 | 272 | 192.3 | 192.3 |
| 33 | 23.3 | 23.3 | 93 | 65.8 | 65.8 | 153 | 108.2 | 108.2 | 213 | 150.6 | 150.6 | 273 | 193.0 | 193.0 |
| 34 | 24.0 | 24.0 | 94 | 66.5 | 66.5 | 154 | 108.9 | 108.9 | 214 | 151.3 | 151.3 | 274 | 193.7 | 193.7 |
| 35 | 24.7 | 24.7 | 95 | 67.2 | 67.2 | 155 | 109.6 | 109.6 | 215 | 152.0 | 152.0 | 275 | 194.5 | 194.5 |
| 36 | 25.5 | 25.5 | 96 | 67.9 | 67.9 | 156 | 110.3 | 110.3 | 216 | 152.7 | 152.7 | 276 | 195.2 | 195.2 |
| 37 | 26.2 | 26.2 | 97 | 68.6 | 68.6 | 157 | 111.0 | 111.0 | 217 | 153.4 | 153.4 | 277 | 195.9 | 195.9 |
| 38 | 26.9 | 26.9 | 98 | 69.3 | 69.3 | 158 | 111.7 | 111.7 | 218 | 154.1 | 154.1 | 278 | 196.6 | 196.6 |
| 39 | 27.6 | 27.6 | 99 | 70.0 | 70.0 | 159 | 112.4 | 112.4 | 219 | 154.9 | 154.9 | 279 | 197.3 | 197.3 |
| 40 | 28.3 | 28.3 | 100 | 70.7 | 70.7 | 160 | 113.1 | 113.1 | 220 | 155.6 | 155.6 | 280 | 198.0 | 198.0 |
| 41 | 29.0 | 29.0 | 101 | 71.4 | 71.4 | 161 | 113.8 | 113.8 | 221 | 156.3 | 156.3 | 281 | 198.7 | 198.7 |
| 42 | 29.7 | 29.7 | 102 | 72.1 | 72.1 | 162 | 114.6 | 114.6 | 222 | 157.0 | 157.0 | 282 | 199.4 | 199.4 |
| 43 | 30.4 | 30.4 | 103 | 72.8 | 72.8 | 163 | 115.3 | 115.3 | 223 | 157.7 | 157.7 | 283 | 200.1 | 200.1 |
| 44 | 31.1 | 31.1 | 104 | 73.5 | 73.5 | 164 | 116.0 | 116.0 | 224 | 158.4 | 158.4 | 284 | 200.8 | 200.8 |
| 45 | 31.8 | 31.8 | 105 | 74.2 | 74.2 | 165 | 116.7 | 116.7 | 225 | 159.1 | 159.1 | 285 | 201.5 | 201.5 |
| 46 | 32.5 | 32.5 | 106 | 75.0 | 75.0 | 166 | 117.4 | 117.4 | 226 | 159.8 | 159.8 | 286 | 202.2 | 202.2 |
| 47 | 33.2 | 33.2 | 107 | 75.7 | 75.7 | 167 | 118.1 | 118.1 | 227 | 160.5 | 160.5 | 287 | 202.9 | 202.9 |
| 48 | 33.9 | 33.9 | 108 | 76.4 | 76.4 | 168 | 118.8 | 118.8 | 228 | 161.2 | 161.2 | 288 | 203.6 | 203.6 |
| 49 | 34.6 | 34.6 | 109 | 77.1 | 77.1 | 169 | 119.5 | 119.5 | 229 | 161.9 | 161.9 | 289 | 204.4 | 204.4 |
| 50 | 35.4 | 35.4 | 110 | 77.8 | 77.8 | 170 | 120.2 | 120.2 | 230 | 162.6 | 162.6 | 290 | 205.1 | 205.1 |
| 51 | 36.1 | 36.1 | 111 | 78.5 | 78.5 | 171 | 120.9 | 120.9 | 231 | 163.3 | 163.3 | 291 | 205.8 | 205.8 |
| 52 | 36.8 | 36.8 | 112 | 79.2 | 79.2 | 172 | 121.6 | 121.6 | 232 | 164.0 | 164.0 | 292 | 206.5 | 206.5 |
| 53 | 37.5 | 37.5 | 113 | 79.9 | 79.9 | 173 | 122.3 | 122.3 | 233 | 164.8 | 164.8 | 293 | 207.2 | 207.2 |
| 54 | 38.2 | 38.2 | 114 | 80.6 | 80.6 | 174 | 123.0 | 123.0 | 234 | 165.5 | 165.5 | 294 | 207.9 | 207.9 |
| 55 | 38.9 | 38.9 | 115 | 81.3 | 81.3 | 175 | 123.7 | 123.7 | 235 | 166.2 | 166.2 | 295 | 208.6 | 208.6 |
| 56 | 39.6 | 39.6 | 116 | 82.0 | 82.0 | 176 | 124.5 | 124.5 | 236 | 166.9 | 166.9 | 296 | 209.3 | 209.3 |
| 57 | 40.3 | 40.3 | 117 | 82.7 | 82.7 | 177 | 125.2 | 125.2 | 237 | 167.6 | 167.6 | 297 | 210.0 | 210.0 |
| 58 | 41.0 | 41.0 | 118 | 83.4 | 83.4 | 178 | 125.9 | 125.9 | 238 | 168.3 | 168.3 | 298 | 210.7 | 210.7 |
| 59 | 41.7 | 41.7 | 119 | 84.1 | 84.1 | 179 | 126.6 | 126.6 | 239 | 169.0 | 169.0 | 299 | 211.4 | 211.4 |
| 60 | 42.4 | 42.4 | 120 | 84.9 | 84.9 | 180 | 127.3 | 127.3 | 240 | 169.7 | 169.7 | 300 | 212.1 | 212.1 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

45° 3h 0m

## TRAVERSE TABLE TO DEGREES

45° 8h 0m

| Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. | Dist. | D. Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 212·8 | 212·8 | 361 | 255·3 | 255·3 | 421 | 297·7 | 297·7 | 481 | 340·1 | 340·1 | 541 | 382·5 | 382·5 |
| 302 | 213·5 | 213·5 | 362 | 256·0 | 256·0 | 422 | 298·4 | 298·4 | 482 | 340·8 | 340·8 | 542 | 383·2 | 383·2 |
| 303 | 214·3 | 214·3 | 363 | 256·7 | 256·7 | 423 | 299·1 | 299·1 | 483 | 341·5 | 341·5 | 543 | 383·9 | 383·9 |
| 304 | 215·0 | 215·0 | 364 | 257·4 | 257·4 | 424 | 299·8 | 299·8 | 484 | 342·2 | 342·2 | 544 | 384·7 | 384·7 |
| 305 | 215·7 | 215·7 | 365 | 258·1 | 258·1 | 425 | 300·5 | 300·5 | 485 | 342·9 | 342·9 | 545 | 385·4 | 385·4 |
| 306 | 216·4 | 216·4 | 366 | 258·8 | 258·8 | 426 | 301·2 | 301·2 | 486 | 343·6 | 343·6 | 546 | 386·1 | 386·1 |
| 307 | 217·1 | 217·1 | 367 | 259·5 | 259·5 | 427 | 301·9 | 301·9 | 487 | 344·3 | 344·3 | 547 | 386·8 | 386·8 |
| 308 | 217·8 | 217·8 | 368 | 260·2 | 260·2 | 428 | 302·6 | 302·6 | 488 | 345·1 | 345·1 | 548 | 387·5 | 387·5 |
| 309 | 218·5 | 218·5 | 369 | 260·9 | 260·9 | 429 | 303·4 | 303·4 | 489 | 345·8 | 345·8 | 549 | 388·2 | 388·2 |
| 310 | 219·2 | 219·2 | 370 | 261·6 | 261·6 | 430 | 304·1 | 304·1 | 490 | 346·5 | 346·5 | 550 | 388·9 | 388·9 |
| 311 | 219·9 | 219·9 | 371 | 262·3 | 262·3 | 431 | 304·8 | 304·8 | 491 | 347·2 | 347·2 | 551 | 389·6 | 389·6 |
| 312 | 220·6 | 220·6 | 372 | 263·0 | 263·0 | 432 | 305·5 | 305·5 | 492 | 347·9 | 347·9 | 552 | 390·3 | 390·3 |
| 313 | 221·3 | 221·3 | 373 | 263·8 | 263·8 | 433 | 306·2 | 306·2 | 493 | 348·6 | 348·6 | 553 | 391·0 | 391·0 |
| 314 | 222·0 | 222·0 | 374 | 264·5 | 264·5 | 434 | 306·9 | 306·9 | 494 | 349·3 | 349·3 | 554 | 391·7 | 391·7 |
| 315 | 222·7 | 222·7 | 375 | 265·2 | 265·2 | 435 | 307·6 | 307·6 | 495 | 350·0 | 350·0 | 555 | 392·4 | 392·4 |
| 316 | 223·4 | 223·4 | 376 | 265·9 | 265·9 | 436 | 308·3 | 308·3 | 496 | 350·7 | 350·7 | 556 | 393·1 | 393·1 |
| 317 | 224·2 | 224·2 | 377 | 266·6 | 266·6 | 437 | 309·0 | 309·0 | 497 | 351·4 | 351·4 | 557 | 393·9 | 393·9 |
| 318 | 224·9 | 224·9 | 378 | 267·3 | 267·3 | 438 | 309·7 | 309·7 | 498 | 352·1 | 352·1 | 558 | 394·6 | 394·6 |
| 319 | 225·6 | 225·6 | 379 | 268·0 | 268·0 | 439 | 310·4 | 310·4 | 499 | 352·8 | 352·8 | 559 | 395·3 | 395·3 |
| 320 | 226·3 | 226·3 | 380 | 268·7 | 268·7 | 440 | 311·1 | 311·1 | 500 | 353·5 | 353·5 | 560 | 396·0 | 396·0 |
| 321 | 227·0 | 227·0 | 381 | 269·4 | 269·4 | 441 | 311·8 | 311·8 | 501 | 354·3 | 354·3 | 561 | 396·7 | 396·7 |
| 322 | 227·7 | 227·7 | 382 | 270·1 | 270·1 | 442 | 312·5 | 312·5 | 502 | 355·0 | 355·0 | 562 | 397·4 | 397·4 |
| 323 | 228·4 | 228·4 | 383 | 270·8 | 270·8 | 443 | 313·3 | 313·3 | 503 | 355·7 | 355·7 | 563 | 398·1 | 398·1 |
| 324 | 229·1 | 229·1 | 384 | 271·5 | 271·5 | 444 | 314·0 | 314·0 | 504 | 356·4 | 356·4 | 564 | 398·8 | 398·8 |
| 325 | 229·8 | 229·8 | 385 | 272·2 | 272·2 | 445 | 314·7 | 314·7 | 505 | 357·1 | 357·1 | 565 | 399·5 | 399·5 |
| 326 | 230·5 | 230·5 | 386 | 272·9 | 272·9 | 446 | 315·4 | 315·4 | 506 | 357·8 | 357·8 | 566 | 400·2 | 400·2 |
| 327 | 231·2 | 231·2 | 387 | 273·7 | 273·7 | 447 | 316·1 | 316·1 | 507 | 358·5 | 358·5 | 567 | 400·9 | 400·9 |
| 328 | 231·9 | 231·9 | 388 | 274·4 | 274·4 | 448 | 316·8 | 316·8 | 508 | 359·2 | 359·2 | 568 | 401·6 | 401·6 |
| 329 | 232·6 | 232·6 | 389 | 275·1 | 275·1 | 449 | 317·5 | 317·5 | 509 | 359·9 | 359·9 | 569 | 402·3 | 402·3 |
| 330 | 233·3 | 233·3 | 390 | 275·8 | 275·8 | 450 | 318·2 | 318·2 | 510 | 360·6 | 360·6 | 570 | 403·0 | 403·0 |
| 331 | 234·1 | 234·1 | 391 | 276·5 | 276·5 | 451 | 318·9 | 318·9 | 511 | 361·3 | 361·3 | 571 | 403·8 | 403·8 |
| 332 | 234·8 | 234·8 | 392 | 277·2 | 277·2 | 452 | 319·6 | 319·6 | 512 | 362·0 | 362·0 | 572 | 404·5 | 404·5 |
| 333 | 235·5 | 235·5 | 393 | 277·9 | 277·9 | 453 | 320·3 | 320·3 | 513 | 362·7 | 362·7 | 573 | 405·2 | 405·2 |
| 334 | 236·2 | 236·2 | 394 | 278·6 | 278·6 | 454 | 321·0 | 321·0 | 514 | 363·5 | 363·5 | 574 | 405·9 | 405·9 |
| 335 | 236·9 | 236·9 | 395 | 279·3 | 279·3 | 455 | 321·7 | 321·7 | 515 | 364·2 | 364·2 | 575 | 406·6 | 406·6 |
| 336 | 237·6 | 237·6 | 396 | 280·0 | 280·0 | 456 | 322·4 | 322·4 | 516 | 364·9 | 364·9 | 576 | 407·3 | 407·3 |
| 337 | 238·3 | 238·3 | 397 | 280·7 | 280·7 | 457 | 323·2 | 323·2 | 517 | 365·6 | 365·6 | 577 | 408·0 | 408·0 |
| 338 | 239·0 | 239·0 | 398 | 281·4 | 281·4 | 458 | 323·9 | 323·9 | 518 | 366·3 | 366·3 | 578 | 408·7 | 408·7 |
| 339 | 239·7 | 239·7 | 399 | 282·1 | 282·1 | 459 | 324·6 | 324·6 | 519 | 367·0 | 367·0 | 579 | 409·4 | 409·4 |
| 340 | 240·4 | 240·4 | 400 | 282·8 | 282·8 | 460 | 325·3 | 325·3 | 520 | 367·7 | 367·7 | 580 | 410·1 | 410·1 |
| 341 | 241·1 | 241·1 | 401 | 283·6 | 283·6 | 461 | 326·0 | 326·0 | 521 | 368·4 | 368·4 | 581 | 410·8 | 410·8 |
| 342 | 241·8 | 241·8 | 402 | 284·3 | 284·3 | 462 | 326·7 | 326·7 | 522 | 369·1 | 369·1 | 582 | 411·5 | 411·5 |
| 343 | 242·5 | 242·5 | 403 | 285·0 | 285·0 | 463 | 327·4 | 327·4 | 523 | 369·8 | 369·8 | 583 | 412·2 | 412·2 |
| 344 | 243·2 | 243·2 | 404 | 285·7 | 285·7 | 464 | 328·1 | 328·1 | 524 | 370·5 | 370·5 | 584 | 412·9 | 412·9 |
| 345 | 244·0 | 244·0 | 405 | 286·4 | 286·4 | 465 | 328·8 | 328·8 | 525 | 371·2 | 371·2 | 585 | 413·7 | 413·7 |
| 346 | 244·7 | 244·7 | 406 | 287·1 | 287·1 | 466 | 329·5 | 329·5 | 526 | 371·9 | 371·9 | 586 | 414·4 | 414·4 |
| 347 | 245·4 | 245·4 | 407 | 287·8 | 287·8 | 467 | 330·2 | 330·2 | 527 | 372·6 | 372·6 | 587 | 415·1 | 415·1 |
| 348 | 246·1 | 246·1 | 408 | 288·5 | 288·5 | 468 | 330·9 | 330·9 | 528 | 373·4 | 373·4 | 588 | 415·8 | 415·8 |
| 349 | 246·8 | 246·8 | 409 | 289·2 | 289·2 | 469 | 331·6 | 331·6 | 529 | 374·1 | 374·1 | 589 | 416·5 | 416·5 |
| 350 | 247·5 | 247·5 | 410 | 289·9 | 289·9 | 470 | 332·3 | 332·3 | 530 | 374·8 | 374·8 | 590 | 417·2 | 417·2 |
| 351 | 248·2 | 248·2 | 411 | 290·6 | 290·6 | 471 | 333·1 | 333·1 | 531 | 375·5 | 375·5 | 591 | 417·9 | 417·9 |
| 352 | 248·9 | 248·9 | 412 | 291·3 | 291·3 | 472 | 333·8 | 333·8 | 532 | 376·2 | 376·2 | 592 | 418·6 | 418·6 |
| 353 | 249·6 | 249·6 | 413 | 292·0 | 292·0 | 473 | 334·5 | 334·5 | 533 | 376·9 | 376·9 | 593 | 419·3 | 419·3 |
| 354 | 250·3 | 250·3 | 414 | 292·7 | 292·7 | 474 | 335·2 | 335·2 | 534 | 377·6 | 377·6 | 594 | 420·0 | 420·0 |
| 355 | 251·0 | 251·0 | 415 | 293·5 | 293·5 | 475 | 335·9 | 335·9 | 535 | 378·3 | 378·3 | 595 | 420·7 | 420·7 |
| 356 | 251·7 | 251·7 | 416 | 294·2 | 294·2 | 476 | 336·6 | 336·6 | 536 | 379·0 | 379·0 | 596 | 421·4 | 421·4 |
| 357 | 252·4 | 252·4 | 417 | 294·9 | 294·9 | 477 | 337·3 | 337·3 | 537 | 379·7 | 379·7 | 597 | 422·1 | 422·1 |
| 358 | 253·1 | 253·1 | 418 | 295·6 | 295·6 | 478 | 338·0 | 338·0 | 538 | 380·4 | 380·4 | 598 | 422·8 | 422·8 |
| 359 | 253·9 | 253·9 | 419 | 296·3 | 296·3 | 479 | 338·7 | 338·7 | 539 | 381·1 | 381·1 | 599 | 423·6 | 423·6 |
| 360 | 254·6 | 254·6 | 420 | 297·0 | 297·0 | 480 | 339·4 | 339·4 | 540 | 381·8 | 381·8 | 600 | 424·3 | 424·3 |
| Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. | Dist. | Dep. | D. Lat. |

45° 8h 0m

## DEPARTURE AND CORRESPONDING DIFFERENCE OF LONGITUDE

| Lat. | Departure | | | | | | | | | | Parts | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | D to 1° | 15′ | 30′ | 45′ |
| 0° | 1·00 | 2·00 | 3·00 | 4·00 | 5·00 | 6·00 | 7·00 | 8·00 | 9·00 | 10·00 | 0·04 | 0·01 | 0·02 | 0·03 |
| 4 | 1·00 | 2·00 | 3·01 | 4·01 | 5·01 | 6·01 | 7·02 | 8·02 | 9·02 | 10·02 | 0·08 | 0·02 | 0·04 | 0·06 |
| 6 | 1·01 | 2·01 | 3·02 | 4·02 | 5·03 | 6·03 | 7·04 | 8·04 | 9·05 | 10·06 | 0·12 | 0·03 | 0·06 | 0·09 |
| 8 | 1·01 | 2·02 | 3·03 | 4·04 | 5·05 | 6·06 | 7·07 | 8·08 | 9·09 | 10·10 | 0·14 | 0·03 | 0·07 | 0·10 |
| 10 | 1·02 | 2·03 | 3·05 | 4·06 | 5·08 | 6·09 | 7·11 | 8·11 | 9·14 | 10·15 | 0·16 | 0·04 | 0·08 | 0·12 |
| 12 | 1·02 | 2·04 | 3·07 | 4·09 | 5·11 | 6·13 | 7·16 | 8·18 | 9·20 | 10·22 | 0·18 | 0·04 | 0·08 | 0·13 |
| 14 | 1·03 | 2·06 | 3·09 | 4·12 | 5·15 | 6·18 | 7·21 | 8·24 | 9·28 | 10·31 | 0·20 | 0·05 | 0·10 | 0·15 |
| 15 | 1·04 | 2·07 | 3·11 | 4·14 | 5·18 | 6·21 | 7·25 | 8·28 | 9·32 | 10·35 | 0·22 | 0.05 | 0·11 | 0·16 |
| 16 | 1·04 | 2·08 | 3·12 | 4·16 | 5·20 | 6·24 | 7·28 | 8·32 | 9·36 | 10·40 | 0·24 | 0·06 | 0·12 | 0·18 |
| 17 | 1·05 | 2·09 | 3·14 | 4·18 | 5·23 | 6·27 | 7·32 | 8·37 | 9·41 | 10·46 | 0·26 | 0·06 | 0·13 | 0·19 |
| 18 | 1·05 | 2·10 | 3·15 | 4·21 | 5·26 | 6·31 | 7·36 | 8·41 | 9·46 | 10·51 | 0·28 | 0·07 | 0·14 | 0·21 |
| 19 | 1·06 | 2·12 | 3·17 | 4·23 | 5·29 | 6·35 | 7·40 | 8·46 | 9·52 | 10·58 | 0·30 | 0·07 | 0·15 | 0·22 |
| 20 | 1·06 | 2·13 | 3·19 | 4·26 | 5·32 | 6·39 | 7·45 | 8·51 | 9·58 | 10·64 | 0·32 | 0·08 | 0·16 | 0·24 |
| 21 | 1·07 | 2·14 | 3·21 | 4·28 | 5·36 | 6·43 | 7·50 | 8·57 | 9·64 | 10·71 | 0·34 | 0·08 | 0·17 | 0·25 |
| 22 | 1·08 | 2·16 | 3·24 | 4·31 | 5·39 | 6·47 | 7·55 | 8·63 | 9·71 | 10·79 | 0·36 | 0·09 | 0·18 | 0·27 |
| 23 | 1·09 | 2·17 | 3·26 | 4·35 | 5·43 | 6·52 | 7·60 | 8·69 | 9·78 | 10·86 | 0·38 | 0·09 | 0·19 | 0·28 |
| 24 | 1·09 | 2·19 | 3·28 | 4·38 | 5·47 | 6·57 | 7·66 | 8·76 | 9·85 | 10·95 | 0·40 | 0·10 | 0·20 | 0·30 |
| 25 | 1·10 | 2·21 | 3·31 | 4·41 | 5·52 | 6·62 | 7·72 | 8·83 | 9·93 | 11·03 | 0·42 | 0·10 | 0·21 | 0·31 |
| 26 | 1·11 | 2·23 | 3·34 | 4·45 | 5·56 | 6·68 | 7·79 | 8·90 | 10·01 | 11·13 | 0·44 | 0·11 | 0·22 | 0·33 |
| 27 | 1·12 | 2·24 | 3·37 | 4·49 | 5·61 | 6·73 | 7·86 | 8·98 | 10·10 | 11·22 | 0·46 | 0·11 | 0·23 | 0·34 |
| 28 | 1·13 | 2·27 | 3·40 | 4·53 | 5·66 | 6·80 | 7·93 | 9·06 | 10·19 | 11·33 | 0·48 | 0·12 | 0·24 | 0·36 |
| 29 | 1·14 | 2·29 | 3·43 | 4·57 | 5·72 | 6·86 | 8·00 | 9·15 | 10·29 | 11·43 | 0·50 | 0·12 | 0·25 | 0·37 |
| 30 | 1·15 | 2·31 | 3·46 | 4·62 | 5·77 | 6·93 | 8·08 | 9·24 | 10·39 | 11·55 | 0·52 | 0·13 | 0·26 | 0·39 |
| 31 | 1·17 | 2·33 | 3·50 | 4·67 | 5·83 | 7·00 | 8·17 | 9·33 | 10·50 | 11·67 | 0·54 | 0·13 | 0·27 | 0·40 |
| 32 | 1·18 | 2·36 | 3·54 | 4·72 | 5·90 | 7·08 | 8·25 | 9·43 | 10·61 | 11·79 | 0·56 | 0·13 | 0·28 | 0·41 |
| 33 | 1·19 | 2·38 | 3·58 | 4·77 | 5·96 | 7·15 | 8·35 | 9·54 | 10·73 | 11·92 | 0·58 | 0·14 | 0·29 | 0·43 |
| 34 | 1·21 | 2·41 | 3·62 | 4·82 | 6·03 | 7·24 | 8·44 | 9·65 | 10·86 | 12·06 | 0·60 | 0·15 | 0·30 | 0·45 |
| 35 | 1·22 | 2·44 | 3·66 | 4·88 | 6·10 | 7·32 | 8·54 | 9·76 | 10·99 | 12·21 | 0·62 | 0·15 | 0·31 | 0·46 |
| 36 | 1·24 | 2·47 | 3·71 | 4·94 | 6·18 | 7·42 | 8·65 | 9·89 | 11·12 | 12·36 | 0·64 | 0·16 | 0·32 | 0·48 |
| 37 | 1·25 | 2·50 | 3·76 | 5·01 | 6·26 | 7·51 | 8·76 | 10·02 | 11·27 | 12·52 | 0·66 | 0·16 | 0·33 | 0·49 |
| 38 | 1·27 | 2·54 | 3·81 | 5·08 | 6·35 | 7·61 | 8·88 | 10·15 | 11·42 | 12·69 | 0·68 | 0·17 | 0·34 | 0·51 |
| 39 | 1·29 | 2·57 | 3·86 | 5·15 | 6·43 | 7·72 | 9·01 | 10·29 | 11·58 | 12·87 | 0·70 | 0·17 | 0·35 | 0·52 |
| 40 | 1·31 | 2·61 | 3·92 | 5·22 | 6·53 | 7·83 | 9·14 | 10·44 | 11·75 | 13·05 | 0·72 | 0·18 | 0·36 | 0·54 |
| 41 | 1·33 | 2·65 | 3·98 | 5·30 | 6·63 | 7·95 | 9·28 | 10·60 | 11·93 | 13·25 | 0·74 | 0·18 | 0·37 | 0·55 |
| 42 | 1·35 | 2·69 | 4·04 | 5·38 | 6·73 | 8·07 | 9·42 | 10·77 | 12·11 | 13·46 | 0·76 | 0·19 | 0·38 | 0·57 |
| 43 | 1·37 | 2·73 | 4·10 | 5·47 | 6·84 | 8·20 | 9·57 | 10·94 | 12·31 | 13·67 | 0·78 | 0·19 | 0·39 | 0·58 |
| 44 | 1·39 | 2·78 | 4·17 | 5·56 | 6·95 | 8·34 | 9·73 | 11·12 | 12·51 | 13·90 | 0·80 | 0·20 | 0·40 | 0·60 |
| 45 | 1·41 | 2·83 | 4·24 | 5·66 | 7·07 | 8·49 | 9·90 | 11·31 | 12·73 | 14·14 | 0·82 | 0·20 | 0·41 | 0·61 |
| 46 | 1·44 | 2·88 | 4·32 | 5·76 | 7·20 | 8·64 | 10·08 | 11·52 | 12·96 | 14·40 | 0·84 | 0·21 | 0·42 | 0·63 |
| 47 | 1·47 | 2·93 | 4·40 | 5·87 | 7·33 | 8·80 | 10·26 | 11·73 | 13·20 | 14·66 | 0·86 | 0·21 | 0·43 | 0·64 |
| 48 | 1·49 | 2·99 | 4·48 | 5·98 | 7·47 | 8·97 | 10·46 | 11·96 | 13·45 | 14·94 | 0·88 | 0·22 | 0·44 | 0·66 |
| 49 | 1·52 | 3·05 | 4·57 | 6·10 | 7·62 | 9·15 | 10·67 | 12·19 | 13·72 | 15·24 | 0·90 | 0·22 | 0·45 | 0·67 |
| 50 | 1·56 | 3·11 | 4·67 | 6·22 | 7·78 | 9·33 | 10·89 | 12·45 | 14·00 | 15·56 | 0·92 | 0·23 | 0·46 | 0·69 |
| 51 | 1·59 | 3·18 | 4·77 | 6·36 | 7·95 | 9·53 | 11·12 | 12·71 | 14·30 | 15·89 | 0·94 | 0·23 | 0·47 | 0·70 |
| 52 | 1·62 | 3·25 | 4·87 | 6·50 | 8·12 | 9·75 | 11·37 | 12·99 | 14·62 | 16·24 | 0·96 | 0·24 | 0·48 | 0·72 |
| 53 | 1·66 | 3·32 | 4·98 | 6·65 | 8·31 | 9·97 | 11·63 | 13·29 | 14·95 | 16·62 | 0·98 | 0·24 | 0·49 | 0·73 |
| 54 | 1·70 | 3·40 | 5·10 | 6·81 | 8·51 | 10·21 | 11·91 | 13·61 | 15·31 | 17·01 | 1·00 | 0·25 | 0·50 | 0·75 |
| 55 | 1·74 | 3·49 | 5·23 | 6·97 | 8·72 | 10·46 | 12·20 | 13·95 | 15·69 | 17·43 | 1·02 | 0·25 | 0·51 | 0·76 |
| 56 | 1·79 | 3·58 | 5·36 | 7·15 | 8·94 | 10·73 | 12·52 | 14·31 | 16·09 | 17·88 | 1·04 | 0·26 | 0·52 | 0·78 |
| 57 | 1·84 | 3·67 | 5·51 | 7·34 | 9·18 | 11·02 | 12·85 | 14·67 | 16·52 | 18·36 | 1·06 | 0·26 | 0·53 | 0·79 |
| 58 | 1·89 | 3·77 | 5·66 | 7·55 | 9·44 | 11·32 | 13·21 | 15·10 | 16·98 | 18·87 | 1·08 | 0·27 | 0·54 | 0·81 |
| 59 | 1·94 | 3·88 | 5·82 | 7·77 | 9·71 | 11·65 | 13·59 | 15·53 | 17·47 | 19·42 | 1·10 | 0·27 | 0·55 | 0·82 |
| 60 | 2·00 | 4·00 | 6·00 | 8·00 | 10·00 | 12·00 | 14·00 | 16·00 | 18·00 | 20·00 | 1·12 | 0·28 | 0·56 | 0·84 |
| 61 | 2·06 | 4·13 | 6·19 | 8·25 | 10·31 | 12·38 | 14·44 | 16·50 | 18·56 | 20·63 | 1·14 | 0·28 | 0·57 | 0·85 |
| 62 | 2·13 | 4·26 | 6·39 | 8·52 | 10·65 | 12·78 | 14·91 | 17·04 | 19·17 | 21·30 | 1·16 | 0·29 | 0·58 | 0·87 |
| 63 | 2·20 | 4·41 | 6·61 | 8·81 | 11·01 | 13·22 | 15·42 | 17·62 | 19·82 | 22·03 | 1·18 | 0·29 | 0·59 | 0·88 |
| 64 | 2·28 | 4·56 | 6·84 | 9·12 | 11·41 | 13·69 | 15·97 | 18·25 | 20·53 | 22·81 | 1·20 | 0·30 | 0·60 | 0·90 |
| 65 | 2·37 | 4·73 | 7·10 | 9·46 | 11·83 | 14·20 | 16·56 | 18·93 | 21·30 | 23·66 | 1·22 | 0·30 | 0·61 | 0·91 |
| 66 | 2·46 | 4·92 | 7·38 | 9·83 | 12·29 | 14·75 | 17·21 | 19·67 | 22·13 | 24·59 | 1·24 | 0·31 | 0·62 | 0·93 |
| 67 | 2·56 | 5·12 | 7·68 | 10·24 | 12·80 | 15·36 | 17·92 | 20·47 | 23·03 | 25·59 | 1·26 | 0·31 | 0·63 | 0·94 |
| 68 | 2·67 | 5·34 | 8·01 | 10·68 | 13·35 | 16·02 | 18·69 | 21·36 | 24·03 | 26·69 | 1·28 | 0·32 | 0·64 | 0·96 |
| 69 | 2·79 | 5·58 | 8·37 | 11·16 | 13·95 | 16·74 | 19·53 | 22·32 | 25·11 | 27·90 | 1·30 | 0·32 | 0·65 | 0·97 |

## DIFFERENCE OF LONGITUDE AND CORRESPONDING DEPARTURE

| Lat. | Difference of Longitude | | | | | | | | | | Parts | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | D to 1° | 15′ | 30′ | 45′ |
| 0° | 1·00 | 2·00 | 3·00 | 4·00 | 5·00 | 6·00 | 7·00 | 8·00 | 9·00 | 10·00 | 0·01 | 0·00 | 0·00 | 0·01 |
| 4 | 1·00 | 2·00 | 2·99 | 3·99 | 4·99 | 5·99 | 6·98 | 7·98 | 8·98 | 9·98 | 0·02 | 0·00 | 0·01 | 0·02 |
| 6 | 0·99 | 1·99 | 2·98 | 3·98 | 4·97 | 5·97 | 6·96 | 7·96 | 8·95 | 9·95 | 0·03 | 0·01 | 0·02 | 0·02 |
| 8 | 0·99 | 1·98 | 2·97 | 3·96 | 4·95 | 5·94 | 6·93 | 7·92 | 8·91 | 9·90 | 0·04 | 0·01 | 0·02 | 0·03 |
| 10 | 0·98 | 1·97 | 2·95 | 3·94 | 4·92 | 5·91 | 6·89 | 7·88 | 8·86 | 9·85 | 0·05 | 0·01 | 0·03 | 0·04 |
| 12 | 0·98 | 1·96 | 2·93 | 3·91 | 4·89 | 5·87 | 6·85 | 7·83 | 8·80 | 9·78 | 0·06 | 0·02 | 0·03 | 0·05 |
| 14 | 0·97 | 1·94 | 2·91 | 3·88 | 4·85 | 5·82 | 6·79 | 7·76 | 8·73 | 9·70 | 0·07 | 0·02 | 0·04 | 0·05 |
| 15 | 0·97 | 1·93 | 2·90 | 3·86 | 4·83 | 5·80 | 6·76 | 7·73 | 8·69 | 9·66 | 0·08 | 0·02 | 0·04 | 0·06 |
| 16 | 0·96 | 1·92 | 2·88 | 3·85 | 4·81 | 5·77 | 6·73 | 7·69 | 8·65 | 9·61 | 0·09 | 0·02 | 0·05 | 0·07 |
| 17 | 0·96 | 1·91 | 2·87 | 3·83 | 4·78 | 5·74 | 6·69 | 7·65 | 8·61 | 9·56 | 0·10 | 0·03 | 0·05 | 0·08 |
| 18 | 0·95 | 1·90 | 2·85 | 3·80 | 4·76 | 5·71 | 6·66 | 7·61 | 8·56 | 9·51 | 0·11 | 0·03 | 0·06 | 0·08 |
| 19 | 0·95 | 1·89 | 2·84 | 3·78 | 4·73 | 5·67 | 6·62 | 7·56 | 8·51 | 9·46 | 0·12 | 0·03 | 0·06 | 0·09 |
| 20 | 0·94 | 1·88 | 2·82 | 3·76 | 4·70 | 5·64 | 6·58 | 7·52 | 8·46 | 9·40 | 0·13 | 0·03 | 0·07 | 0·10 |
| 21 | 0·93 | 1·87 | 2·80 | 3·73 | 4·67 | 5·60 | 6·54 | 7·47 | 8·40 | 9·34 | 0·14 | 0·04 | 0·07 | 0·11 |
| 22 | 0·93 | 1·85 | 2·78 | 3·71 | 4·64 | 5·56 | 6·49 | 7·42 | 8·34 | 9·27 | 0·15 | 0·04 | 0·08 | 0·11 |
| 23 | 0·92 | 1·84 | 2·76 | 3·68 | 4·60 | 5·52 | 6·44 | 7·36 | 8·28 | 9·21 | 0·16 | 0·04 | 0·08 | 0·12 |
| 24 | 0·91 | 1·83 | 2·74 | 3·65 | 4·57 | 5·48 | 6·39 | 7·31 | 8·22 | 9·14 | 0·17 | 0·04 | 0·09 | 0·13 |
| 25 | 0·91 | 1·81 | 2·72 | 3·63 | 4·53 | 5·44 | 6·34 | 7·25 | 8·16 | 9·06 | | | | |
| 26 | 0·90 | 1·80 | 2·70 | 3·60 | 4·49 | 5·39 | 6·29 | 7·19 | 8·09 | 8·99 | | | | |
| 27 | 0·89 | 1·78 | 2·67 | 3·56 | 4·46 | 5·35 | 6·24 | 7·13 | 8·02 | 8·91 | | | | |
| 28 | 0·88 | 1·77 | 2·65 | 3·53 | 4·4[illegible] | 5·30 | 6·18 | 7·06 | 7·95 | 8·83 | | | | |
| 29 | 0·87 | 1·75 | 2·62 | 3·50 | 4·37 | 5·25 | 6·12 | 7·00 | 7·87 | 8·75 | | | | |
| 30 | 0·87 | 1·73 | 2·60 | 3·46 | 4·33 | 5·20 | 6·06 | 6·93 | 7·79 | 8·66 | | | | |
| 31 | 0·86 | 1·71 | 2·57 | 3·43 | 4·29 | 5·14 | 6·00 | 6·86 | 7·71 | 8·57 | | | | |
| 32 | 0·85 | 1·70 | 2·54 | 3·39 | 4·24 | 5·09 | 5·94 | 6·78 | 7·63 | 8·48 | | | | |
| 33 | 0·84 | 1·68 | 2·52 | 3·35 | 4·19 | 5·03 | 5·87 | 6·71 | 7·55 | 8·39 | | | | |
| 34 | 0·83 | 1·66 | 2·49 | 3·32 | 4·15 | 4·97 | 5·80 | 6·63 | 7·46 | 8·29 | | | | |
| 35 | 0·82 | 1·64 | 2·46 | 3·28 | 4·10 | 4·91 | 5·73 | 6·55 | 7·37 | 8·19 | | | | |
| 36 | 0·81 | 1·62 | 2·43 | 3·24 | 4·05 | 4·85 | 5·66 | 6·47 | 7·28 | 8·09 | | | | |
| 37 | 0·80 | 1·60 | 2·40 | 3·19 | 3·99 | 4·79 | 5·59 | 6·39 | 7·19 | 7·99 | | | | |
| 38 | 0·79 | 1·58 | 2·36 | 3·15 | 3·94 | 4·73 | 5·52 | 6·30 | 7·09 | 7·88 | | | | |
| 39 | 0·78 | 1·55 | 2·33 | 3·11 | 3·89 | 4·66 | 5·44 | 6·22 | 6·99 | 7·77 | | | | |
| 40 | 0·77 | 1·53 | 2·30 | 3·06 | 3·83 | 4·60 | 5·36 | 6·13 | 6·89 | 7·66 | | | | |
| 41 | 0·75 | 1·51 | 2·26 | 3·02 | 3·77 | 4·53 | 5·28 | 6·04 | 6·79 | 7·55 | | | | |
| 42 | 0·74 | 1·49 | 2·23 | 2·97 | 3·72 | 4·46 | 5·20 | 5·95 | 6·69 | 7·43 | | | | |
| 43 | 0·73 | 1·46 | 2·19 | 2·93 | 3·66 | 4·39 | 5·12 | 5·85 | 6·58 | 7·31 | | | | |
| 44 | 0·72 | 1·44 | 2·16 | 2·88 | 3·60 | 4·32 | 5·04 | 5·75 | 6·47 | 7·19 | | | | |
| 45 | 0·71 | 1·41 | 2·12 | 2·83 | 3·54 | 4·24 | 4·95 | 5·66 | 6·36 | 7·07 | | | | |
| 46 | 0·69 | 1·39 | 2·08 | 2·78 | 3·47 | 4·17 | 4·86 | 5·56 | 6·25 | 6·95 | | | | |
| 47 | 0·68 | 1·36 | 2·04 | 2·73 | 3·41 | 4·09 | 4·77 | 5·46 | 6·14 | 6·82 | | | | |
| 48 | 0·67 | 1·34 | 2·01 | 2·68 | 3·35 | 4·01 | 4·68 | 5·35 | 6·02 | 6·69 | | | | |
| 49 | 0·66 | 1·31 | 1·57 | 2·62 | 3·28 | 3·94 | 4·59 | 5·25 | 5·90 | 6·56 | | | | |
| 50 | 0·64 | 1·29 | 1·93 | 2·57 | 3·21 | 3·86 | 4·50 | 5·14 | 5·79 | 6·43 | | | | |
| 51 | 0·63 | 1·26 | 1·89 | 2·52 | 3·15 | 3·78 | 4·41 | 5·03 | 5·66 | 6·29 | | | | |
| 52 | 0·62 | 1·23 | 1·85 | 2·46 | 3·08 | 3·69 | 4·31 | 4·93 | 5·54 | 6·16 | | | | |
| 53 | 0·60 | 1·20 | 1·81 | 2·41 | 3·01 | 3·61 | 4·21 | 4·81 | 5·42 | 6·02 | | | | |
| 54 | 0·59 | 1·18 | 1·76 | 2·35 | 2·94 | 3·53 | 4·11 | 4·70 | 5·29 | 5·88 | | | | |
| 55 | 0·57 | 1·16 | 1·72 | 2·29 | 2·87 | 3·44 | 4·02 | 4·59 | 5·16 | 5·74 | | | | |
| 56 | 0·56 | 1·12 | 1·68 | 2·24 | 2·80 | 3·35 | 3·91 | 4·47 | 5·03 | 5·59 | | | | |
| 57 | 0·54 | 1·09 | 1·63 | 2·18 | 2·72 | 3·27 | 3·81 | 4·36 | 4·90 | 5·45 | | | | |
| 58 | 0·53 | 1·06 | 1·59 | 2·12 | 2·65 | 3·18 | 3·71 | 4·24 | 4·77 | 5·30 | | | | |
| 59 | 0·52 | 1·03 | 1·55 | 2·06 | 2·58 | 3·09 | 3·61 | 4·12 | 4·64 | 5·16 | | | | |
| 60 | 0·50 | 1·00 | 1·50 | 2·00 | 2·50 | 3·00 | 3·50 | 4·00 | 4·50 | 5·00 | | | | |
| 61 | 0·48 | 0·97 | 1·45 | 1·94 | 2·42 | 2·91 | 3·39 | 3·88 | 4·36 | 4·85 | | | | |
| 62 | 0·47 | 0·94 | 1·41 | 1·88 | 2·35 | 2·82 | 3·29 | 3·76 | 4·23 | 4·69 | | | | |
| 63 | 0·45 | 0·91 | 1·36 | 1·82 | 2·27 | 2·72 | 3·18 | 3·63 | 4·09 | 4·54 | | | | |
| 64 | 0·44 | 0·88 | 1·32 | 1·75 | 2·19 | 2·63 | 3·07 | 3·51 | 3·95 | 4·38 | | | | |
| 65 | 0·42 | 0·85 | 1·27 | 1·69 | 2·11 | 2·54 | 2·96 | 3·38 | 3·80 | 4·23 | | | | |
| 66 | 0·41 | 0·81 | 1·22 | 1·63 | 2·03 | 2·44 | 2·85 | 3·25 | 3·66 | 4·07 | | | | |
| 67 | 0·39 | 0·78 | 1·17 | 1·56 | 1·95 | 2·34 | 2·74 | 3·13 | 3·52 | 3·91 | | | | |
| 68 | 0·37 | 0·75 | 1·12 | 1·50 | 1·87 | 2·25 | 2·62 | 3·00 | 3·37 | 3·75 | | | | |
| 69 | 0·36 | 0·72 | 1·08 | 1·43 | 1·79 | 2·15 | 2·51 | 2·87 | 3·23 | 3·58 | | | | |

## SPHERICAL TRAVERSE TABLE

| ° | 0° M | 0° N | 1° M | 1° N | 2° M | 2° N | 3° M | 3° N | 4° M | 4° N | 5° M | 5° N | 6° M | 6° N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 100·0 | 0 | | | | | | | | | | | | |
| 1 | 100·0 | 0 | 100·0 | 0·0 | | | | | | | | | | |
| 2 | 100·1 | 0 | 100·1 | 0·1 | 100·1 | 0·1 | | | | | | | | |
| 3 | 100·1 | 0 | 100·1 | 0·1 | 100·2 | 0·2 | 100·3 | 0·3 | | | | | | |
| 4 | 100·2 | 0 | 100·3 | 0·1 | 100·3 | 0·2 | 100·4 | 0·4 | 100·5 | 0·5 | | | | |
| 5 | 100·4 | 0 | 100·4 | 0·1 | 100·4 | 0·3 | 100·5 | 0·5 | 100·6 | 0·6 | 100·8 | 0·8 | | |
| 6 | 100·5 | 0 | 100·6 | 0·2 | 100·6 | 0·4 | 100·7 | 0·5 | 100·8 | 0·7 | 100·9 | 0·9 | 101·1 | 1·1 |
| 7 | 100·7 | 0 | 100·8 | 0·2 | 100·8 | 0·4 | 100·9 | 0·6 | 101·0 | 0·9 | 101·1 | 1·1 | 101·3 | 1·3 |
| 8 | 101·0 | 0 | 101·0 | 0·2 | 101·0 | 0·5 | 101·1 | 0·7 | 101·2 | 1·0 | 101·4 | 1·2 | 101·5 | 1·5 |
| 9 | 101·2 | 0 | 101·3 | 0·3 | 101·3 | 0·5 | 101·4 | 0·8 | 101·5 | 1·1 | 101·6 | 1·4 | 101·8 | 1·7 |
| 10 | 101·5 | 0 | 101·6 | 0·3 | 101·6 | 0·6 | 101·7 | 0·9 | 101·8 | 1·2 | 101·9 | 1·5 | 102·1 | 1·8 |
| 11 | 101·9 | 0 | 101·9 | 0·3 | 101·9 | 0·7 | 102·0 | 1·0 | 102·1 | 1·4 | 102·3 | 1·7 | 102·4 | 2·0 |
| 12 | 102·2 | 0 | 102·2 | 0·4 | 102·3 | 0·7 | 102·4 | 1·1 | 102·5 | 1·5 | 102·6 | 1·9 | 102·8 | 2·2 |
| 13 | 102·6 | 0 | 102·6 | 0·4 | 102·7 | 0·8 | 102·8 | 1·2 | 102·9 | 1·6 | 103·3 | 2·0 | 103·2 | 2·4 |
| 14 | 103·1 | 0 | 103·1 | 0·4 | 103·1 | 0·9 | 103·2 | 1·3 | 103·3 | 1·7 | 103·5 | 2·2 | 103·6 | 2·6 |
| 15 | 103·5 | 0 | 103·5 | 0·5 | 103·6 | 0·9 | 103·7 | 1·4 | 103·8 | 1·9 | 103·9 | 2·3 | 104·1 | 2·8 |
| 16 | 104·0 | 0 | 104·0 | 0·5 | 104·1 | 1·0 | 104·2 | 1·5 | 104·3 | 2·0 | 104·4 | 2·5 | 104·6 | 3·0 |
| 17 | 104·6 | 0 | 104·6 | 0·5 | 104·6 | 1·1 | 104·7 | 1·6 | 104·8 | 2·1 | 104·7 | 2·7 | 105·1 | 3·2 |
| 18 | 105·1 | 0 | 105·2 | 0·6 | 105·2 | 1·1 | 105·3 | 1·7 | 105·4 | 2·3 | 105·5 | 2·8 | 105·7 | 3·4 |
| 19 | 105·8 | 0 | 105·8 | 0·6 | 105·8 | 1·2 | 105·9 | 1·8 | 106·0 | 2·4 | 106·2 | 3·0 | 106·3 | 3·6 |
| 20 | 106·4 | 0 | 106·4 | 0·6 | 106·5 | 1·3 | 106·6 | 1·9 | 106·7 | 2·5 | 106·8 | 3·2 | 107·0 | 3·8 |
| 21 | 107·1 | 0 | 107·1 | 0·7 | 107·2 | 1·3 | 107·3 | 2·0 | 107·4 | 2·7 | 107·5 | 3·4 | 107·7 | 4·0 |
| 22 | 107·8 | 0 | 107·9 | 0·7 | 107·9 | 1·4 | 108·0 | 2·1 | 108·1 | 2·8 | 108·3 | 3·5 | 108·4 | 4·2 |
| 23 | 108·6 | 0 | 108·6 | 0·7 | 108·7 | 1·5 | 108·8 | 2·2 | 108·9 | 3·0 | 109·0 | 3·7 | 109·2 | 4·5 |
| 24 | 109·5 | 0 | 109·5 | 0·8 | 109·5 | 1·5 | 109·6 | 2·3 | 109·7 | 3·1 | 109·9 | 3·9 | 110·1 | 4·7 |
| 25 | 110·3 | 0 | 110·4 | 0·8 | 110·1 | 1·6 | 110·5 | 2·4 | 110·6 | 3·3 | 110·8 | 4·1 | 110·9 | 4·9 |
| 26 | 111·3 | 0 | 111·3 | 0·8 | 111·3 | 1·7 | 111·4 | 2·6 | 111·5 | 3·4 | 111·7 | 4·3 | 111·9 | 5·1 |
| 27 | 112·2 | 0 | 112·2 | 0·9 | 112·3 | 1·8 | 112·4 | 2·7 | 112·5 | 3·5 | 112·7 | 4·5 | 112·8 | 5·3 |
| 28 | 113·3 | 0 | 113·3 | 0·9 | 113·3 | 1·9 | 113·4 | 2·8 | 113·5 | 3·7 | 113·7 | 4·7 | 113·9 | 5·6 |
| 29 | 114·3 | 0 | 114·4 | 1·0 | 114·4 | 1·9 | 114·5 | 2·9 | 114·6 | 3·9 | 114·8 | 4·8 | 115·0 | 5·8 |
| 30 | 115·5 | 0 | 115·5 | 1·0 | 115·4 | 2·0 | 115·6 | 3·0 | 115·7 | 4·0 | 115·9 | 5·0 | 116·1 | 6·1 |
| 31 | 116·7 | 0 | 116·7 | 1·0 | 116·7 | 2·1 | 116·8 | 3·1 | 116·9 | 4·2 | 117·1 | 5·3 | 117·3 | 6·3 |
| 32 | 117·9 | 0 | 117·9 | 1·1 | 118·0 | 2·2 | 118·1 | 3·3 | 118·2 | 4·4 | 118·4 | 5·5 | 118·6 | 6·6 |
| 33 | 119·2 | 0 | 119·3 | 1·1 | 119·3 | 2·3 | 119·4 | 3·4 | 119·5 | 4·5 | 119·7 | 5·7 | 119·9 | 6·8 |
| 34 | 120·6 | 0 | 120·6 | 1·2 | 120·7 | 2·4 | 120·8 | 3·5 | 120·9 | 4·7 | 121·1 | 5·9 | 121·3 | 7·1 |
| 35 | 122·1 | 0 | 122·1 | 1·2 | 122·1 | 2·4 | 122·2 | 3·7 | 122·4 | 4·9 | 122·5 | 6·2 | 122·7 | 7·4 |
| 36 | 123·6 | 0 | 123·6 | 1·3 | 123·7 | 2·5 | 123·8 | 3·8 | 123·9 | 5·1 | 124·1 | 6·4 | 124·3 | 7·6 |
| 37 | 125·2 | 0 | 125·2 | 1·3 | 125·3 | 2·6 | 125·4 | 3·9 | 125·5 | 5·3 | 125·7 | 6·6 | 125·9 | 7·9 |
| 38 | 126·9 | 0 | 126·9 | 1·4 | 127·0 | 2·7 | 127·1 | 4·1 | 127·2 | 5·5 | 127·4 | 6·8 | 127·6 | 8·2 |
| 39 | 128·7 | 0 | 128·7 | 1·4 | 128·8 | 2·8 | 128·9 | 4·2 | 129·0 | 5·7 | 129·2 | 7·1 | 129·4 | 8·5 |
| 40 | 130·5 | 0 | 130·6 | 1·5 | 130·6 | 2·9 | 130·7 | 4·4 | 130·9 | 5·9 | 131·0 | 7·3 | 131·3 | 8·8 |
| 41 | 132·5 | 0 | 132·5 | 1·5 | 132·6 | 3·0 | 132·7 | 4·6 | 132·8 | 6·1 | 133·0 | 7·6 | 133·2 | 9·1 |
| 42 | 134·6 | 0 | 134·6 | 1·6 | 134·6 | 3·1 | 134·7 | 4·7 | 134·9 | 6·3 | 135·1 | 7·9 | 135·3 | 9·5 |
| 43 | 136·7 | 0 | 136·8 | 1·6 | 136·8 | 3·3 | 136·9 | 4·9 | 137·1 | 6·5 | 137·3 | 8·2 | 137·5 | 9·8 |
| 44 | 139·0 | 0 | 139·0 | 1·7 | 139·1 | 3·4 | 139·2 | 5·1 | 139·4 | 6·7 | 139·5 | 8·4 | 139·8 | 10·1 |
| 45 | 141·4 | 0 | 141·4 | 1·7 | 141·5 | 3·5 | 141·6 | 5·2 | 141·8 | 7·0 | 142·0 | 8·7 | 142·2 | 10·5 |
| 46 | 144·0 | 0 | 144·0 | 1·8 | 144·0 | 3·6 | 144·2 | 5·4 | 144·3 | 7·2 | 144·5 | 9·1 | 144·7 | 10·9 |
| 47 | 146·6 | 0 | 146·6 | 1·9 | 146·7 | 3·7 | 146·8 | 5·6 | 147·0 | 7·5 | 147·2 | 9·4 | 147·4 | 11·3 |
| 48 | 149·4 | 0 | 149·5 | 1·9 | 149·5 | 3·9 | 149·7 | 5·8 | 149·8 | 7·8 | 150·0 | 9·7 | 150·3 | 11·7 |
| 49 | 152·4 | 0 | 152·4 | 2·0 | 152·5 | 4·0 | 152·6 | 6·0 | 152·1 | 8·0 | 153·0 | 10·1 | 153·3 | 12·1 |
| 50 | 155·6 | 0 | 155·6 | 2·1 | 155·7 | 4·2 | 155·8 | 6·2 | 155·7 | 8·3 | 156·2 | 10·4 | 156·4 | 12·5 |
| 51 | 158·9 | 0 | 158·9 | 2·2 | 159·0 | 4·3 | 159·1 | 6·5 | 159·3 | 8·6 | 159·5 | 10·8 | 159·8 | 13·0 |
| 52 | 162·4 | 0 | 162·5 | 2·2 | 162·5 | 4·5 | 162·6 | 6·7 | 162·8 | 8·9 | 163·0 | 11·2 | 163·3 | 13·4 |
| 53 | 166·2 | 0 | 166·2 | 2·3 | 166·3 | 4·6 | 166·4 | 6·9 | 166·6 | 9·3 | 166·8 | 11·6 | 167·1 | 13·9 |
| 54 | 170·1 | 0 | 170·2 | 2·4 | 170·2 | 4·8 | 170·4 | 7·2 | 170·5 | 9·6 | 170·8 | 12·0 | 171·1 | 14·5 |
| 55 | 174·3 | 0 | 174·4 | 2·5 | 174·4 | 5·0 | 174·6 | 7·5 | 174·8 | 10·0 | 175·0 | 12·5 | 175·2 | 15·0 |
| 56 | 178·8 | 0 | 178·9 | 2·6 | 178·9 | 5·2 | 179·5 | 7·8 | 179·3 | 10·4 | 179·5 | 13·0 | 179·8 | 15·6 |
| 57 | 183·6 | 0 | 183·6 | 2·7 | 183·7 | 5·4 | 183·9 | 8·1 | 184·1 | 10·8 | 184·3 | 13·5 | 184·6 | 16·2 |
| 58 | 188·7 | 0 | 188·7 | 2·8 | 188·2 | 5·6 | 189·0 | 8·4 | 189·2 | 11·2 | 189·4 | 14·0 | 189·7 | 16·8 |
| 59 | 194·2 | 0 | 194·2 | 2·9 | 194·3 | 5·8 | 194·4 | 8·7 | 194·6 | 11·6 | 194·9 | 14·6 | 195·2 | 17·5 |
| 60 | 200·0 | 0 | 200·0 | 3·0 | 200·1 | 6·0 | 200·3 | 9·1 | 200·5 | 12·1 | 200·8 | 15·1 | 201·1 | 18·2 |

## SPHERICAL TRAVERSE TABLE

| ° | 0° M | 0° N | 1° M | 1° N | 2° M | 2° N | 3° M | 3° N | 4° M | 4° N | 5° M | 5° N | 6° M | 6° N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 61 | 206·3 | 0 | 206·3 | 3·1 | 206·4 | 6·3 | 206·5 | 9·4 | 206·8 | 12·6 | 207·1 | 15·8 | 207·4 | 19·0 |
| 62 | 213·0 | 0 | 213·0 | 3·3 | 213·2 | 6·6 | 213·3 | 9·9 | 213·5 | 13·1 | 213·8 | 16·4 | 214·2 | 19·8 |
| 63 | 220·3 | 0 | 220·3 | 3·4 | 220·4 | 6·8 | 220·6 | 10·3 | 220·8 | 13·7 | 221·1 | 17·2 | 221·5 | 20·6 |
| 64 | 228·1 | 0 | 228·2 | 3·6 | 228·3 | 7·2 | 228·4 | 10·7 | 228·7 | 14·3 | 229·0 | 17·9 | 229·4 | 21·5 |
| 65 | 236·6 | 0 | 236·7 | 3·7 | 236·8 | 7·5 | 236·9 | 11·2 | 237·2 | 15·0 | 237·5 | 18·8 | 237·9 | 22·5 |
| 66 | 245·8 | 0 | 245·9 | 3·9 | 246·0 | 7·8 | 246·2 | 11·8 | 246·5 | 15·7 | 246·8 | 19·6 | 247·2 | 23·6 |
| 67 | 255·9 | 0 | 256·0 | 4·1 | 256·1 | 8·2 | 256·2 | 12·3 | 256·6 | 16·5 | 256·9 | 20·6 | 257·3 | 24·8 |
| 68 | 266·9 | 0 | 267·0 | 4·3 | 267·1 | 8·6 | 267·3 | 13·0 | 267·6 | 17·3 | 268·0 | 21·7 | 268·4 | 26·0 |
| 69 | 279·0 | 0 | 279·1 | 4·5 | 279·2 | 9·1 | 279·4 | 13·6 | 279·7 | 18·2 | 280·1 | 22·8 | 280·6 | 27·4 |
| 70 | 292·4 | 0 | 292·4 | 4·8 | 292·6 | 9·6 | 292·8 | 14·4 | 293·1 | 19·2 | 293·5 | 24·0 | 294·0 | 28·9 |
| 71 | 307·2 | 0 | 307·2 | 5·1 | 307·3 | 10·1 | 307·6 | 15·2 | 307·9 | 20·3 | 308·3 | 25·4 | 308·9 | 30·5 |
| 72 | 323·6 | 0 | 323·7 | 5·4 | 323·8 | 10·7 | 324·1 | 16·1 | 324·4 | 21·5 | 324·8 | 26·9 | 325·4 | 32·3 |
| 73 | 342·0 | 0 | 342·1 | 5·7 | 342·2 | 11·4 | 342·4 | 17·1 | 342·9 | 22·9 | 343·3 | 28·6 | 343·9 | 34·4 |
| 74 | 362·8 | 0 | 362·9 | 6·1 | 363·0 | 12·2 | 363·3 | 18·3 | 363·7 | 24·4 | 364·2 | 30·5 | 364·8 | 36·6 |
| 75 | 386·4 | 0 | 386·4 | 6·5 | 386·6 | 13·0 | 386·9 | 19·6 | 387·3 | 26·1 | 387·8 | 32·6 | 388·5 | 39·2 |
| 76 | 413·3 | 0 | 404·0 | 7·0 | 413·6 | 14·0 | 413·9 | 21·0 | 414·4 | 28·0 | 414·9 | 35·1 | 415·6 | 42·2 |
| 77 | 444·5 | 0 | 444·6 | 7·6 | 444·8 | 15·1 | 445·2 | 22·7 | 445·6 | 30·3 | 446·1 | 37·9 | 447·0 | 43·5 |
| 78 | 481·0 | 0 | 481·0 | 8·2 | 481·3 | 16·4 | 481·6 | 24·6 | 482·1 | 32·9 | 482·8 | 41·2 | 483·6 | 49·4 |
| 79 | 524·1 | 0 | 524·2 | 9·0 | 524·4 | 18·0 | 524·8 | 27·0 | 525·4 | 36·0 | 526·1 | 45·0 | 527·0 | 54·1 |
| 80 | 575·9 | 0 | 576·0 | 9·9 | 576·2 | 19·8 | 576·7 | 29·7 | 577·3 | 39·7 | 578·2 | 49·6 | 579·1 | 59·6 |

| ° | 7° M | 7° N | 8° M | 8° N | 9° M | 9° N | 10° M | 10° N | 11° M | 11° N | 12° M | 12° N | 13° M | 13° N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7 | 101·5 | 1·5 | | | | | | | | | | | | |
| 8 | 101·7 | 1·7 | 102·0 | 2·0 | | | | | | | | | | |
| 9 | 102·0 | 1·9 | 102·2 | 2·2 | 102·5 | 2·5 | | | | | | | | |
| 10 | 102·3 | 2·2 | 102·5 | 2·5 | 102·8 | 2·8 | 103·1 | 3·1 | | | | | | |
| 11 | 102·6 | 2·4 | 102·9 | 2·7 | 103·1 | 3·1 | 103·4 | 3·4 | 103·8 | 3·8 | | | | |
| 12 | 103·0 | 2·6 | 103·2 | 3·0 | 103·5 | 3·4 | 103·8 | 3·7 | 104·1 | 4·1 | 104·5 | 4·5 | | |
| 13 | 103·4 | 2·8 | 103·6 | 3·2 | 103·9 | 3·7 | 104·2 | 4·1 | 104·5 | 4·5 | 104·9 | 4·9 | 105·3 | 5·3 |
| 14 | 103·8 | 3·1 | 104·1 | 3·5 | 104·3 | 3·9 | 104·6 | 4·4 | 105·0 | 4·8 | 105·4 | 5·3 | 105·8 | 5·8 |
| 15 | 104·3 | 3·3 | 104·5 | 3·8 | 104·8 | 4·2 | 105·1 | 4·7 | 105·5 | 5·2 | 105·8 | 5·7 | 106·2 | 6·2 |
| 16 | 104·8 | 3·5 | 105·0 | 4·0 | 105·3 | 4·5 | 105·6 | 5·1 | 106·0 | 5·6 | 106·4 | 6·1 | 106·8 | 6·6 |
| 17 | 105·3 | 3·7 | 105·6 | 4·3 | 105·9 | 4·8 | 106·2 | 5·4 | 106·5 | 5·9 | 106·9 | 6·5 | 107·3 | 7·1 |
| 18 | 106·0 | 4·0 | 106·2 | 4·6 | 106·5 | 5·1 | 106·8 | 5·7 | 107·1 | 6·3 | 107·5 | 6·9 | 107·9 | 7·5 |
| 19 | 106·6 | 4·2 | 106·8 | 4·8 | 107·1 | 5·5 | 107·4 | 6·1 | 107·7 | 6·7 | 108·1 | 7·3 | 108·5 | 7·9 |
| 20 | 107·2 | 4·5 | 107·5 | 5·1 | 107·7 | 5·8 | 108·1 | 6·4 | 108·4 | 7·1 | 108·8 | 7·7 | 109·2 | 8·4 |
| 21 | 107·9 | 4·7 | 108·2 | 5·4 | 108·4 | 6·1 | 108·8 | 6·8 | 109·1 | 7·5 | 109·5 | 8·2 | 109·9 | 8·9 |
| 22 | 108·7 | 5·0 | 108·9 | 5·7 | 109·2 | 6·4 | 109·5 | 7·1 | 109·9 | 7·8 | 110·3 | 8·6 | 110·7 | 9·3 |
| 23 | 109·4 | 5·2 | 109·7 | 6·0 | 110·0 | 6·7 | 110·3 | 7·5 | 110·7 | 8·3 | 111·1 | 9·0 | 111·5 | 9·8 |
| 24 | 110·3 | 5·5 | 110·5 | 6·3 | 110·8 | 7·0 | 111·0 | 7·9 | 111·5 | 8·7 | 111·9 | 9·5 | 112·3 | 10·3 |
| 25 | 111·2 | 5·7 | 111·4 | 6·6 | 111·7 | 7·4 | 111·9 | 8·2 | 112·4 | 9·1 | 112·8 | 9·9 | 113·2 | 10·8 |
| 26 | 112·1 | 6·0 | 112·4 | 6·8 | 112·6 | 7·7 | 112·9 | 8·6 | 113·4 | 9·5 | 113·7 | 10·4 | 114·2 | 11·3 |
| 27 | 113·1 | 6·3 | 113·3 | 7·2 | 113·6 | 8·1 | 114·0 | 9·0 | 114·3 | 9·9 | 114·7 | 10·8 | 115·2 | 11·8 |
| 28 | 114·1 | 6·5 | 114·4 | 7·5 | 114·7 | 8·4 | 115·1 | 9·4 | 115·4 | 10·3 | 115·8 | 11·3 | 116·2 | 12·3 |
| 29 | 115·2 | 6·8 | 115·5 | 7·8 | 115·8 | 8·8 | 116·1 | 9·8 | 116·5 | 10·8 | 116·9 | 11·8 | 117·3 | 12·8 |
| 30 | 116·3 | 7·1 | 116·6 | 8·1 | 116·9 | 9·1 | 117·2 | 10·2 | 117·6 | 11·2 | 118·0 | 12·3 | 118·5 | 13·3 |
| 31 | 117·5 | 7·4 | 117·8 | 8·4 | 118·1 | 9·5 | 118·5 | 10·6 | 118·8 | 11·7 | 119·3 | 12·8 | 119·7 | 13·9 |
| 32 | 118·6 | 7·7 | 119·1 | 8·8 | 119·4 | 9·9 | 119·8 | 11·0 | 120·1 | 12·1 | 120·6 | 13·3 | 121·0 | 14·4 |
| 33 | 120·1 | 8·0 | 120·4 | 9·1 | 120·7 | 10·3 | 121·1 | 11·4 | 121·5 | 12·6 | 121·9 | 13·8 | 122·7 | 15·0 |
| 34 | 121·5 | 8·3 | 121·8 | 9·5 | 122·1 | 10·7 | 122·5 | 11·9 | 122·9 | 13·1 | 123·3 | 14·3 | 123·8 | 15·6 |
| 35 | 123·0 | 8·6 | 123·3 | 9·8 | 123·6 | 11·1 | 124·0 | 12·3 | 124·4 | 13·6 | 124·8 | 14·9 | 125·3 | 16·2 |
| 36 | 124·5 | 8·9 | 124·8 | 10·2 | 125·1 | 11·5 | 125·5 | 12·8 | 125·9 | 14·1 | 126·4 | 15·4 | 126·9 | 16·7 |
| 37 | 126·2 | 9·3 | 126·4 | 10·6 | 126·8 | 11·9 | 127·1 | 13·3 | 127·6 | 14·6 | 128·0 | 16·0 | 128·5 | 17·4 |
| 38 | 127·9 | 9·6 | 128·1 | 11·0 | 128·5 | 12·4 | 128·9 | 13·8 | 129·3 | 15·2 | 129·7 | 16·6 | 130·2 | 18·0 |
| 39 | 129·6 | 9·9 | 129·9 | 11·4 | 130·3 | 12·8 | 130·7 | 14·3 | 131·1 | 15·7 | 131·5 | 17·2 | 132·1 | 18·7 |
| 40 | 131·5 | 10·3 | 131·8 | 11·8 | 132·2 | 13·3 | 132·6 | 14·8 | 133·0 | 16·3 | 133·5 | 17·8 | 134·0 | 19·4 |
| 41 | 133·5 | 10·7 | 133·8 | 12·2 | 134·1 | 13·8 | 134·5 | 15·3 | 135·0 | 16·9 | 135·5 | 18·5 | 136·0 | 20·1 |
| 42 | 135·6 | 11·1 | 135·9 | 12·6 | 136·2 | 14·3 | 136·6 | 15·9 | 137·1 | 17·5 | 137·6 | 19·1 | 138·1 | 20·8 |
| 43 | 137·8 | 11·4 | 138·1 | 13·1 | 138·4 | 14·8 | 138·8 | 16·4 | 139·3 | 18·1 | 139·8 | 19·8 | 140·3 | 21·5 |

## SPHERICAL TRAVERSE TABLE

| ° | 7° M | 7° N | 8° M | 8° N | 9° M | 9° N | 10° M | 10° N | 11° M | 11° N | 12° M | 12° N | 13° M | 13° N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 44 | 140·1 | 11·9 | 140·4 | 13·6 | 140·7 | 15·4 | 141·2 | 17·0 | 141·6 | 18·8 | 142·1 | 20·5 | 142·7 | 22·3 |
| 45 | 142·5 | 12·3 | 142·8 | 14·0 | 143·2 | 15·8 | 143·6 | 17·6 | 144·1 | 19·4 | 144·6 | 21·3 | 145·1 | 23·1 |
| 46 | 145·0 | 12·7 | 145·4 | 14·5 | 145·7 | 16·4 | 146·2 | 18·3 | 146·6 | 20·1 | 147·2 | 22·0 | 147·7 | 23·9 |
| 47 | 147·7 | 13·2 | 148·1 | 15·1 | 148·5 | 17·0 | 148·9 | 18·9 | 149·4 | 20·8 | 149·9 | 22·8 | 150·8 | 24·8 |
| 48 | 150·6 | 13·6 | 150·9 | 15·6 | 151·3 | 17·6 | 151·7 | 19·6 | 152·2 | 21·6 | 152·8 | 23·6 | 153·4 | 25·6 |
| 49 | 153·6 | 14·1 | 153·9 | 16·2 | 154·3 | 18·2 | 154·8 | 20·3 | 155·3 | 22·4 | 155·9 | 24·4 | 156·4 | 26·6 |
| 50 | 156·7 | 14·6 | 157·1 | 16·7 | 157·5 | 18·9 | 158·0 | 21·0 | 158·5 | 23·2 | 159·0 | 25·3 | 159·7 | 27·5 |
| 51 | 160·1 | 15·2 | 160·5 | 17·4 | 160·9 | 19·6 | 161·4 | 21·8 | 161·9 | 24·0 | 162·5 | 26·2 | 163·1 | 28·5 |
| 52 | 163·6 | 15·7 | 164·0 | 18·0 | 164·4 | 20·3 | 165·0 | 22·6 | 165·5 | 24·9 | 166·1 | 27·2 | 166·7 | 29·5 |
| 53 | 167·4 | 16·3 | 167·8 | 18·6 | 168·2 | 21·0 | 168·7 | 23·4 | 169·3 | 25·8 | 169·9 | 28·2 | 170·5 | 30·6 |
| 54 | 171·4 | 16·9 | 171·8 | 19·3 | 172·2 | 21·8 | 172·8 | 24·3 | 173·3 | 26·8 | 173·9 | 29·3 | 174·6 | 31·8 |
| 55 | 175·7 | 17·5 | 176·1 | 20·1 | 176·5 | 22·6 | 177·0 | 25·2 | 177·6 | 27·8 | 178·2 | 30·4 | 178·9 | 33·0 |
| 56 | 180·2 | 18·2 | 180·6 | 20·8 | 181·1 | 23·5 | 181·6 | 26·1 | 182·2 | 28·8 | 182·8 | 31·5 | 183·5 | 34·2 |
| 57 | 185·0 | 18·9 | 185·4 | 21·6 | 185·9 | 24·4 | 186·4 | 27·1 | 187·0 | 29·9 | 187·7 | 32·7 | 188·4 | 35·5 |
| 58 | 190·1 | 19·6 | 190·6 | 22·5 | 191·1 | 25·3 | 191·6 | 28·2 | 189·2 | 31·1 | 192·9 | 34·0 | 193·6 | 36·9 |
| 59 | 195·6 | 20·4 | 196·1 | 23·4 | 196·6 | 26·4 | 197·2 | 29·3 | 197·8 | 32·3 | 198·5 | 35·4 | 199·3 | 38·4 |
| 60 | 201·5 | 21·3 | 202·0 | 24·3 | 202·5 | 27·4 | 203·1 | 30·5 | 203·7 | 33·7 | 204·5 | 36·8 | 205·3 | 40·0 |
| 61 | 207·8 | 22·1 | 208·3 | 25·3 | 208·8 | 28·6 | 209·9 | 31·8 | 210·1 | 35·1 | 210·9 | 38·3 | 211·7 | 41·6 |
| 62 | 214·6 | 23·1 | 215·1 | 26·4 | 215·7 | 29·8 | 216·3 | 33·2 | 217·0 | 36·6 | 217·8 | 40·0 | 218·6 | 43·4 |
| 63 | 221·9 | 24·1 | 222·4 | 27·6 | 223·0 | 31·1 | 223·7 | 34·6 | 224·4 | 38·1 | 225·2 | 41·7 | 226·1 | 45·3 |
| 64 | 229·8 | 25·2 | 230·4 | 28·8 | 231·0 | 32·5 | 231·6 | 36·1 | 232·4 | 39·8 | 233·2 | 43·6 | 234·1 | 47·3 |
| 65 | 238·4 | 26·3 | 238·9 | 30·1 | 239·6 | 34·0 | 240·3 | 37·8 | 241·0 | 41·7 | 241·9 | 45·6 | 242·8 | 49·5 |
| 66 | 247·7 | 27·6 | 248·4 | 31·6 | 248·9 | 35·6 | 249·7 | 39·6 | 250·5 | 43·7 | 251·4 | 47·7 | 252·3 | 51·8 |
| 67 | 257·9 | 28·9 | 258·4 | 33·1 | 259·1 | 37·3 | 259·9 | 41·5 | 260·7 | 45·8 | 261·6 | 50·1 | 262·7 | 54·4 |
| 68 | 269·0 | 30·4 | 269·6 | 34·8 | 270·3 | 39·2 | 271·1 | 43·6 | 271·9 | 48·1 | 272·9 | 52·6 | 274·0 | 57·1 |
| 69 | 281·1 | 32·0 | 281·8 | 36·6 | 282·5 | 41·3 | 283·4 | 45·9 | 284·3 | 50·6 | 285·3 | 55·4 | 286·4 | 60·1 |
| 70 | 294·6 | 33·7 | 295·3 | 38·6 | 296·0 | 43·5 | 296·9 | 48·4 | 297·9 | 53·4 | 298·9 | 58·4 | 300·1 | 63·4 |
| 71 | 309·5 | 35·7 | 310·2 | 40·8 | 311·0 | 46·0 | 311·9 | 51·2 | 312·9 | 56·4 | 314·0 | 61·7 | 315·2 | 67·0 |
| 72 | 326·0 | 37·8 | 326·8 | 43·2 | 327·6 | 48·7 | 328·6 | 54·3 | 329·6 | 59·8 | 330·8 | 65·4 | 332·1 | 71·0 |
| 73 | 344·6 | 40·2 | 345·4 | 46·0 | 346·3 | 51·8 | 347·3 | 57·7 | 348·4 | 63·6 | 349·7 | 69·5 | 351·0 | 75·5 |
| 74 | 365·5 | 42·8 | 366·4 | 49·0 | 367·3 | 55·2 | 368·4 | 61·7 | 369·6 | 67·8 | 370·9 | 74·1 | 372·3 | 80·5 |
| 75 | 389·0 | 45·8 | 390·2 | 52·5 | 391·2 | 59·1 | 392·3 | 65·8 | 393·6 | 72·5 | 395·1 | 79·3 | 396·5 | 86·2 |
| 76 | 416·5 | 49·2 | 417·4 | 56·4 | 418·5 | 63·5 | 419·7 | 70·7 | 421·1 | 78·0 | 422·6 | 85·2 | 424·3 | 92·6 |
| 77 | 447·9 | 53·2 | 448·9 | 60·9 | 450·1 | 68·6 | 541·4 | 76·4 | 452·9 | 84·2 | 454·5 | 92·1 | 456·2 | 100·0 |
| 78 | 484·6 | 57·8 | 485·7 | 66·1 | 487·0 | 74·5 | 488·4 | 83·0 | 490·0 | 91·4 | 491·7 | 100·0 | 493·6 | 108·6 |
| 79 | 528·0 | 63·1 | 529·2 | 72·3 | 530·6 | 81·5 | 532·2 | 90·7 | 533·9 | 100·0 | 535·8 | 109·3 | 537·9 | 118·8 |
| 80 | 580·2 | 69·6 | 581·5 | 79·7 | 583·1 | 89·8 | 584·8 | 100·0 | 586·7 | 110·2 | 588·7 | 120·9 | 591·0 | 130·9 |

| ° | 14° M | 14° N | 15° M | 15° N | 16° M | 16° N | 17° M | 17° N | 18° M | 18° N | 19° M | 19° N | 20° M | 20° N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 14 | 106·2 | 6·2 | | | | | | | | | | | | |
| 15 | 106·7 | 6·7 | 107·2 | 7·2 | | | | | | | | | | |
| 16 | 107·2 | 7·1 | 107·7 | 7·7 | 108·2 | 8·2 | | | | | | | | |
| 17 | 107·8 | 7·6 | 108·3 | 8·2 | 108·8 | 8·8 | 109·3 | 9·3 | | | | | | |
| 18 | 108·4 | 8·1 | 108·9 | 8·7 | 109·3 | 9·3 | 109·9 | 9·9 | 110·6 | 10·6 | | | | |
| 19 | 109·0 | 8·6 | 109·5 | 9·2 | 110·0 | 9·9 | 110·6 | 10·5 | 111·2 | 11·2 | 111·9 | 11·9 | | |
| 20 | 109·7 | 9·1 | 110·2 | 9·8 | 110·7 | 10·4 | 111·3 | 11·1 | 111·9 | 11·8 | 112·5 | 12·5 | 113·2 | 13·2 |
| 21 | 110·4 | 9·6 | 110·9 | 10·3 | 111·4 | 10·0 | 112·0 | 11·7 | 112·6 | 12·5 | 113·3 | 13·2 | 114·0 | 14·0 |
| 22 | 111·2 | 10·1 | 111·7 | 10·8 | 112·2 | 11·6 | 112·8 | 12·3 | 113·4 | 13·1 | 114·1 | 13·9 | 114·8 | 14·7 |
| 23 | 112·0 | 10·6 | 112·5 | 11·4 | 113·0 | 12·2 | 113·6 | 13·0 | 114·2 | 13·8 | 114·9 | 14·6 | 115·6 | 15·4 |
| 24 | 112·8 | 11·1 | 113·3 | 11·9 | 113·9 | 12·8 | 114·5 | 13·6 | 115·1 | 14·5 | 115·8 | 15·3 | 116·5 | 15·2 |
| 25 | 113·7 | 11·6 | 114·2 | 12·5 | 114·8 | 13·4 | 115·4 | 14·3 | 116·0 | 15·1 | 116·7 | 16·1 | 117·4 | 17·0 |
| 26 | 114·6 | 12·2 | 115·2 | 13·1 | 115·7 | 14·0 | 116·3 | 14·9 | 117·0 | 15·8 | 117·7 | 17·0 | 118·4 | 17·7 |
| 27 | 115·7 | 12·7 | 116·2 | 13·6 | 116·8 | 14·6 | 117·4 | 15·6 | 118·0 | 16·6 | 118·8 | 17·5 | 119·4 | 18·5 |
| 28 | 116·7 | 13·3 | 117·3 | 14·2 | 117·8 | 15·2 | 118·4 | 16·3 | 119·1 | 17·3 | 119·8 | 18·3 | 120·5 | 19·3 |
| 29 | 117·8 | 13·8 | 118·4 | 14·8 | 118·9 | 15·9 | 119·6 | 16·9 | 120·2 | 18·0 | 120·9 | 19·1 | 121·7 | 20·2 |
| 30 | 119·0 | 14·4 | 119·5 | 15·5 | 120·1 | 16·6 | 120·7 | 17·6 | 121·4 | 18·8 | 122·1 | 19·9 | 122·9 | 21·0 |
| 31 | 120·2 | 15·0 | 120·8 | 16·1 | 121·4 | 17·2 | 122·0 | 18·4 | 122·7 | 19·5 | 123·4 | 20·7 | 124·1 | 21·9 |
| 32 | 121·5 | 15·6 | 122·1 | 16·7 | 122·7 | 17·9 | 123·3 | 19·1 | 124·0 | 20·3 | 124·7 | 21·5 | 125·5 | 22·7 |

## SPHERICAL TRAVERSE TABLE

| ° | 14° M | 14° N | 15° M | 15° N | 16° M | 16° N | 17° M | 17° N | 18° M | 18° N | 19° M | 19° N | 20° M | 20° N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 33 | 122.9 | 16.2 | 123.4 | 17.4 | 124.0 | 18.6 | 124.7 | 19.9 | 125.4 | 21.1 | 126.1 | 22.4 | 126.9 | 23.6 |
| 34 | 124.3 | 16.8 | 124.9 | 18.1 | 125.5 | 19.3 | 126.1 | 20.6 | 126.8 | 21.9 | 127.6 | 23.2 | 128.4 | 24.6 |
| 35 | 125.8 | 17.5 | 126.4 | 18.8 | 127.0 | 20.1 | 127.7 | 21.4 | 128.4 | 22.7 | 129.1 | 24.1 | 129.9 | 25.5 |
| 36 | 127.4 | 18.1 | 128.0 | 19.5 | 128.6 | 20.8 | 129.2 | 22.2 | 130.0 | 23.6 | 130.7 | 25.0 | 131.5 | 26.4 |
| 37 | 129.0 | 18.8 | 129.6 | 20.2 | 130.3 | 21.6 | 130.9 | 23.0 | 131.7 | 24.5 | 132.4 | 25.9 | 133.2 | 27.4 |
| 38 | 130.8 | 19.5 | 131.4 | 20.9 | 132.0 | 22.4 | 132.7 | 23.9 | 133.4 | 25.4 | 134.2 | 26.9 | 135.0 | 28.4 |
| 39 | 132.6 | 20.2 | 133.2 | 21.7 | 133.9 | 23.2 | 134.6 | 24.8 | 135.3 | 26.3 | 136.1 | 27.9 | 136.9 | 29.5 |
| 40 | 134.5 | 20.9 | 135.1 | 22.5 | 135.8 | 24.1 | 136.5 | 25.6 | 137.3 | 27.3 | 138.1 | 28.9 | 138.9 | 30.5 |
| 41 | 136.5 | 21.7 | 137.2 | 23.3 | 137.8 | 24.9 | 138.6 | 26.6 | 139.3 | 28.2 | 140.1 | 29.9 | 141.0 | 31.6 |
| 42 | 138.7 | 22.4 | 139.3 | 24.1 | 140.0 | 25.8 | 140.7 | 27.5 | 141.5 | 29.3 | 142.3 | 31.0 | 143.2 | 32.8 |
| 43 | 140.9 | 23.2 | 141.6 | 25.0 | 142.2 | 26.7 | 143.0 | 28.5 | 143.8 | 30.3 | 144.6 | 32.1 | 145.5 | 33.9 |
| 44 | 143.3 | 24.1 | 143.9 | 25.9 | 144.6 | 27.7 | 145.4 | 29.5 | 146.2 | 31.4 | 147.0 | 33.2 | 147.9 | 35.1 |
| 45 | 145.7 | 24.9 | 146.4 | 26.8 | 147.1 | 28.7 | 147.9 | 30.6 | 148.7 | 32.5 | 149.6 | 34.4 | 150.5 | 36.4 |
| 46 | 148.4 | 25.8 | 149.0 | 27.7 | 149.8 | 29.7 | 150.5 | 31.7 | 151.4 | 33.6 | 152.2 | 35.7 | 153.2 | 37.7 |
| 47 | 151.1 | 26.7 | 151.8 | 28.7 | 152.5 | 30.7 | 153.3 | 32.8 | 154.2 | 34.8 | 155.1 | 36.9 | 156.0 | 39.0 |
| 48 | 154.0 | 27.7 | 154.7 | 29.8 | 155.5 | 31.8 | 156.3 | 34.0 | 157.1 | 36.1 | 158.1 | 38.2 | 159.0 | 40.4 |
| 49 | 157.1 | 28.7 | 157.8 | 30.8 | 158.6 | 33.0 | 159.4 | 35.2 | 160.3 | 37.4 | 161.2 | 39.6 | 162.2 | 41.9 |
| 50 | 160.3 | 29.7 | 161.1 | 31.9 | 161.8 | 34.2 | 162.7 | 36.4 | 163.6 | 38.7 | 164.5 | 41.1 | 165.6 | 43.4 |
| 51 | 163.8 | 30.8 | 164.5 | 33.1 | 165.3 | 35.4 | 166.2 | 37.8 | 167.1 | 40.1 | 168.1 | 42.5 | 169.1 | 44.9 |
| 52 | 167.4 | 31.9 | 168.2 | 34.3 | 169.0 | 36.7 | 169.8 | 39.1 | 170.8 | 41.6 | 171.8 | 44.1 | 172.8 | 46.6 |
| 53 | 171.2 | 33.1 | 172.0 | 35.6 | 172.9 | 38.0 | 173.8 | 40.6 | 174.7 | 43.1 | 175.7 | 45.7 | 176.8 | 48.3 |
| 54 | 175.3 | 34.3 | 176.1 | 36.9 | 177.0 | 39.5 | 177.9 | 42.1 | 178.9 | 44.7 | 179.9 | 47.4 | 181.0 | 50.1 |
| 55 | 179.7 | 35.6 | 180.5 | 38.3 | 181.4 | 40.9 | 182.3 | 43.7 | 183.3 | 46.4 | 184.4 | 49.2 | 185.5 | 52.0 |
| 56 | 184.3 | 37.0 | 185.1 | 39.7 | 186.0 | 42.5 | 187.0 | 45.3 | 188.0 | 48.2 | 189.1 | 51.0 | 190.3 | 54.0 |
| 57 | 189.2 | 38.4 | 190.1 | 41.3 | 191.0 | 44.2 | 192.0 | 47.1 | 193.1 | 50.0 | 194.2 | 53.0 | 195.4 | 56.0 |
| 58 | 194.5 | 39.9 | 195.3 | 42.9 | 196.3 | 45.9 | 197.3 | 48.9 | 198.4 | 52.0 | 199.6 | 55.1 | 200.8 | 58.2 |
| 59 | 200.1 | 41.5 | 201.0 | 44.6 | 202.0 | 47.7 | 203.0 | 50.9 | 204.2 | 54.1 | 205.3 | 57.3 | 206.6 | 60.6 |
| 60 | 206.1 | 43.2 | 207.1 | 46.4 | 208.1 | 49.7 | 209.1 | 53.0 | 210.3 | 56.3 | 211.5 | 59.6 | 212.8 | 63.0 |
| 61 | 212.6 | 45.0 | 213.5 | 48.3 | 214.6 | 51.7 | 215.7 | 55.2 | 216.9 | 58.6 | 218.2 | 62.1 | 219.5 | 65.7 |
| 62 | 219.5 | 46.9 | 220.5 | 50.4 | 221.6 | 53.9 | 222.7 | 57.5 | 224.0 | 61.1 | 225.3 | 64.8 | 226.7 | 68.4 |
| 63 | 227.0 | 48.9 | 228.0 | 52.6 | 229.1 | 56.3 | 230.3 | 60.0 | 231.6 | 63.8 | 233.0 | 67.6 | 234.4 | 71.4 |
| 64 | 235.1 | 51.1 | 236.2 | 54.9 | 237.3 | 58.8 | 238.5 | 62.7 | 239.9 | 66.6 | 241.3 | 70.6 | 242.8 | 74.6 |
| 65 | 243.9 | 53.5 | 245.0 | 57.5 | 246.2 | 61.5 | 247.4 | 65.6 | 248.8 | 69.7 | 250.3 | 73.8 | 251.8 | 78.1 |
| 66 | 253.4 | 56.0 | 254.5 | 60.2 | 255.8 | 64.4 | 257.1 | 68.7 | 258.5 | [illegible] | 260.0 | 77.3 | 261.6 | 81.7 |
| 67 | 263.8 | 58.7 | 265.0 | 63.2 | 266.2 | 67.5 | 267.6 | 72.0 | 269.1 | 76.5 | 270.7 | 81.1 | 272.4 | 85.7 |
| 68 | 275.1 | 61.7 | 276.4 | 66.3 | 277.7 | 71.0 | 279.1 | 75.7 | 280.7 | 80.4 | 282.3 | 85.2 | 284.1 | 90.1 |
| 69 | 287.6 | 64.9 | 288.9 | 69.8 | 290.3 | 74.7 | 291.8 | 79.6 | 293.4 | 84.6 | 295.1 | 89.7 | 296.9 | 94.8 |
| 70 | 301.3 | 68.5 | 302.7 | 73.6 | 304.2 | 78.8 | 305.7 | 84.0 | 307.4 | 89.3 | 309.2 | 94.6 | 311.1 | 100.0 |
| 71 | 316.6 | 72.4 | 318.0 | 77.8 | 319.5 | 83.3 | 321.2 | 88.8 | 323.0 | 94.4 | 324.9 | 100.0 | 326.9 | 105.7 |
| 72 | 335.5 | 76.7 | 335.0 | 82.5 | 336.7 | 88.3 | 338.4 | 94.1 | 340.3 | 100.0 | 342.3 | 106.0 | 344.4 | 112.0 |
| 73 | 352.5 | 81.5 | 354.1 | 87.6 | 355.8 | 93.8 | 357.7 | 100.0 | 359.6 | 106.3 | 361.7 | 112.6 | 364.0 | 119.0 |
| 74 | 373.9 | 86.9 | 375.6 | 93.4 | 377.4 | 100.0 | 379.4 | 106.6 | 381.5 | 113.3 | 383.7 | 120.1 | 386.1 | 126.9 |
| 75 | 398.2 | 93.0 | 400.0 | 100.0 | 401.9 | 107.0 | 404.0 | 114.1 | 406.3 | 121.3 | 408.6 | 128.5 | 411.2 | 135.8 |
| 76 | 426.0 | 100.0 | 427.9 | 107.5 | 430.0 | 115.1 | 432.2 | 122.6 | 434.6 | 130.3 | 437.2 | 138.1 | 439.9 | 146.0 |
| 77 | 458.2 | 108.0 | 460.2 | 116.1 | 462.5 | 124.2 | 464.8 | 132.4 | 467.4 | 140.7 | 471.2 | 149.1 | 473.1 | 157.7 |
| 78 | 495.7 | 117.3 | 497.9 | 127.6 | 500.4 | 134.9 | 502.8 | 143.8 | 505.7 | 152.9 | 508.7 | 162.0 | 511.8 | 171.2 |
| 79 | 540.1 | 118.3 | 542.6 | 137.8 | 548.2 | 147.5 | 548.0 | 157.3 | 551.1 | 167.2 | 554.3 | 177.1 | 557.7 | 187.2 |
| 80 | 593.5 | 141.1 | 596.2 | 152.0 | 599.1 | 162.6 | 602.2 | 173.4 | 605.5 | 184.3 | 609.1 | 195.3 | 612.8 | 206.4 |

| ° | 21° M | 21° N | 22° M | 22° N | 23° M | 23° N | 24° M | 24° N | 25° M | 25° N | 26° M | 26° N | 27° M | 27° N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 21 | 114.7 | 14.7 | | | | | | | | | | | | |
| 22 | 115.5 | 15.5 | 116.3 | 16.3 | | | | | | | | | | |
| 23 | 116.4 | 16.3 | 117.2 | 17.1 | 118.0 | 18.0 | | | | | | | | |
| 24 | 117.2 | 17.1 | 118.1 | 18.0 | 118.9 | 18.9 | 119.8 | 19.8 | | | | | | |
| 25 | 118.2 | 17.9 | 119.0 | 18.8 | 119.9 | 19.8 | 120.8 | 20.8 | 121.7 | 21.7 | | | | |
| 26 | 119.2 | 18.7 | 120.0 | 19.7 | 120.9 | 20.7 | 121.8 | 21.7 | 122.8 | 22.8 | 123.8 | 23.8 | | |
| 27 | 120.2 | 19.6 | 121.0 | 20.6 | 121.9 | 21.6 | 122.8 | 22.7 | 123.8 | 23.8 | 124.9 | 24.8 | 126.0 | 26.0 |
| 28 | 121.3 | 20.4 | 122.1 | 21.5 | 123.0 | 22.6 | 124.0 | 23.7 | 125.0 | 24.8 | 126.0 | 25.9 | 127.1 | 27.1 |

## SPHERICAL TRAVERSE TABLE

| ° | 21° M | 21° N | 22° M | 22° N | 23° M | 23° N | 24° M | 24° N | 25° M | 25° N | 26° M | 26° N | 27° M | 27° N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 29 | 122·5 | 21·3 | 123·3 | 22·4 | 124·2 | 23·5 | 125·2 | 24·7 | 126·2 | 25·8 | 127·2 | 27·0 | 128·3 | 28·2 |
| 30 | 123·2 | 22·2 | 124·5 | 23·3 | 125·4 | 24·5 | 126·4 | 25·7 | 127·4 | 26·9 | 128·2 | 28·2 | 129·6 | 29·4 |
| 31 | 125·0 | 23·1 | 125·8 | 24·3 | 126·7 | 25·5 | 127·7 | 26·7 | 128·7 | 28·0 | 129·8 | 29·3 | 130·9 | 30·6 |
| 32 | 126·3 | 24·0 | 127·2 | 25·2 | 128·1 | 26·5 | 129·1 | 27·8 | 130·1 | 29·1 | 131·2 | 30·5 | 132·3 | 31·8 |
| 33 | 127·7 | 24·9 | 128·6 | 26·2 | 129·5 | 27·6 | 130·5 | 28·9 | 131·6 | 30·3 | 132·7 | 31·7 | 133·8 | 33·1 |
| 34 | 129·2 | 25·9 | 130·1 | 27·2 | 131·0 | 28·6 | 132·0 | 30·0 | 133·1 | 31·4 | 134·2 | 32·9 | 135·4 | 34·4 |
| 35 | 130·8 | 26·9 | 131·7 | 28·3 | 132·6 | 29·7 | 133·6 | 31·2 | 134·7 | 32·6 | 135·8 | 34·1 | 137·0 | 35·7 |
| 36 | 132·4 | 27·9 | 133·3 | 29·4 | 134·3 | 30·8 | 135·3 | 32·3 | 136·4 | 33·9 | 137·5 | 35·4 | 138·7 | 37·0 |
| 37 | 134·1 | 28·9 | 135·0 | 30·4 | 136·0 | 32·0 | 137·1 | 33·5 | 138·2 | 35·1 | 139·3 | 36·7 | 140·5 | 38·4 |
| 38 | 135·9 | 30·0 | 136·9 | 31·6 | 137·9 | 33·2 | 138·9 | 34·8 | 140·0 | 36·4 | 141·2 | 38·1 | 142·4 | 39·8 |
| 39 | 137·8 | 31·1 | 138·8 | 32·7 | 139·5 | 34·4 | 140·9 | 36·0 | 142·0 | 37·8 | 143·2 | 39·5 | 144·4 | 41·2 |
| 40 | 139·8 | 32·2 | 140·8 | 33·9 | 141·8 | 35·6 | 142·9 | 37·4 | 144·0 | 39·1 | 145·2 | 40·9 | 146·5 | 42·8 |
| 41 | 141·9 | 33·4 | 142·9 | 35·1 | 143·9 | 36·9 | 145·0 | 38·7 | 146·2 | 40·5 | 147·4 | 42·4 | 148·7 | 44·3 |
| 42 | 144·1 | 34·6 | 145·1 | 36·4 | 146·2 | 38·2 | 147·3 | 40·1 | 148·5 | 42·0 | 149·7 | 43·9 | 151·0 | 45·9 |
| 43 | 146·5 | 35·8 | 147·5 | 37·7 | 148·5 | 39·6 | 149·7 | 41·5 | 150·9 | 43·5 | 152·1 | 45·5 | 153·5 | 47·5 |
| 44 | 148·9 | 37·1 | 149·9 | 39·0 | 151·0 | 41·0 | 152·2 | 43·0 | 153·4 | 45·0 | 154·7 | 47·1 | 156·0 | 49·2 |
| 45 | 151·5 | 38·4 | 152·5 | 40·4 | 153·6 | 42·4 | 154·8 | 44·5 | 156·0 | 46·6 | 157·3 | 48·8 | 158·7 | 50·4 |
| 46 | 154·2 | 39·7 | 155·3 | 41·8 | 156·4 | 44·0 | 157·6 | 46·1 | 158·8 | 48·3 | 160·2 | 50·5 | 161·6 | 52·8 |
| 47 | 157·1 | 41·2 | 158·1 | 43·3 | 159·3 | 45·5 | 160·5 | 47·8 | 161·8 | 50·0 | 163·1 | 52·3 | 164·6 | 54·6 |
| 48 | 160·1 | 42·6 | 161·2 | 44·9 | 162·3 | 47·1 | 163·6 | 49·4 | 164·9 | 51·8 | 166·3 | 54·2 | 167·7 | 56·6 |
| 49 | 163·3 | 44·2 | 164·4 | 46·5 | 165·6 | 48·8 | 166·8 | 51·2 | 168·2 | 53·6 | 169·6 | 56·1 | 171·1 | 58·6 |
| 50 | 166·6 | 45·7 | 167·8 | 48·1 | 169·0 | 50·6 | 170·3 | 53·1 | 171·6 | 55·6 | 173·1 | 58·1 | 174·6 | 60·7 |
| 51 | 170·2 | 47·4 | 171·4 | 49·9 | 172·7 | 52·4 | 173·9 | 55·0 | 175·3 | 57·6 | 176·8 | 60·2 | 178·3 | 62·9 |
| 52 | 174·0 | 49·1 | 175·2 | 51·7 | 176·4 | 54·3 | 177·8 | 57·0 | 179·2 | 59·7 | 180·7 | 62·4 | 182·3 | 65·2 |
| 53 | 178·0 | 50·9 | 179·2 | 53·6 | 180·5 | 56·3 | 181·9 | 59·1 | 183·3 | 61·9 | 184·9 | 64·7 | 186·5 | 67·6 |
| 54 | 182·2 | 52·8 | 183·5 | 55·6 | 184·8 | 58·4 | 186·2 | 61·3 | 187·7 | 64·2 | 189·3 | 67·1 | 190·9 | 70·1 |
| 55 | 186·7 | 54·8 | 188·0 | 57·7 | 189·4 | 60·6 | 190·8 | 63·6 | 192·4 | 66·6 | 194·0 | 69·7 | 195·7 | 72·8 |
| 56 | 191·6 | 56·9 | 192·9 | 59·9 | 194·3 | 62·9 | 195·7 | 66·0 | 197·3 | 69·1 | 199·0 | 72·3 | 200·7 | 75·5 |
| 57 | 196·7 | 59·1 | 198·0 | 62·2 | 199·5 | 65·4 | 201·0 | 68·6 | 202·6 | 71·8 | 204·3 | 75·1 | 206·1 | 78·5 |
| 58 | 202·1 | 61·4 | 203·5 | 64·7 | 205·0 | 67·9 | 206·6 | 71·2 | 208·2 | 74·6 | 210·0 | 78·0 | 211·8 | 81·5 |
| 59 | 208·0 | 63·9 | 209·4 | 67·2 | 210·9 | 70·6 | 212·5 | 74·1 | 214·2 | 77·6 | 216·0 | 81·2 | 217·9 | 84·8 |
| 60 | 214·2 | 66·5 | 215·7 | 70·0 | 217·3 | 73·5 | 218·9 | 77·1 | 220·7 | 80·8 | 222·5 | 84·5 | 224·5 | 88·2 |
| 61 | 220·9 | 69·2 | 222·5 | 72·9 | 224·1 | 76·6 | 225·8 | 80·3 | 227·6 | 84·1 | 229·5 | 88·0 | 231·5 | 9[illegible]·9 |
| 62 | 228·2 | 72·2 | 229·7 | 76·0 | 231·4 | 79·8 | 233·2 | 83·7 | 235·0 | 87·7 | 237·0 | 91·7 | 239·1 | 95·8 |
| 63 | 235·9 | 75·3 | 237·6 | 79·3 | 239·3 | 83·3 | 241·1 | 87·4 | 243·0 | 91·5 | 245·1 | 95·7 | 247·2 | 100·0 |
| 64 | 244·3 | 78·7 | 246·0 | 82·8 | 247·8 | 87·0 | 249·7 | 91·3 | 251·7 | 95·6 | 253·8 | 100·0 | 256·0 | 104·5 |
| 65 | 253·5 | 82·3 | 255·2 | 86·6 | 257·1 | 91·0 | 259·0 | 95·5 | 261·1 | 100·0 | 263·3 | 104·6 | 265·6 | 109·3 |
| 66 | 263·4 | 86·2 | 265·2 | 90·7 | 267·1 | 95·3 | 269·1 | 100·0 | 271·3 | 104·7 | 273·5 | 109·5 | 275·9 | 114·4 |
| 67 | 274·1 | 90·4 | 276·0 | 95·2 | 278·0 | 100·0 | 280·1 | 104·9 | 282·4 | 109·9 | 284·7 | 114·9 | 287·2 | 120·0 |
| 68 | 285·9 | 95·0 | 287·9 | 100·0 | 290·0 | 105·1 | 292·2 | 110·2 | 294·5 | 115·4 | 297·0 | 120·7 | 299·6 | 126·1 |
| 69 | 298·9 | 100·0 | 301·0 | 105·3 | 303·1 | 110·6 | 305·4 | 116·0 | 307·9 | 121·5 | 310·5 | 127·1 | 313·2 | 132·7 |
| 70 | 313·2 | 105·5 | 315·3 | 111·0 | 317·6 | 116·6 | 320·1 | 122·3 | 322·6 | 128·1 | 325·3 | 134·0 | 328·1 | 140·0 |
| 71 | 329·0 | 111·5 | 331·3 | 117·3 | 333·7 | 123·3 | 336·2 | 129·3 | 338·9 | 135·4 | 341·7 | 141·6 | 344·7 | 148·0 |
| 72 | 346·6 | 118·1 | 349·0 | 124·3 | 351·6 | 130·6 | 354·2 | 137·0 | 357·1 | 143·5 | 360·0 | 150·1 | 363·2 | 156·8 |
| 73 | 366·4 | 125·6 | 368·9 | 132·1 | 371·6 | 138·8 | 374·4 | 145·6 | 377·4 | 152·5 | 380·5 | 159·5 | 383·9 | 166·7 |
| 74 | 388·6 | 133·9 | 391·3 | 140·9 | 394·1 | 148·0 | 397·1 | 155·3 | 400·3 | 162·6 | 403·6 | 170·1 | 407·2 | 177·7 |
| 75 | 413·9 | 143·3 | 416·7 | 150·8 | 419·7 | 158·4 | 422·9 | 166·5 | 426·3 | 174·0 | 429·9 | 182·0 | 432·6 | 190·2 |
| 76 | 442·8 | 154·0 | 445·8 | 162·0 | 449·0 | 170·3 | 452·5 | 178·6 | 456·1 | 187·0 | 459·9 | 195·6 | 463·9 | 204·4 |
| 77 | 476·2 | 166·3 | 479·4 | 175·0 | 482·9 | 183·9 | 486·6 | 192·8 | 490·5 | 202·0 | 494·6 | 211·3 | 498·9 | 220·7 |
| 78 | 515·2 | 180·6 | 518·7 | 190·9 | 522·5 | 199·7 | 526·5 | 209·5 | 530·7 | 219·4 | 535·1 | 229·5 | 539·8 | 239·7 |
| 79 | 561·4 | 197·5 | 565·3 | 207·8 | 569·3 | 218·4 | 573·7 | 229·1 | 578·3 | 239·9 | 583·1 | 250·9 | 588·2 | 262·1 |
| 80 | 616·9 | 217·7 | 621·1 | 229·1 | 625·6 | 240·7 | 630·4 | 252·5 | 635·4 | 264·5 | 610·7 | 276·6 | 646·3 | 289·0 |

| ° | 28° M | 28° N | 29° M | 29° N | 30° M | 30° N | 31° M | 31° N | 32° M | 32° N | 33° M | 33° N | 34° M | 34° N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 28 | 128·3 | 28·3 | | | | | | | | | | | | |
| 29 | 129·5 | 29·5 | 130·7 | 30·7 | | | | | | | | | | |
| 30 | 130·8 | 30·7 | 132·0 | 32·0 | 133·3 | 33·3 | | | | | | | | |
| 31 | 132·1 | 31·9 | 133·4 | 33·3 | 134·7 | 34·7 | 136·1 | 36·1 | | | | | | |
| 32 | 133·5 | 33·2 | 134·8 | 34·6 | 136·2 | 36·1 | 137·6 | 37·5 | 139·0 | 39·0 | | | | |
| 33 | 135·0 | 34·5 | 136·3 | 36·0 | 137·7 | 37·5 | 139·1 | 39·0 | 140·6 | 40·6 | 142·2 | 42·2 | | |

## SPHERICAL TRAVERSE TABLE

| | 28° | | 29° | | 30° | | 31° | | 32° | | 33° | | 34° | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° | M | N | M | N | M | N | M | N | M | N | M | N | M | N |
| 34 | 136.6 | 35.9 | 137.9 | 37.4 | 139.3 | 38.9 | 140.7 | 40.5 | 142.2 | 42.1 | 143.8 | 43.8 | 145.5 | 45.5 |
| 35 | 138.3 | 37.2 | 139.6 | 38.8 | 141.0 | 40.4 | 142.4 | 42.1 | 143.9 | 43.8 | 145.6 | 45.5 | 147.3 | 47.2 |
| 36 | 140.0 | 38.6 | 141.3 | 40.3 | 142.7 | 41.9 | 144.2 | 43.7 | 145.8 | 45.4 | 147.4 | 47.2 | 149.1 | 49.0 |
| 37 | 141.8 | 40.1 | 143.2 | 41.8 | 144.6 | 43.5 | 146.1 | 45.3 | 147.6 | 47.1 | 149.3 | 48.9 | 151.0 | 50.8 |
| 38 | 143.7 | 41.5 | 145.1 | 43.3 | 146.5 | 45.1 | 148.0 | 46.9 | 149.6 | 48.8 | 151.3 | 50.7 | 153.1 | 52.7 |
| 39 | 145.7 | 43.1 | 147.1 | 44.9 | 148.6 | 46.7 | 150.1 | 48.7 | 151.7 | 50.6 | 153.4 | 52.6 | 155.2 | 54.6 |
| 40 | 147.8 | 44.6 | 149.3 | 46.5 | 150.7 | 48.4 | 152.3 | 50.4 | 153.9 | 52.4 | 155.7 | 54.5 | 157.5 | 56.6 |
| 41 | 150.1 | 46.2 | 151.5 | 48.2 | 153.0 | 50.2 | 154.6 | 52.2 | 156.2 | 54.3 | 158.0 | 56.4 | 159.8 | 58.6 |
| 42 | 152.4 | 47.9 | 153.9 | 49.9 | 155.4 | 52.0 | 157.0 | 54.1 | 158.7 | 56.3 | 160.4 | 58.5 | 162.3 | 60.8 |
| 43 | 154.9 | 49.6 | 156.3 | 51.7 | 157.9 | 53.8 | 159.5 | 56.0 | 161.2 | 58.3 | 163.0 | 60.6 | 164.9 | 62.9 |
| 44 | 157.5 | 51.3 | 158.9 | 53.5 | 160.5 | 55.8 | 162.2 | 58.0 | 163.9 | 60.3 | 165.8 | 62.7 | 167.7 | 65.1 |
| 45 | 160.2 | 53.2 | 161.7 | 55.4 | 163.3 | 57.7 | 165.0 | 60.1 | 166.8 | 62.5 | 168.6 | 64.9 | 170.6 | 67.4 |
| 46 | 163.0 | 55.1 | 164.6 | 57.4 | 166.2 | 59.8 | 167.9 | 62.2 | 169.7 | 64.7 | 171.6 | 67.2 | 173.6 | 69.8 |
| 47 | 166.1 | 57.0 | 167.6 | 59.4 | 169.3 | 61.9 | 171.1 | 64.4 | 172.9 | 67.0 | 174.8 | 69.6 | 176.9 | 72.3 |
| 48 | 169.3 | 59.0 | 170.9 | 61.6 | 172.6 | 64.1 | 174.3 | 66.7 | 176.2 | 69.4 | 178.2 | 72.1 | 180.3 | 74.9 |
| 49 | 172.6 | 61.2 | 174.3 | 63.8 | 176.0 | 66.4 | 177.8 | 69.1 | 179.7 | 71.9 | 181.7 | 74.7 | 183.9 | 77.6 |
| 50 | 176.2 | 63.4 | 177.9 | 66.1 | 179.1 | 68.8 | 181.5 | 71.6 | 183.4 | 74.5 | 185.5 | 77.4 | 187.7 | 80.4 |
| 51 | 180.0 | 65.7 | 181.7 | 68.4 | 183.5 | 70.3 | 185.4 | 74.2 | 187.4 | 77.2 | 189.5 | 80.2 | 191.7 | 83.3 |
| 52 | 184.0 | 68.1 | 185.7 | 70.9 | 187.6 | 73.9 | 189.5 | 76.9 | 191.5 | 80.0 | 193.7 | 83.1 | 195.9 | 86.3 |
| 53 | 188.2 | 70.6 | 190.0 | 73.6 | 191.9 | 76.6 | 193.8 | 79.7 | 195.9 | 82.9 | 198.1 | 86.2 | 200.4 | 89.5 |
| 54 | 192.7 | 73.2 | 194.5 | 76.3 | 196.4 | 79.5 | 198.5 | 82.7 | 200.6 | 86.0 | 202.9 | 89.4 | 205.2 | 92.8 |
| 55 | 197.5 | 75.9 | 199.3 | 79.2 | 201.3 | 82.4 | 203.4 | 85.8 | 205.6 | 89.2 | 207.9 | 92.7 | 210.3 | 96.3 |
| 56 | 202.5 | 78.8 | 204.5 | 82.2 | 206.5 | 85.6 | 208.6 | 89.1 | 210.9 | 92.6 | 213.2 | 96.3 | 215.7 | 100.0 |
| 57 | 207.9 | 80.0 | 209.9 | 85.4 | 212.0 | 88.9 | 214.2 | 92.5 | 216.6 | 96.2 | 218.9 | 100.0 | 221.5 | 103.9 |
| 58 | 213.7 | 85.1 | 215.8 | 88.7 | 217.9 | 92.4 | 220.2 | 96.2 | 222.5 | 100.0 | 225.0 | 103.9 | 227.6 | 107.9 |
| 59 | 219.9 | 88.5 | 222.0 | 92.2 | 224.2 | 96.1 | 226.5 | 100.0 | 228.9 | 104.0 | 231.5 | 108.1 | 234.2 | 112.3 |
| 60 | 226.5 | 92.1 | 228.7 | 96.0 | 230.9 | 100.0 | 233.3 | 104.1 | 235.8 | 108.2 | 238.5 | 112.5 | 241.2 | 116.8 |
| 61 | 233.6 | 95.9 | 235.8 | 100.0 | 238.2 | 104.2 | 240.6 | 108.4 | 243.2 | 112.7 | 245.9 | 117.2 | 248.8 | 121.7 |
| 62 | 241.2 | 100.0 | 243.5 | 104.2 | 246.0 | 108.6 | 248.5 | 113.0 | 251.2 | 117.5 | 254.0 | 122.1 | 256.9 | 126.9 |
| 63 | 249.5 | 104.3 | 251.8 | 108.8 | 254.3 | 113.3 | 257.0 | 117.9 | 259.7 | 122.6 | 262.6 | 127.5 | 265.7 | 132.4 |
| 64 | 258.4 | 109.0 | 260.8 | 113.6 | 263.4 | 118.4 | 266.1 | 123.2 | 269.0 | 128.1 | 272.0 | 133.1 | 275.2 | 138.3 |
| 65 | 268.0 | 114.0 | 270.5 | 118.9 | 273.2 | 123.8 | 276.0 | 128.9 | 279.0 | 134.0 | 282.1 | 139.3 | 285.4 | 144.6 |
| 66 | 278.5 | 119.4 | 281.1 | 124.5 | 283.9 | 129.7 | 286.8 | 135.0 | 289.9 | 140.3 | 293.2 | 145.9 | 296.6 | 151.5 |
| 67 | 289.9 | 125.3 | 292.6 | 130.6 | 295.5 | 136.0 | 298.6 | 141.6 | 301.8 | 147.2 | 305.2 | 153.0 | 308.6 | 158.9 |
| 68 | 302.3 | 131.6 | 305.2 | 137.2 | 308.2 | 142.9 | 311.4 | 148.7 | 314.8 | 154.7 | 318.3 | 160.7 | 322.0 | 167.0 |
| 69 | 316.0 | 138.5 | 319.0 | 144.4 | 322.2 | 150.4 | 325.5 | 156.5 | 329.0 | 162.8 | 332.7 | 169.2 | 336.6 | 175.7 |
| 70 | 331.1 | 146.1 | 334.3 | 152.3 | 337.6 | 158.6 | 341.1 | 165.1 | 344.8 | 171.7 | 348.6 | 178.4 | 352.7 | 185.3 |
| 71 | 347.9 | 154.4 | 351.2 | 161.0 | 354.7 | 167.7 | 358.3 | 174.5 | 362.2 | 181.5 | 366.2 | 188.6 | 370.5 | 195.9 |
| 72 | 366.5 | 163.6 | 370.0 | 170.6 | 373.7 | 177.7 | 377.5 | 184.9 | 381.6 | 192.3 | 385.9 | 199.9 | 390.3 | 207.6 |
| 73 | 387.4 | 173.9 | 391.1 | 181.3 | 394.9 | 188.8 | 399.0 | 196.5 | 403.3 | 204.4 | 407.8 | 212.4 | 412.6 | 220.6 |
| 74 | 410.9 | 185.4 | 414.8 | 193.9 | 413.9 | 201.3 | 423.2 | 209.5 | 427.8 | 217.9 | 432.6 | 226.5 | 437.6 | 235.2 |
| 75 | 437.6 | 198.4 | 441.8 | 206.8 | 446.1 | 215.5 | 450.7 | 224.2 | 455.6 | 234.3 | 460.7 | 242.4 | 466.0 | 251.7 |
| 76 | 468.2 | 213.3 | 472.6 | 222.3 | 477.3 | 231.6 | 482.2 | 241.0 | 487.4 | 250.6 | 492.9 | 260.5 | 498.6 | 270.5 |
| 77 | 503.5 | 230.3 | 508.3 | 240.1 | 513.3 | 250.1 | 518.6 | 260.3 | 524.2 | 270.7 | 530.1 | 281.3 | 536.2 | 292.1 |
| 78 | 544.7 | 250.1 | 549.9 | 260.8 | 555.4 | 271.6 | 561.1 | 282.9 | 567.2 | 294.0 | 573.5 | 305.5 | 580.2 | 317.3 |
| 79 | 593.6 | 273.5 | 599.2 | 285.2 | 605.2 | 297.0 | 611.4 | 309.1 | 618.0 | 321.5 | 624.9 | 334.1 | 632.2 | 347.0 |
| 80 | 652.2 | 301.5 | 658.4 | 314.4 | 665.0 | 327.4 | 671.8 | 340.8 | 679.0 | 354.4 | 686.7 | 368.3 | 694.6 | 382.5 |

| | 35° | | 36° | | 37° | | 38° | | 39° | | 40° | | 41° | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° | M | N | M | N | M | N | M | N | M | N | M | N | M | N |
| 35 | 149.0 | 49.0 | | | | | | | | | | | | |
| 36 | 150.9 | 50.9 | 152.8 | 52.8 | | | | | | | | | | |
| 37 | 152.9 | 52.8 | 154.8 | 54.7 | 156.8 | 56.8 | | | | | | | | |
| 38 | 154.9 | 54.7 | 156.9 | 56.8 | 158.9 | 58.9 | 161.0 | 61.0 | | | | | | |
| 39 | 157.1 | 56.7 | 159.0 | 58.8 | 161.1 | 61.0 | 163.3 | 63.3 | 165.6 | 65.6 | | | | |
| 40 | 159.4 | 58.8 | 161.4 | 61.0 | 163.5 | 63.2 | 165.7 | 65.6 | 168.0 | 67.9 | 170.4 | 70.4 | | |
| 41 | 161.8 | 60.9 | 163.8 | 63.2 | 166.0 | 65.5 | 168.1 | 67.9 | 170.5 | 70.4 | 173.0 | 72.9 | 175.6 | 75.6 |
| 42 | 164.3 | 63.0 | 166.3 | 65.4 | 168.2 | 67.8 | 170.8 | 70.3 | 173.1 | 72.9 | 175.7 | 75.5 | 178.4 | 78.3 |
| 43 | 166.9 | 65.3 | 169.0 | 67.7 | 171.2 | 70.3 | 173.5 | 72.9 | 175.9 | 75.5 | 178.5 | 78.2 | 181.2 | 81.1 |
| 44 | 169.7 | 67.6 | 171.8 | 70.2 | 174.1 | 72.8 | 176.4 | 75.4 | 178.9 | 78.2 | 181.5 | 81.0 | 184.2 | 83.9 |

## SPHERICAL TRAVERSE TABLE

| ° | 35° M | 35° N | 36° M | 36° N | 37° M | 37° N | 38° M | 38° N | 39° M | 39° N | 40° M | 40° N | 41° M | 41° N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 45 | 172·6 | 70·0 | 174·8 | 72·7 | 177·1 | 75·4 | 179·5 | 78·1 | 182·0 | 81·0 | 184·6 | 83·9 | 187·4 | 86·9 |
| 46 | 176·7 | 72·5 | 177·9 | 75·2 | 180·2 | 78·0 | 182·7 | 80·9 | 185·2 | 83·9 | 187·9 | 86·9 | 190·7 | 90·0 |
| 47 | 179·0 | 75·1 | 181·2 | 77·9 | 183·6 | 80·8 | 186·1 | 83·8 | 188·7 | 86·8 | 191·4 | 90·0 | 194·3 | 93·2 |
| 48 | 182·5 | 77·8 | 184·7 | 80·7 | 187·1 | 83·7 | 189·6 | 86·8 | 192·3 | 89·9 | 195·1 | 93·2 | 198·0 | 96·5 |
| 49 | 186·1 | 80·5 | 188·4 | 83·6 | 190·9 | 86·7 | 192·4 | 89·9 | 196·1 | 93·2 | 199·0 | 96·5 | 202·0 | 100·0 |
| 50 | 189·9 | 83·4 | 192·3 | 86·6 | 194·8 | 89·8 | 197·4 | 93·1 | 200·2 | 96·5 | 203·1 | 100·0 | 206·1 | 103·6 |
| 51 | 194·0 | 86·5 | 196·4 | 89·7 | 199·0 | 93·1 | 201·6 | 96·5 | 204·5 | 100·0 | 207·4 | 103·6 | 210·5 | 107·3 |
| 52 | 198·3 | 89·6 | 200·0 | 93·0 | 203·4 | 96·4 | 206·1 | 100·0 | 209·0 | 103·6 | 212·0 | 107·4 | 215·2 | 111·3 |
| 53 | 202·8 | 92·9 | 205·4 | 96·4 | 208·1 | 100·0 | 210·9 | 103·7 | 213·8 | 107·5 | 216·9 | 111·3 | 220·2 | 115·4 |
| 54 | 207·7 | 96·4 | 210·3 | 100·0 | 213·0 | 103·7 | 215·9 | 107·5 | 218·9 | 111·5 | 222·1 | 115·5 | 225·4 | 119·6 |
| 55 | 212·8 | 100·0 | 215·5 | 103·8 | 218·3 | 107·6 | 221·2 | 111·6 | 224·3 | 115·6 | 227·6 | 119·8 | 231·0 | 124·1 |
| 56 | 218·3 | 103·8 | 221·0 | 107·7 | 223·9 | 111·7 | 226·9 | 115·8 | 230·1 | 120·1 | 233·4 | 124·4 | 237·0 | 128·9 |
| 57 | 224·1 | 107·8 | 226·9 | 111·9 | 229·9 | 116·0 | 233·0 | 120·3 | 236·3 | 124·7 | 239·7 | 129·2 | 243·3 | 133·9 |
| 58 | 230·4 | 112·1 | 233·3 | 116·3 | 236·3 | 120·6 | 239·5 | 125·0 | 242·8 | 129·6 | 246·3 | 134·3 | 250·0 | 139·1 |
| 59 | 237·0 | 116·5 | 240·0 | 121·0 | 243·1 | 125·4 | 246·4 | 130·0 | 249·8 | 134·8 | 253·5 | 139·7 | 257·3 | 144·7 |
| 60 | 244·2 | 121·3 | 247·2 | 125·8 | 250·4 | 130·5 | 253·8 | 135·3 | 257·4 | 140·3 | 261·1 | 145·3 | 265·0 | 150·6 |
| 61 | 251·8 | 126·3 | 255·0 | 131·1 | 258·3 | 135·9 | 261·8 | 140·9 | 265·4 | 146·1 | 269·3 | 151·4 | 273·3 | 156·8 |
| 62 | 260·0 | 131·7 | 263·2 | 136·6 | 266·7 | 141·7 | 270·3 | 146·9 | 274·1 | 152·3 | 278·1 | 157·8 | 282·2 | 163·5 |
| 63 | 268·9 | 137·4 | 272·3 | 142·6 | 275·8 | 147·9 | 279·5 | 153·3 | 283·4 | 158·9 | 287·5 | 164·7 | 291·9 | 170·6 |
| 64 | 278·5 | 143·6 | 282·0 | 149·0 | 285·6 | 154·5 | 289·5 | 160·2 | 293·5 | 166·0 | 297·8 | 172·0 | 302·3 | 178·2 |
| 65 | 288·9 | 150·2 | 292·4 | 155·8 | 296·3 | 161·6 | 300·3 | 167·5 | 304·5 | 173·7 | 308·9 | 179·9 | 313·5 | 186·4 |
| 66 | 300·1 | 157·3 | 303·9 | 163·2 | 307·9 | 169·2 | 312·0 | 175·5 | 316·4 | 181·9 | 321·0 | 188·5 | 325·8 | 195·2 |
| 67 | 312·4 | 165·0 | 316·3 | 171·2 | 320·5 | 177·5 | 324·8 | 184·1 | 329·3 | 190·8 | 334·1 | 197·7 | 339·1 | 204·8 |
| 68 | 325·9 | 173·3 | 330·0 | 179·8 | 334·2 | 186·5 | 338·8 | 193·4 | 343·5 | 200·4 | 348·5 | 207·7 | 353·7 | 215·1 |
| 69 | 340·7 | 182·4 | 344·9 | 189·3 | 349·4 | 196·3 | 354·1 | 203·5 | 359·1 | 211·0 | 364·3 | 218·6 | 369·7 | 226·5 |
| 70 | 356·9 | 192·4 | 361·4 | 199·6 | 366·1 | 207·0 | 371·0 | 214·6 | 376·2 | 222·5 | 381·7 | 230·5 | 387·4 | 238·8 |
| 71 | 375·0 | 203·4 | 379·7 | 211·0 | 384·6 | 218·8 | 389·8 | 226·9 | 395·2 | 235·2 | 401·0 | 243·7 | 407·0 | 252·5 |
| 72 | 395·1 | 215·5 | 400·0 | 223·6 | 405·2 | 231·9 | 410·7 | 240·5 | 416·4 | 249·2 | 422·4 | 258·2 | 428·8 | 267·5 |
| 73 | 417·5 | 229·0 | 422·8 | 237·6 | 428·3 | 246·5 | 434·0 | 255·5 | 440·1 | 264·9 | 446·5 | 274·5 | 453·2 | 284·3 |
| 74 | 442·9 | 244·2 | 448·4 | 253·4 | 454·3 | 262·8 | 460·4 | 272·5 | 466·8 | 282·4 | 473·6 | 292·6 | 480·7 | 303·2 |
| 75 | 471·7 | 261·3 | 477·6 | 271·1 | 483·8 | 281·2 | 490·3 | 291·6 | 497·2 | 302·2 | 504·4 | 313·3 | 511·9 | 324·5 |
| 76 | 504·6 | 280·8 | 510·9 | 291·4 | 517·6 | 302·2 | 524·6 | 313·4 | 531·9 | 324·8 | 539·6 | 336·5 | 547·7 | 348·7 |
| 77 | 542·7 | 303·3 | 549·5 | 314·7 | 556·6 | 326·4 | 564·1 | 338·4 | 572·0 | 350·8 | 580·3 | 363·5 | 589·0 | 376·5 |
| 78 | 587·2 | 329·4 | 594·5 | 341·8 | 602·2 | 354·5 | 610·4 | 367·6 | 618·9 | 381·0 | 627·9 | 394·8 | 637·3 | 409·0 |
| 79 | 639·8 | 360·2 | 647·8 | 373·8 | 656·2 | 387·7 | 665·1 | 401·9 | 674·4 | 416·6 | 684·1 | 431·7 | 694·4 | 447·2 |
| 80 | 703·0 | 397·1 | 711·8 | 412·1 | 721·1 | 427·4 | 730·8 | 443·1 | 741·0 | 459·2 | 751·8 | 475·9 | 763·0 | 493·0 |

| ° | 42° M | 42° N | 43° M | 43° N | 44° M | 44° N | 45° M | 45° N | 46° M | 46° N | 47° M | 47° N | 48° M | 48° N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 42 | 181·1 | 81·1 | | | | | | | | | | | | |
| 43 | 184·0 | 84·0 | 187·0 | 87·0 | | | | | | | | | | |
| 44 | 187·1 | 86·9 | 190·1 | 90·0 | 193·3 | 93·3 | | | | | | | | |
| 45 | 190·3 | 90·0 | 193·4 | 93·3 | 196·6 | 96·6 | 200·0 | 100·0 | | | | | | |
| 46 | 193·7 | 93·2 | 196·8 | 96·6 | 200·1 | 100·0 | 203·6 | 103·5 | 207·2 | 107·2 | | | | |
| 47 | 197·3 | 96·6 | 200·5 | 100·0 | 203·8 | 103·6 | 207·4 | 107·2 | 211·1 | 111·0 | 215·0 | 115·0 | | |
| 48 | 201·1 | 100·0 | 204·3 | 103·6 | 207·8 | 107·3 | 211·3 | 111·1 | 215·1 | 115·0 | 219·1 | 119·1 | 223·3 | 123·3 |
| 49 | 205·1 | 103·6 | 208·4 | 107·3 | 211·9 | 111·1 | 215·6 | 115·0 | 219·4 | 119·1 | 223·5 | 123·4 | 227·8 | 127·8 |
| 50 | 209·3 | 107·3 | 212·7 | 111·1 | 216·3 | 115·1 | 220·0 | 119·2 | 224·0 | 123·4 | 228·2 | 127·8 | 232·5 | 132·4 |
| 51 | 213·8 | 111·2 | 217·3 | 115·2 | 220·9 | 119·3 | 224·7 | 123·5 | 228·7 | 127·9 | 233·0 | 132·4 | 237·5 | 137·2 |
| 52 | 218·6 | 115·2 | 222·1 | 119·4 | 225·8 | 123·6 | 229·7 | 128·0 | 233·8 | 132·5 | 238·2 | 137·3 | 242·7 | 142·2 |
| 53 | 223·6 | 119·5 | 227·2 | 123·7 | 231·0 | 128·2 | 235·0 | 132·7 | 239·2 | 137·4 | 243·6 | 142·3 | 248·3 | 147·4 |
| 54 | 228·9 | 123·9 | 232·6 | 128·3 | 236·5 | 132·9 | 240·6 | 137·6 | 244·9 | 142·5 | 249·5 | 147·6 | 254·3 | 152·9 |
| 55 | 234·6 | 128·6 | 238·4 | 133·2 | 242·4 | 137·9 | 246·6 | 142·8 | 251·0 | 147·9 | 255·6 | 153·1 | 260·6 | 158·6 |
| 56 | 240·6 | 133·5 | 244·5 | 138·2 | 248·6 | 143·2 | 252·9 | 148·3 | 257·4 | 153·5 | 262·2 | 159·0 | 267·3 | 164·7 |
| 57 | 247·7 | 138·6 | 251·0 | 143·6 | 255·2 | 148·7 | 259·7 | 154·0 | 264·3 | 159·5 | 269·2 | 165·1 | 274·4 | 171·0 |
| 58 | 253·9 | 144·1 | 258·0 | 149·2 | 262·3 | 154·5 | 266·9 | 160·0 | 271·7 | 165·7 | 276·7 | 171·6 | 282·0 | 177·7 |
| 59 | 261·3 | 149·9 | 265·5 | 155·2 | 269·9 | 160·7 | 274·6 | 166·4 | 279·5 | 172·3 | 284·7 | 178·5 | 290·2 | 184·8 |
| 60 | 269·1 | 156·0 | 273·5 | 161·5 | 278·0 | 167·3 | 282·8 | 173·2 | 287·9 | 179·4 | 293·3 | 185·7 | 298·9 | 192·4 |
| 61 | 277·6 | 162·4 | 282·0 | 168·2 | 286·7 | 174·2 | 291·7 | 180·4 | 296·9 | 186·8 | 302·4 | 193·5 | 308·3 | 200·4 |

## SPHERICAL TRAVERSE TABLE

| ° | 42° M | 42° N | 43° M | 43° N | 44° M | 44° N | 45° M | 45° N | 46° M | 46° N | 47° M | 47° N | 48° M | 48° N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 62 | 286·6 | 169·3 | 291·2 | 175·4 | 296·1 | 181·6 | 301·2 | 188·1 | 306·6 | 194·8 | 312·3 | 201·7 | 318·3 | 208·9 |
| 63 | 296·4 | 176·7 | 301·2 | 183·0 | 306·2 | 189·5 | 311·5 | 196·3 | 317·1 | 203·2 | 323·0 | 210·5 | 329·2 | 218·0 |
| 64 | 307·0 | 184·6 | 311·9 | 191·2 | 317·3 | 198·0 | 322·6 | 205·0 | 328·4 | 212·3 | 334·5 | 219·9 | 340·9 | 227·7 |
| 65 | 318·4 | 193·1 | 323·5 | 200·0 | 328·9 | 207·1 | 334·6 | 214·4 | 340·6 | 222·1 | 347·0 | 230·0 | 353·6 | 238·2 |
| 66 | 330·8 | 202·2 | 336·2 | 209·4 | 341·8 | 216·9 | 347·7 | 224·6 | 353·9 | 232·6 | 360·5 | 240·9 | 367·4 | 249·5 |
| 67 | 344·4 | 212·1 | 349·9 | 219·7 | 355·8 | 227·5 | 361·9 | 235·6 | 368·4 | 244·0 | 375·3 | 252·6 | 382·5 | 261·7 |
| 68 | 359·2 | 222·9 | 365·1 | 230·8 | 371·1 | 239·0 | 377·5 | 247·5 | 384·3 | 256·3 | 391·4 | 265·4 | 398·9 | 274·9 |
| 69 | 375·5 | 234·6 | 381·5 | 242·9 | 387·9 | 251·6 | 394·6 | 260·5 | 401·7 | 269·8 | 409·2 | 279·4 | 417·0 | 289·3 |
| 70 | 393·4 | 247·4 | 399·8 | 256·2 | 406·5 | 265·3 | 413·5 | 274·7 | 420·9 | 284·5 | 428·7 | 294·6 | 437·0 | 305·1 |
| 71 | 413·3 | 261·5 | 420·0 | 270·8 | 427·0 | 280·5 | 434·4 | 290·4 | 442·2 | 300·7 | 450·4 | 311·4 | 459·0 | 322·6 |
| 72 | 435·5 | 277·1 | 442·5 | 287·0 | 449·9 | 297·2 | 457·6 | 307·8 | 465·9 | 318·7 | 474·5 | 330·0 | 483·6 | 341·8 |
| 73 | 460·2 | 294·5 | 467·7 | 305·0 | 475·5 | 315·9 | 483·7 | 327·1 | 492·4 | 338·7 | 501·5 | 350·8 | 511·2 | 363·3 |
| 74 | 488·2 | 314·0 | 496·1 | 325·2 | 504·3 | 336·8 | 513·1 | 348·7 | 522·3 | 361·1 | 532·0 | 374·0 | 542·2 | 387·3 |
| 75 | 519·9 | 336·2 | 528·3 | 348·0 | 537·1 | 360·4 | 546·4 | 373·2 | 556·2 | 386·5 | 566·5 | 400·2 | 577·4 | 414·5 |
| 76 | 556·2 | 361·1 | 565·2 | 374·0 | 574·6 | 387·3 | 584·6 | 401·1 | 595·0 | 415·3 | 606·1 | 430·1 | 617·7 | 445·5 |
| 77 | 598·2 | 390·0 | 607·8 | 403·9 | 618·0 | 418·3 | 628·7 | 433·2 | 639·9 | 448·5 | 651·8 | 464·5 | 664·4 | 481·1 |
| 78 | 647·2 | 423·6 | 657·6 | 438·7 | 668·6 | 453·4 | 680·2 | 470·5 | 692·4 | 437·2 | 705·2 | 504·5 | 718·8 | 522·5 |
| 79 | 705·2 | 463·2 | 716·6 | 479·7 | 728·6 | 496·8 | 741·2 | 514·5 | 754·4 | 532·7 | 768·5 | 551·7 | 783·2 | 571·4 |
| 80 | 774·9 | 510·6 | 787·4 | 528·9 | 800·6 | 547·7 | 814·4 | 567·1 | 829·0 | 587·3 | 844·4 | 608·2 | 860·6 | 629·9 |

| ° | 49° M | 49° N | 50° M | 50° N | 51° M | 51° N | 52° M | 52° N | 53° M | 53° N | 54° M | 54° N | 55° M | 55° N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 49 | 232·3 | 132·3 | | | | | | | | | | | | |
| 50 | 237·1 | 137·1 | 242·0 | 142·0 | | | | | | | | | | |
| 51 | 242·2 | 142·1 | 247·2 | 147·2 | 252·5 | 152·5 | | | | | | | | |
| 52 | 247·6 | 147·2 | 252·7 | 152·5 | 258·1 | 158·1 | 263·8 | 163·8 | | | | | | |
| 53 | 253·3 | 152·7 | 258·5 | 158·2 | 264·0 | 163·9 | 269·9 | 169·9 | 276·1 | 176·1 | | | | |
| 54 | 259·3 | 158·3 | 264·7 | 164·0 | 270·3 | 170·0 | 276·3 | 176·2 | 282·7 | 182·7 | 289·4 | 189·4 | | |
| 55 | 265·7 | 164·3 | 271·2 | 170·2 | 277·0 | 176·4 | 283·2 | 182·8 | 289·7 | 189·5 | 296·6 | 196·6 | 304·0 | 204·0 |
| 56 | 272·6 | 170·5 | 278·2 | 176·7 | 284·2 | 183·1 | 290·5 | 189·8 | 297·2 | 196·7 | 304·2 | 204·1 | 311·8 | 211·7 |
| 57 | 279·9 | 177·1 | 285·6 | 183·5 | 291·8 | 190·2 | 298·2 | 197·1 | 305·1 | 204·3 | 312·4 | 211·9 | 320·1 | 219·9 |
| 58 | 287·6 | 184·1 | 293·6 | 190·7 | 299·9 | 197·6 | 306·5 | 204·8 | 313·6 | 212·4 | 321·0 | 220·3 | 329·0 | 228·5 |
| 59 | 296·0 | 191·5 | 302·1 | 198·3 | 308·5 | 205·5 | 315·4 | 213·0 | 322·6 | 220·9 | 330·3 | 229·1 | 338·5 | 237·7 |
| 60 | 304·9 | 199·2 | 311·1 | 206·4 | 317·8 | 213·9 | 324·9 | 221·7 | 332·3 | 229·9 | 340·3 | 238·4 | 348·7 | 247·4 |
| 61 | 314·4 | 207·5 | 320·9 | 215·0 | 327·8 | 222·8 | 335·0 | 230·9 | 342·7 | 239·4 | 350·9 | 248·3 | 359·6 | 257·6 |
| 62 | 324·7 | 216·4 | 331·4 | 224·1 | 338·5 | 232·3 | 346·0 | 240·7 | 353·9 | 249·6 | 362·4 | 258·9 | 371·3 | 268·6 |
| 63 | 335·7 | 225·8 | 342·7 | 233·9 | 350·0 | 242·4 | 357·8 | 251·2 | 366·0 | 260·4 | 374·7 | 270·1 | 384·0 | 280·3 |
| 64 | 347·7 | 235·9 | 354·9 | 244·3 | 362·5 | 253·2 | 370·5 | 262·4 | 379·1 | 272·1 | 388·1 | 282·2 | 397·7 | 292·8 |
| 65 | 360·7 | 246·7 | 368·1 | 255·6 | 376·0 | 264·8 | 384·3 | 274·5 | 393·2 | 284·6 | 402·6 | 295·2 | 412·5 | 306·3 |
| 66 | 374·8 | 258·4 | 382·5 | 267·7 | 390·6 | 277·4 | 399·3 | 287·5 | 408·5 | 298·1 | 418·3 | 309·1 | 418·9 | 320·8 |
| 67 | 390·1 | 271·0 | 398·2 | 280·8 | 406·6 | 290·9 | 415·7 | 301·5 | 425·3 | 312·6 | 435·4 | 324·3 | 446·2 | 336·4 |
| 68 | 406·9 | 284·7 | 415·3 | 295·0 | 424·1 | 305·6 | 433·6 | 316·8 | 443·6 | 328·5 | 454·2 | 340·7 | 465·4 | 353·5 |
| 69 | 425·3 | 299·7 | 434·1 | 310·5 | 443·3 | 321·7 | 453·2 | 333·4 | 463·7 | 345·7 | 474·7 | 358·6 | 486·5 | 372·0 |
| 70 | 445·7 | 316·1 | 454·9 | 327·2 | 464·6 | 339·3 | 474·9 | 351·7 | 485·8 | 364·6 | 497·4 | 378·2 | 509·8 | 392·4 |
| 71 | 468·2 | 334·1 | 477·8 | 346·1 | 488·1 | 358·6 | 498·9 | 371·7 | 510·4 | 385·4 | 522·6 | 399·7 | 535·5 | 414·8 |
| 72 | 493·3 | 354·0 | 503·4 | 366·8 | 514·2 | 380·1 | 525·6 | 393·9 | 537·7 | 408·4 | 550·6 | 423·6 | 564·2 | 439·5 |
| 73 | 521·3 | 376·3 | 532·1 | 389·8 | 543·5 | 403·9 | 555·5 | 418·6 | 568·3 | 434·1 | 581·9 | 450·2 | 596·3 | 467·1 |
| 74 | 553·0 | 401·2 | 564·4 | 415·6 | 576·5 | 430·7 | 589·3 | 446·4 | 602·8 | 462·8 | 617·2 | 480·0 | 632·5 | 498·0 |
| 75 | 588·9 | 429·3 | 601·1 | 444·8 | 613·9 | 460·9 | 627·6 | 477·7 | 642·0 | 495·3 | 657·3 | 513·7 | 673·6 | 533·0 |
| 76 | 630·1 | 461·4 | 643·1 | 478·0 | 656·8 | 495·3 | 671·4 | 513·4 | 686·8 | 532·3 | 703·2 | 552·0 | 720·7 | 572·8 |
| 77 | 677·6 | 498·3 | 691·6 | 516·2 | 706·4 | 534·9 | 722·1 | 554·4 | 738·7 | 574·8 | 756·3 | 596·2 | 775·0 | 618·6 |
| 78 | 733·1 | 541·2 | 748·3 | 560·7 | 764·3 | 581·0 | 781·2 | 602·2 | 799·2 | 624·3 | 818·3 | 647·5 | 838·6 | 671·5 |
| 79 | 798·8 | 591·8 | 815·3 | 613·1 | 832·8 | 635·3 | 851·3 | 658·5 | 870·8 | 682·7 | 891·6 | 708·1 | 913·7 | 734·7 |
| 80 | 877·8 | 652·4 | 895·9 | 675·9 | 915·1 | 700·3 | 935·4 | 725·9 | 950·6 | 752·6 | 979·7 | 780·6 | 1004 | 809·9 |

## SPHERICAL TRAVERSE TABLE

| ° | 56° M | 56° N | 57° M | 57° N | 58° M | 58° N | 59° M | 59° N | 60° M | 60° N | 61° M | 61° N | 62° M | 62° N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 56 | 319·8 | 219·8 | | | | | | | | | | | | |
| 57 | 328·3 | 228·3 | 337·1 | 237·2 | | | | | | | | | | |
| 58 | 337·5 | 237·3 | 346·5 | 246·4 | 356·1 | 256·1 | | | | | | | | |
| 59 | 347·2 | 246·7 | 356·5 | 256·3 | 366·4 | 266·3 | 377·0 | 277·0 | | | | | | |
| 60 | 357·7 | 256·8 | 367·2 | 266·1 | 377·4 | 277·2 | 383·3 | 288·3 | 400·0 | 300·0 | | | | |
| 61 | 368·9 | 267·5 | 378·7 | 277·8 | 389·5 | 288·7 | 400·5 | 300·2 | 412·5 | 312·5 | 425·5 | 325·5 | | |
| 62 | 380·9 | 278·8 | 391·1 | 289·6 | 402·0 | 301·0 | 413·6 | 313·0 | 426·0 | 325·8 | 439·4 | 339·3 | 453·7 | 353·7 |
| 63 | 393·9 | 291·0 | 404·4 | 302·2 | 415·7 | 314·1 | 427·7 | 326·6 | 440·5 | 339·9 | 454·3 | 354·1 | 469·2 | 369·1 |
| 64 | 407·9 | 303·9 | 418·8 | 315·7 | 430·5 | 328·1 | 442·9 | 341·2 | 456·2 | 355·1 | 470·5 | 36[illegible]·9 | 485·9 | 385·6 |
| 65 | 423·1 | 317·9 | 434·0 | 330·2 | 446·5 | 343·2 | 459·4 | 356·9 | 473·2 | 371·4 | 488·1 | 386·9 | 504·0 | 403·3 |
| 66 | 439·7 | 333·0 | 451·4 | 345·9 | 464·0 | 359·4 | 477·4 | 373·8 | 491·7 | 389·0 | 507·1 | 405·2 | 523·7 | 422·4 |
| 67 | 457·7 | 349·3 | 469·9 | 362·8 | 483·0 | 377·0 | 496·9 | 392·1 | 511·9 | 398·8 | 527·9 | 425·0 | 545·1 | 443·1 |
| 68 | 477·4 | 366·9 | 490·1 | 381·1 | 503·7 | 396·1 | 518·3 | 411·9 | 533·9 | 428·7 | 550·6 | 446·5 | 568·6 | 465·5 |
| 69 | 499·0 | 386·2 | 512·3 | 401·1 | 526·6 | 416·9 | 541·8 | 433·6 | 558·1 | 451·2 | 575·6 | 470·0 | 594·4 | 489·9 |
| 70 | 522·9 | 407·3 | 536·8 | 423·1 | 551·7 | 429·7 | 567·7 | 457·3 | 584·8 | 475·9 | 603·1 | 495·7 | 622·8 | 516·7 |
| 71 | 549·3 | 430·6 | 564·0 | 447·2 | 579·6 | 464·8 | 596·4 | 483·3 | 614·3 | 503·0 | 633·6 | 523·9 | 654·3 | 546·2 |
| 72 | 578·7 | 456·3 | 594·2 | 473·9 | 610·7 | 492·5 | 628·3 | 512·2 | 647·2 | 533·1 | 667·5 | 555·2 | 689·3 | 578·8 |
| 73 | 611·6 | 484·9 | 628·0 | 503·7 | 645·4 | 523·4 | 664·1 | 544·4 | 684·1 | 566·7 | 705·5 | 590·1 | 728·5 | 615·2 |
| 74 | 648·8 | 517·0 | 666·1 | 537·0 | 684·6 | 558·1 | 704·4 | 580·5 | 725·6 | 604·0 | 748·3 | 629·1 | 772·8 | 655·9 |
| 75 | 690·9 | 553·3 | 709·4 | 574·7 | 729·1 | 597·3 | 756·2 | 621·1 | 772·7 | 646·4 | 796·9 | 673·3 | 823·0 | 701·9 |
| 76 | 739·2 | 594·6 | 758·9 | 617·6 | 780·0 | 641·9 | 802·6 | 667·5 | 826·7 | 694·7 | 852·6 | 723·6 | 880·5 | 754·3 |
| 77 | 795·0 | 642·2 | 816·2 | 667·0 | 838·9 | 693·2 | 863·1 | 720·9 | 889·1 | 750·2 | 916·9 | 781·4 | 946·9 | 814·6 |
| 78 | 860·1 | 697·5 | 883·1 | 724·5 | 907·6 | 752·9 | 933·9 | 783·0 | 961·9 | 814·9 | 992·1 | 848·8 | 1024 | 884·8 |
| 79 | 937·2 | 762·7 | 962·3 | 792·2 | 989·0 | 823·3 | 1018 | 856·2 | 1048 | 891·1 | 1081 | 928·1 | 1116 | 967·6 |
| 80 | 1030 | 840·8 | 1057 | 873·3 | 1087 | 907·6 | 1118 | 943·9 | 1152 | 982·3 | 1188 | 1023 | 1227 | 1067 |

| ° | 63° M | 63° N | 64° M | 64° N | 65° M | 65° N | 66° M | 66° N | 67° M | 67° N | 68° M | 68° N | 69° M | 69° N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 63 | 485·2 | 385·2 | | | | | | | | | | | | |
| 64 | 502·5 | 402·4 | 520·4 | 420·4 | | | | | | | | | | |
| 65 | 521·2 | 420·9 | 539·8 | 439·7 | 559·9 | 459·9 | | | | | | | | |
| 66 | 541·6 | 440·8 | 560·9 | 460·5 | 581·8 | 481·7 | 604·5 | 504·5 | | | | | | |
| 67 | 563·7 | 462·4 | 583·8 | 483·0 | 605·6 | 505·2 | 629·2 | 529·1 | 655·0 | 555·0 | | | | |
| 68 | 588·0 | 485·8 | 608·9 | 507·5 | 631·6 | 530·8 | 656·3 | 555·9 | 683·2 | 583·1 | 712·6 | 612·6 | | |
| 69 | 614·6 | 511·3 | 636·5 | 534·1 | 660·3 | 558·7 | 686·1 | 595·1 | 714·2 | 613·7 | 744·9 | 644·8 | 778·6 | 678·6 |
| 70 | 644·0 | 539·2 | 667·0 | 563·3 | 691·8 | 589·2 | 718·9 | 617·1 | 748·3 | 647·3 | 780·5 | 680·0 | 815·9 | 715·7 |
| 71 | 676·6 | 570·0 | 700·7 | 595·4 | 726·8 | 622·8 | 755·2 | 652·3 | 786·1 | 684·2 | 819·9 | 718·8 | 857·1 | 756·6 |
| 72 | 712·8 | 604·0 | 738·2 | 631·0 | 765·7 | 660·0 | 795·6 | 691·3 | 828·2 | 725·1 | 863·9 | 761·7 | 903·0 | 801·8 |
| 73 | 753·4 | 641·9 | 780·2 | 670·6 | 809·3 | 701·4 | 840·9 | 734·6 | 875·3 | 770·6 | 913·0 | 809·6 | 954·4 | 852·1 |
| 74 | 799·1 | 684·4 | 827·6 | 715·0 | 858·4 | 747·9 | 892·0 | 783·3 | 928·5 | 821·6 | 968·5 | 863·2 | 1002 | 908·5 |
| 75 | 851·0 | 732·5 | 881·4 | 765·2 | 914·2 | 800·4 | 949·9 | 838·2 | 988·8 | 879·2 | 1031 | 923·7 | 1078 | 972·2 |
| 76 | 910·5 | 787·2 | 942·9 | 822·3 | 978·1 | 860·1 | 1016 | 900·8 | 1058 | 944·9 | 1103 | 992·7 | 1153 | 1045 |
| 77 | 979·2 | 850·1 | 1014 | 888·1 | 1052 | 928·9 | 1093 | 972·9 | 1138 | 1020 | 1187 | 1072 | 1241 | 1128 |
| 78 | 1059 | 923·3 | 1097 | 964·6 | 1087 | 1009 | 1183 | 1057 | 1231 | 1108 | 1284 | 1164 | 1342 | 1226 |
| 79 | 1154 | 1010 | 1196 | 1055 | 1240 | 1103 | 1288 | 1155 | 1341 | 1212 | 1399 | 1273 | 1462 | 1340 |
| 80 | 1268 | 1113 | 1314 | 1163 | 1363 | 1216 | 1416 | 1274 | 1474 | 1336 | 1537 | 1404 | 1607 | 1477 |

| ° | 70° M | 70° N | 71° M | 71° N | 72° M | 72° N | 73° M | 73° N | 74° M | 74° N | 75° M | 75° N | 76° M | 76° N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 70 | 854·9 | 754·9 | | | | | | | | | | | | |
| 71 | 898·1 | 797·9 | 943·5 | 843·5 | | | | | | | | | | |
| 72 | 946·2 | 845·6 | 994·0 | 893·8 | 1047 | 947·2 | | | | | | | | |
| 73 | 1000 | 898·6 | 1051 | 949·9 | 1107 | 1008 | 1170 | 1070 | | | | | | |
| 74 | 1061 | 958·1 | 1114 | 1013 | 1174 | 1073 | 1241 | 1141 | 1316 | 1216 | | | | |
| 75 | 1130 | 1025 | 1187 | 1084 | 1250 | 1149 | 1321 | 1221 | 1402 | 1301 | 1493 | 1394 | | |
| 76 | 1209 | 1102 | 1270 | 1165 | 1338 | 1234 | 1414 | 1312 | 1500 | 1399 | 1597 | 1497 | 1709 | 1609 |
| 77 | 1300 | 1190 | 1366 | 1258 | 1439 | 1333 | 1520 | 1417 | 1613 | 1511 | 1718 | 1617 | 1838 | 1737 |
| 78 | 1406 | 1293 | 1477 | 1366 | 1556 | 1448 | 1645 | 1539 | 1745 | 1641 | 1858 | 1756 | 1988 | 1887 |
| 79 | 1532 | 1413 | 1610 | 1494 | 1696 | 1583 | 1793 | 1683 | 1901 | 1794 | 2025 | 1920 | 2116 | 2063 |
| 80 | 1684 | 1558 | 1769 | 1647 | 1864 | 1745 | 1970 | 1856 | 2089 | 1978 | 2225 | 2117 | 2380 | 2275 |

## MERIDIONAL PARTS

LATITUDE

| ′ | 0° | 1° | 2° | 3° | 4° | 5° | 6° | 7° | 8° | 9° | 10° | 11° | 12° | 13° | 14° | 15° | 16° | 17° | 18° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 60 | 120 | 180 | 240 | 300 | 361 | 421 | 482 | 542 | 603 | 664 | 725 | 787 | 848 | 910 | 973 | 1035 | 1098 |
| 1 | 1 | 61 | 121 | 181 | 241 | 301 | 362 | 422 | 483 | 543 | 604 | 665 | 726 | 788 | 850 | 911 | 974 | 1036 | 1099 |
| 2 | 2 | 62 | 122 | 182 | 242 | 302 | 363 | 423 | 484 | 544 | 605 | 666 | 727 | 789 | 851 | 913 | 975 | 1037 | 1100 |
| 3 | 3 | 63 | 123 | 183 | 243 | 303 | 364 | 424 | 485 | 545 | 606 | 667 | 728 | 790 | 852 | 914 | 976 | 1038 | 1101 |
| 4 | 4 | 64 | 124 | 184 | 244 | 304 | 365 | 425 | 486 | 546 | 607 | 668 | 729 | 791 | 853 | 915 | 977 | 1039 | 1102 |
| 5 | 5 | 65 | 125 | 185 | 245 | 305 | 366 | 426 | 487 | 547 | 608 | 669 | 730 | 792 | 854 | 916 | 978 | 1041 | 1103 |
| 6 | 6 | 66 | 126 | 186 | 246 | 306 | 367 | 427 | 488 | 548 | 609 | 670 | 731 | 793 | 855 | 917 | 979 | 1042 | 1105 |
| 7 | 7 | 67 | 127 | 187 | 247 | 307 | 368 | 428 | 489 | 549 | 610 | 671 | 732 | 794 | 856 | 918 | 980 | 1043 | 1106 |
| 8 | 8 | 68 | 128 | 188 | 248 | 308 | 369 | 429 | 490 | 550 | 611 | 672 | 734 | 795 | 857 | 919 | 981 | 1044 | 1107 |
| 9 | 9 | 69 | 129 | 189 | 249 | 309 | 370 | 430 | 491 | 551 | 612 | 673 | 735 | 796 | 858 | 920 | 982 | 1045 | 1108 |
| 10 | 10 | 70 | 130 | 190 | 250 | 310 | 371 | 431 | 492 | 552 | 613 | 674 | 736 | 797 | 859 | 921 | 983 | 1046 | 1109 |
| 11 | 11 | 71 | 131 | 191 | 251 | 311 | 372 | 432 | 493 | 553 | 614 | 675 | 737 | 798 | 860 | 922 | 984 | 1047 | 1110 |
| 12 | 12 | 72 | 132 | 192 | 252 | 312 | 373 | 433 | 494 | 554 | 615 | 676 | 738 | 799 | 861 | 923 | 985 | 1048 | 1111 |
| 13 | 13 | 73 | 133 | 193 | 253 | 313 | 374 | 434 | 495 | 555 | 616 | 677 | 739 | 800 | 862 | 924 | 986 | 1049 | 1112 |
| 14 | 14 | 74 | 134 | 194 | 254 | 314 | 375 | 435 | 496 | 556 | 617 | 678 | 740 | 801 | 863 | 925 | 987 | 1050 | 1113 |
| 15 | 15 | 75 | 135 | 195 | 255 | 315 | 376 | 436 | 497 | 557 | 618 | 679 | 741 | 802 | 864 | 926 | 988 | 1051 | 1114 |
| 16 | 16 | 76 | 136 | 196 | 256 | 316 | 377 | 437 | 498 | 558 | 619 | 680 | 742 | 803 | 865 | 927 | 989 | 1052 | 1115 |
| 17 | 17 | 77 | 137 | 197 | 257 | 317 | 378 | 438 | 499 | 559 | 620 | 681 | 743 | 804 | 866 | 928 | 990 | 1053 | 1116 |
| 18 | 18 | 78 | 138 | 198 | 258 | 318 | 379 | 439 | 500 | 560 | 621 | 682 | 744 | 805 | 867 | 929 | 991 | 1054 | 1117 |
| 19 | 19 | 79 | 139 | 199 | 259 | 319 | 380 | 440 | 501 | 561 | 622 | 683 | 745 | 806 | 868 | 930 | 993 | 1055 | 1118 |
| 20 | 20 | 80 | 140 | 200 | 260 | 320 | 381 | 441 | 502 | 562 | 623 | 684 | 746 | 807 | 869 | 931 | 994 | 1056 | 1119 |
| 21 | 21 | 81 | 141 | 201 | 261 | 321 | 382 | 442 | 503 | 564 | 624 | 685 | 747 | 808 | 870 | 932 | 995 | 1057 | 1120 |
| 22 | 22 | 82 | 142 | 202 | 262 | 322 | 383 | 443 | 504 | 565 | 625 | 687 | 748 | 809 | 871 | 933 | 996 | 1058 | 1121 |
| 23 | 23 | 83 | 143 | 203 | 263 | 323 | 384 | 444 | 505 | 566 | 626 | 688 | 749 | 810 | 872 | 934 | 997 | 1059 | 1122 |
| 24 | 24 | 84 | 144 | 204 | 264 | 324 | 385 | 445 | 506 | 567 | 627 | 689 | 750 | 811 | 873 | 935 | 998 | 1060 | 1123 |
| 25 | 25 | 85 | 145 | 205 | 265 | 325 | 386 | 446 | 507 | 568 | 628 | 690 | 751 | 812 | 874 | 936 | 999 | 1061 | 1125 |
| 26 | 26 | 86 | 146 | 206 | 266 | 326 | 387 | 447 | 508 | 569 | 629 | 691 | 752 | 813 | 875 | 937 | 1000 | 1063 | 1126 |
| 27 | 27 | 87 | 147 | 207 | 267 | 327 | 388 | 448 | 509 | 570 | 631 | 692 | 753 | 815 | 876 | 938 | 1001 | 1064 | 1127 |
| 28 | 28 | 88 | 148 | 208 | 268 | 328 | 389 | 449 | 510 | 571 | 632 | 693 | 754 | 816 | 877 | 939 | 1002 | 1065 | 1128 |
| 29 | 29 | 89 | 149 | 209 | 269 | 330 | 390 | 450 | 511 | 572 | 633 | 694 | 755 | 817 | 878 | 941 | 1003 | 1066 | 1129 |
| 30 | 30 | 90 | 150 | 210 | 270 | 331 | 391 | 451 | 512 | 573 | 634 | 695 | 756 | 818 | 879 | 942 | 1004 | 1067 | 1130 |
| 31 | 31 | 91 | 151 | 211 | 271 | 332 | 392 | 452 | 513 | 574 | 635 | 696 | 757 | 819 | 880 | 943 | 1005 | 1068 | 1131 |
| 32 | 32 | 92 | 152 | 212 | 272 | 333 | 393 | 453 | 514 | 575 | 636 | 697 | 758 | 820 | 882 | 944 | 1006 | 1069 | 1132 |
| 33 | 33 | 93 | 153 | 213 | 273 | 334 | 394 | 454 | 515 | 576 | 637 | 698 | 759 | 821 | 883 | 945 | 1007 | 1070 | 1133 |
| 34 | 34 | 94 | 154 | 214 | 274 | 335 | 395 | 455 | 516 | 577 | 638 | 699 | 760 | 822 | 884 | 946 | 1008 | 1071 | 1134 |
| 35 | 35 | 95 | 155 | 215 | 275 | 336 | 396 | 456 | 517 | 578 | 639 | 700 | 761 | 823 | 885 | 947 | 1009 | 1072 | 1135 |
| 36 | 36 | 96 | 156 | 216 | 276 | 337 | 397 | 457 | 518 | 579 | 640 | 701 | 762 | 824 | 886 | 948 | 1010 | 1073 | 1136 |
| 37 | 37 | 97 | 157 | 217 | 277 | 338 | 398 | 458 | 519 | 580 | 641 | 702 | 763 | 825 | 887 | 949 | 1011 | 1074 | 1137 |
| 38 | 38 | 98 | 158 | 218 | 278 | 339 | 399 | 459 | 520 | 581 | 642 | 703 | 764 | 826 | 888 | 950 | 1012 | 1075 | 1138 |
| 39 | 39 | 99 | 159 | 219 | 279 | 340 | 400 | 460 | 521 | 582 | 643 | 704 | 765 | 827 | 889 | 951 | 1013 | 1076 | 1139 |
| 40 | 40 | 100 | 160 | 220 | 280 | 341 | 401 | 461 | 522 | 583 | 644 | 705 | 766 | 828 | 890 | 952 | 1014 | 1077 | 1140 |
| 41 | 41 | 101 | 161 | 221 | 281 | 342 | 402 | 462 | 523 | 584 | 645 | 706 | 767 | 829 | 891 | 953 | 1015 | 1078 | 1141 |
| 42 | 42 | 102 | 162 | 222 | 282 | 343 | 403 | 463 | 524 | 585 | 646 | 707 | 768 | 830 | 892 | 954 | 1016 | 1079 | 1142 |
| 43 | 43 | 103 | 163 | 223 | 283 | 344 | 404 | 464 | 525 | 586 | 647 | 708 | 769 | 831 | 893 | 955 | 1018 | 1080 | 1144 |
| 44 | 44 | 104 | 164 | 224 | 284 | 345 | 405 | 465 | 526 | 587 | 648 | 709 | 770 | 832 | 894 | 956 | 1019 | 1081 | 1145 |
| 45 | 45 | 105 | 165 | 225 | 285 | 346 | 406 | 466 | 527 | 588 | 649 | 710 | 771 | 833 | 895 | 957 | 1020 | 1082 | 1146 |
| 46 | 46 | 106 | 166 | 226 | 286 | 347 | 407 | 467 | 528 | 589 | 650 | 711 | 772 | 834 | 896 | 958 | 1021 | 1084 | 1147 |
| 47 | 47 | 107 | 167 | 227 | 287 | 348 | 408 | 468 | 529 | 590 | 651 | 712 | 773 | 835 | 897 | 959 | 1022 | 1085 | 1148 |
| 48 | 48 | 108 | 168 | 228 | 288 | 349 | 409 | 469 | 530 | 591 | 652 | 713 | 774 | 836 | 898 | 960 | 1023 | 1086 | 1149 |
| 49 | 49 | 109 | 169 | 229 | 289 | 350 | 410 | 470 | 531 | 592 | 653 | 714 | 775 | 837 | 899 | 961 | 1024 | 1087 | 1150 |
| 50 | 50 | 110 | 170 | 230 | 290 | 351 | 411 | 471 | 532 | 593 | 654 | 715 | 777 | 838 | 900 | 962 | 1025 | 1088 | 1151 |
| 51 | 51 | 111 | 171 | 231 | 291 | 352 | 412 | 472 | 533 | 594 | 655 | 716 | 778 | 839 | 901 | 963 | 1026 | 1089 | 1152 |
| 52 | 52 | 112 | 172 | 232 | 292 | 353 | 413 | 473 | 534 | 595 | 656 | 717 | 779 | 840 | 902 | 964 | 1027 | 1090 | 1153 |
| 53 | 53 | 113 | 173 | 233 | 293 | 354 | 414 | 474 | 535 | 596 | 657 | 718 | 780 | 841 | 903 | 965 | 1028 | 1091 | 1154 |
| 54 | 54 | 114 | 174 | 234 | 294 | 355 | 415 | 476 | 536 | 597 | 658 | 719 | 781 | 842 | 904 | 966 | 1029 | 1092 | 1155 |
| 55 | 55 | 115 | 175 | 235 | 295 | 356 | 416 | 477 | 537 | 598 | 659 | 720 | 782 | 843 | 905 | 968 | 1030 | 1093 | 1156 |
| 56 | 56 | 116 | 176 | 236 | 296 | 357 | 417 | 478 | 538 | 599 | 660 | 721 | 783 | 844 | 906 | 969 | 1031 | 1094 | 1157 |
| 57 | 57 | 117 | 177 | 237 | 297 | 358 | 418 | 479 | 539 | 600 | 661 | 722 | 784 | 845 | 907 | 970 | 1032 | 1095 | 1158 |
| 58 | 58 | 118 | 178 | 238 | 298 | 359 | 419 | 480 | 540 | 601 | 662 | 723 | 785 | 846 | 908 | 971 | 1033 | 1096 | 1159 |
| 59 | 59 | 119 | 179 | 239 | 299 | 360 | 420 | 481 | 541 | 602 | 663 | 724 | 786 | 847 | 909 | 972 | 1034 | 1097 | 1160 |
| ′ | 0° | 1° | 2° | 3° | 4° | 5° | 6° | 7° | 8° | 9° | 10° | 11° | 12° | 13° | 14° | 15° | 16° | 17° | 18° |

## MERIDIONAL PARTS

LATITUDE

| ′ | 19° | 20° | 21° | 22° | 23° | 24° | 25° | 26° | 27° | 28° | 29° | 30° | 31° | 32° | 33° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1161 | 1225 | 1289 | 1354 | 1419 | 1484 | 1550 | 1616 | 1684 | 1751 | 1819 | 1888 | 1958 | 2028 | 2100 |
| 1 | 1163 | 1226 | 1290 | 1355 | 1420 | 1485 | 1551 | 1618 | 1685 | 1752 | 1821 | 1890 | 1959 | 2030 | 2101 |
| 2 | 1164 | 1227 | 1291 | 1356 | 1421 | 1486 | 1552 | 1619 | 1686 | 1753 | 1822 | 1891 | 1960 | 2031 | 2102 |
| 3 | 1165 | 1228 | 1292 | 1357 | 1422 | 1487 | 1553 | 1620 | 1687 | 1755 | 1823 | 1892 | 1962 | 2032 | 2103 |
| 4 | 1166 | 1229 | 1293 | 1358 | 1423 | 1488 | 1554 | 1621 | 1688 | 1756 | 1824 | 1893 | 1963 | 2033 | 2104 |
| 5 | 1167 | 1230 | 1295 | 1359 | 1424 | 1490 | 1556 | 1622 | 1689 | 1757 | 1825 | 1894 | 1964 | 2034 | 2105 |
| 6 | 1168 | 1232 | 1296 | 1360 | 1425 | 1491 | 1557 | 1623 | 1690 | 1758 | 1826 | 1895 | 1965 | 2035 | 2107 |
| 7 | 1169 | 1233 | 1297 | 1361 | 1426 | 1492 | 1558 | 1624 | 1691 | 1759 | 1827 | 1896 | 1966 | 2037 | 2108 |
| 8 | 1170 | 1234 | 1298 | 1362 | 1427 | 1493 | 1559 | 1625 | 1693 | 1760 | 1829 | 1898 | 1967 | 2038 | 2109 |
| 9 | 1171 | 1235 | 1299 | 1363 | 1428 | 1494 | 1560 | 1626 | 1694 | 1761 | 1830 | 1899 | 1969 | 2039 | 2110 |
| 10 | 1172 | 1236 | 1300 | 1364 | 1430 | 1495 | 1561 | 1628 | 1695 | 1762 | 1831 | 1900 | 1970 | 2040 | 2111 |
| 11 | 1173 | 1237 | 1301 | 1366 | 1431 | 1496 | 1562 | 1629 | 1696 | 1764 | 1832 | 1901 | 1971 | 2041 | 2113 |
| 12 | 1174 | 1238 | 1302 | 1367 | 1432 | 1497 | 1563 | 1630 | 1697 | 1765 | 1833 | 1902 | 1972 | 2043 | 2114 |
| 13 | 1175 | 1239 | 1303 | 1368 | 1433 | 1498 | 1564 | 1631 | 1698 | 1766 | 1834 | 1903 | 1973 | 2044 | 2115 |
| 14 | 1176 | 1240 | 1304 | 1369 | 1434 | 1499 | 1565 | 1632 | 1699 | 1767 | 1835 | 1905 | 1974 | 2045 | 2116 |
| 15 | 1177 | 1241 | 1305 | 1370 | 1435 | 1500 | 1567 | 1633 | 1700 | 1768 | 1837 | 1906 | 1976 | 2046 | 2117 |
| 16 | 1178 | 1242 | 1306 | 1371 | 1436 | 1502 | 1568 | 1634 | 1701 | 1769 | 1838 | 1907 | 1977 | 2047 | 2119 |
| 17 | 1179 | 1243 | 1307 | 1372 | 1437 | 1503 | 1569 | 1635 | 1703 | 1770 | 1839 | 1908 | 1978 | 2048 | 2120 |
| 18 | 1181 | 1244 | 1308 | 1373 | 1438 | 1504 | 1570 | 1637 | 1704 | 1772 | 1840 | 1909 | 1979 | 2050 | 2121 |
| 19 | 1182 | 1245 | 1310 | 1374 | 1439 | 1505 | 1571 | 1638 | 1705 | 1773 | 1841 | 1910 | 1980 | 2051 | 2122 |
| 20 | 1183 | 1246 | 1311 | 1375 | 1440 | 1506 | 1572 | 1639 | 1706 | 1774 | 1842 | 1912 | 1981 | 2052 | 2123 |
| 21 | 1184 | 1248 | 1312 | 1376 | 1441 | 1507 | 1573 | 1640 | 1707 | 1775 | 1843 | 1913 | 1983 | 2053 | 2125 |
| 22 | 1185 | 1249 | 1313 | 1377 | 1443 | 1508 | 1574 | 1641 | 1708 | 1776 | 1845 | 1914 | 1984 | 2054 | 2126 |
| 23 | 1186 | 1250 | 1314 | 1379 | 1444 | 1509 | 1575 | 1642 | 1709 | 1777 | 1846 | 1915 | 1985 | 2056 | 2127 |
| 24 | 1187 | 1251 | 1315 | 1380 | 1445 | 1510 | 1577 | 1643 | 1711 | 1778 | 1847 | 1916 | 1986 | 2057 | 2128 |
| 25 | 1188 | 1252 | 1316 | 1381 | 1446 | 1511 | 1578 | 1644 | 1712 | 1780 | 1848 | 1917 | 1987 | 2058 | 2129 |
| 26 | 1189 | 1253 | 1317 | 1382 | 1447 | 1513 | 1579 | 1645 | 1713 | 1781 | 1849 | 1918 | 1988 | 2059 | 2131 |
| 27 | 1190 | 1254 | 1318 | 1383 | 1448 | 1514 | 1580 | 1647 | 1714 | 1782 | 1850 | 1920 | 1990 | 2060 | 2132 |
| 28 | 1191 | 1255 | 1319 | 1384 | 1449 | 1515 | 1581 | 1648 | 1715 | 1783 | 1852 | 1921 | 1991 | 2061 | 2133 |
| 29 | 1192 | 1256 | 1320 | 1385 | 1450 | 1516 | 1582 | 1649 | 1716 | 1784 | 1853 | 1922 | 1992 | 2063 | 2134 |
| 30 | 1193 | 1257 | 1321 | 1386 | 1451 | 1517 | 1583 | 1650 | 1717 | 1785 | 1854 | 1923 | 1993 | 2064 | 2135 |
| 31 | 1194 | 1258 | 1322 | 1387 | 1452 | 1518 | 1584 | 1651 | 1718 | 1786 | 1855 | 1924 | 1994 | 2065 | 2137 |
| 32 | 1195 | 1259 | 1324 | 1388 | 1453 | 1519 | 1585 | 1652 | 1720 | 1787 | 1856 | 1925 | 1995 | 2066 | 2138 |
| 33 | 1196 | 1260 | 1325 | 1389 | 1455 | 1520 | 1586 | 1653 | 1721 | 1789 | 1857 | 1927 | 1997 | 2067 | 2139 |
| 34 | 1198 | 1261 | 1326 | 1390 | 1456 | 1521 | 1588 | 1654 | 1722 | 1790 | 1858 | 1928 | 1998 | 2069 | 2140 |
| 35 | 1199 | 1262 | 1327 | 1392 | 1457 | 1522 | 1589 | 1656 | 1723 | 1791 | 1860 | 1929 | 1999 | 2070 | 2141 |
| 36 | 1200 | 1264 | 1328 | 1393 | 1458 | 1524 | 1590 | 1657 | 1724 | 1792 | 1861 | 1930 | 2000 | 2071 | 2143 |
| 37 | 1201 | 1265 | 1329 | 1394 | 1459 | 1525 | 1591 | 1658 | 1725 | 1793 | 1862 | 1931 | 2001 | 2072 | 2144 |
| 38 | 1202 | 1266 | 1330 | 1395 | 1460 | 1526 | 1592 | 1659 | 1726 | 1794 | 1863 | 1932 | 2002 | 2073 | 2145 |
| 39 | 1203 | 1267 | 1331 | 1396 | 1461 | 1527 | 1593 | 1660 | 1727 | 1795 | 1864 | 1934 | 2004 | 2075 | 2146 |
| 40 | 1204 | 1268 | 1332 | 1397 | 1462 | 1528 | 1594 | 1661 | 1729 | 1797 | 1865 | 1935 | 2005 | 2076 | 2147 |
| 41 | 1205 | 1269 | 1333 | 1398 | 1463 | 1529 | 1595 | 1662 | 1730 | 1798 | 1866 | 1936 | 2006 | 2077 | 2149 |
| 42 | 1206 | 1270 | 1334 | 1399 | 1464 | 1530 | 1596 | 1663 | 1731 | 1799 | 1868 | 1937 | 2007 | 2078 | 2150 |
| 43 | 1207 | 1271 | 1335 | 1400 | 1465 | 1531 | 1598 | 1664 | 1732 | 1800 | 1869 | 1938 | 2008 | 2079 | 2151 |
| 44 | 1208 | 1272 | 1336 | 1401 | 1467 | 1532 | 1599 | 1666 | 1733 | 1801 | 1870 | 1939 | 2010 | 2080 | 2152 |
| 45 | 1209 | 1273 | 1338 | 1402 | 1468 | 1533 | 1600 | 1667 | 1734 | 1802 | 1871 | 1941 | 2011 | 2082 | 2153 |
| 46 | 1210 | 1274 | 1339 | 1403 | 1469 | 1535 | 1601 | 1668 | 1735 | 1803 | 1872 | 1942 | 2012 | 2083 | 2155 |
| 47 | 1211 | 1275 | 1340 | 1405 | 1470 | 1536 | 1602 | 1669 | 1736 | 1805 | 1873 | 1943 | 2013 | 2084 | 2156 |
| 48 | 1212 | 1276 | 1341 | 1406 | 1471 | 1537 | 1603 | 1670 | 1738 | 1806 | 1875 | 1944 | 2014 | 2085 | 2157 |
| 49 | 1213 | 1277 | 1342 | 1407 | 1472 | 1538 | 1604 | 1671 | 1739 | 1807 | 1876 | 1945 | 2015 | 2086 | 2158 |
| 50 | 1215 | 1278 | 1343 | 1408 | 1473 | 1539 | 1605 | 1672 | 1740 | 1808 | 1877 | 1946 | 2017 | 2088 | 2159 |
| 51 | 1216 | 1280 | 1344 | 1409 | 1474 | 1540 | 1606 | 1673 | 1741 | 1809 | 1878 | 1948 | 2018 | 2089 | 2161 |
| 52 | 1217 | 1281 | 1345 | 1410 | 1475 | 1541 | 1608 | 1675 | 1742 | 1810 | 1879 | 1949 | 2019 | 2090 | 2162 |
| 53 | 1218 | 1282 | 1346 | 1411 | 1476 | 1542 | 1609 | 1676 | 1743 | 1811 | 1880 | 1950 | 2020 | 2091 | 2163 |
| 54 | 1219 | 1283 | 1347 | 1412 | 1477 | 1543 | 1610 | 1677 | 1744 | 1813 | 1881 | 1951 | 2021 | 2092 | 2164 |
| 55 | 1220 | 1284 | 1348 | 1413 | 1479 | 1544 | 1611 | 1678 | 1746 | 1814 | 1883 | 1952 | 2022 | 2094 | 2165 |
| 56 | 1221 | 1285 | 1349 | 1414 | 1480 | 1546 | 1612 | 1679 | 1747 | 1815 | 1884 | 1953 | 2024 | 2095 | 2167 |
| 57 | 1222 | 1286 | 1350 | 1415 | 1481 | 1547 | 1613 | 1680 | 1748 | 1816 | 1885 | 1955 | 2025 | 2096 | 2168 |
| 58 | 1223 | 1287 | 1352 | 1416 | 1482 | 1548 | 1614 | 1681 | 1749 | 1817 | 1886 | 1956 | 2026 | 2097 | 2169 |
| 59 | 1224 | 1288 | 1353 | 1418 | 1483 | 1549 | 1615 | 1682 | 1750 | 1818 | 1887 | 1957 | 2027 | 2098 | 2170 |
| ′ | 19° | 20° | 21° | 22° | 23° | 24° | 25° | 26° | 27° | 28° | 29° | 30° | 31° | 32° | 33° |

## MERIDIONAL PARTS

LATITUDE

| ′ | 34° | 35° | 36° | 37° | 38° | 39° | 40° | 41° | 42° | 43° | 44° | 45° | 46° | 47° | 48° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 2171 | 2244 | 2318 | 2393 | 2468 | 2545 | 2623 | 2702 | 2782 | 2863 | 2946 | 3030 | 3116 | 3203 | 3292 |
| 1 | 2173 | 2246 | 2319 | 2394 | 2470 | 2546 | 2624 | 2703 | 2783 | 2864 | 2947 | 3031 | 3117 | 3204 | 3293 |
| 2 | 2174 | 2247 | 2320 | 2395 | 2471 | 2548 | 2625 | 2704 | 2784 | 2866 | 2949 | 3033 | 3118 | 3206 | 3295 |
| 3 | 2175 | 2248 | 2322 | 2396 | 2472 | 2549 | 2627 | 2706 | 2786 | 2867 | 2950 | 3034 | 3120 | 3207 | 3296 |
| 4 | 2176 | 2249 | 2323 | 2398 | 2473 | 2550 | 2628 | 2707 | 2787 | 2869 | 2951 | 3036 | 3121 | 3209 | 3298 |
| 5 | 2178 | 2250 | 2324 | 2399 | 2475 | 2551 | 2629 | 2708 | 2788 | 2870 | 2953 | 3037 | 3123 | 3210 | 3299 |
| 6 | 2179 | 2252 | 2325 | 2400 | 2476 | 2553 | 2631 | 2710 | 2790 | 2871 | 2954 | 3038 | 3124 | 3212 | 3301 |
| 7 | 2180 | 2253 | 2327 | 2401 | 2477 | 2554 | 2632 | 2711 | 2791 | 2873 | 2956 | 3040 | 3126 | 3213 | 3302 |
| 8 | 2181 | 2254 | 2328 | 2403 | 2478 | 2555 | 2633 | 2712 | 2792 | 2874 | 2957 | 3041 | 3127 | 3214 | 3303 |
| 9 | 2182 | 2255 | 2329 | 2404 | 2480 | 2557 | 2634 | 2714 | 2794 | 2875 | 2958 | 3043 | 3129 | 3216 | 3305 |
| 10 | 2184 | 2257 | 2330 | 2405 | 2481 | 2558 | 2636 | 2715 | 2795 | 2877 | 2960 | 3044 | 3130 | 3217 | 3306 |
| 11 | 2185 | 2258 | 2332 | 2406 | 2482 | 2559 | 2637 | 2716 | 2797 | 2878 | 2961 | 3046 | 3131 | 3219 | 3308 |
| 12 | 2186 | 2259 | 2333 | 2408 | 2484 | 2560 | 2638 | 2718 | 2798 | 2880 | 2963 | 3047 | 3133 | 3220 | 3309 |
| 13 | 2187 | 2260 | 2334 | 2409 | 2485 | 2562 | 2640 | 2719 | 2799 | 2881 | 2964 | 3048 | 3134 | 3222 | 3311 |
| 14 | 2188 | 2261 | 2335 | 2410 | 2486 | 2563 | 2641 | 2720 | 2801 | 2882 | 2965 | 3050 | 3136 | 3223 | 3312 |
| 15 | 2190 | 2263 | 2337 | 2411 | 2487 | 2564 | 2642 | 2722 | 2802 | 2884 | 2967 | 3051 | 3137 | 3225 | 3314 |
| 16 | 2191 | 2264 | 2338 | 2413 | 2489 | 2566 | 2644 | 2723 | 2803 | 2885 | 2968 | 3053 | 3139 | 3226 | 3316 |
| 17 | 2192 | 2265 | 2339 | 2414 | 2490 | 2567 | 2645 | 2724 | 2805 | 2886 | 2970 | 3054 | 3140 | 3228 | 3317 |
| 18 | 2193 | 2266 | 2340 | 2415 | 2491 | 2568 | 2646 | 2726 | 2806 | 2888 | 2971 | 3055 | 3142 | 3229 | 3319 |
| 19 | 2194 | 2268 | 2342 | 2416 | 2492 | 2569 | 2648 | 2727 | 2807 | 2889 | 2972 | 3057 | 3143 | 3231 | 3320 |
| 20 | 2196 | 2269 | 2343 | 2418 | 2494 | 2571 | 2649 | 2728 | 2809 | 2891 | 2974 | 3058 | 3144 | 3232 | 3322 |
| 21 | 2197 | 2270 | 2344 | 2419 | 2495 | 2572 | 2650 | 2729 | 2810 | 2892 | 2975 | 3060 | 3146 | 3234 | 3323 |
| 22 | 2198 | 2271 | 2345 | 2420 | 2496 | 2573 | 2651 | 2731 | 2811 | 2893 | 2976 | 3061 | 3147 | 3235 | 3325 |
| 23 | 2199 | 2272 | 2346 | 2422 | 2498 | 2575 | 2653 | 2732 | 2813 | 2895 | 2978 | 3063 | 3149 | 3237 | 3326 |
| 24 | 2200 | 2274 | 2348 | 2423 | 2499 | 2576 | 2654 | 2733 | 2814 | 2896 | 2979 | 3064 | 3150 | 3238 | 3328 |
| 25 | 2202 | 2275 | 2349 | 2424 | 2500 | 2577 | 2655 | 2735 | 2815 | 289[illegible] | 2981 | 3065 | 3152 | 3240 | 3329 |
| 26 | 2203 | 2276 | 2350 | 2425 | 2501 | 2578 | 2657 | 2736 | 2817 | 2899 | 2982 | 3067 | 3153 | 3241 | 3331 |
| 27 | 2204 | 2277 | 2351 | 2427 | 2503 | 2580 | 2658 | 2737 | 2818 | 2900 | 2983 | 3068 | 3155 | 3242 | 3332 |
| 28 | 2205 | 2279 | 2353 | 2428 | 2504 | 2581 | 2659 | 2739 | 2820 | 2902 | 2985 | 3070 | 3156 | 3244 | 3334 |
| 29 | 2207 | 2280 | 2354 | 2429 | 2505 | 2582 | 2661 | 2740 | 2821 | 2903 | 2986 | 3071 | 3157 | 3245 | 33[illegible]5 |
| 30 | 2208 | 2281 | 2355 | 2430 | 2506 | 2584 | 2662 | 2742 | 2822 | 2904 | 2988 | 3073 | 3159 | 3247 | 3337 |
| 31 | 2209 | 2282 | 2356 | 2432 | 2508 | 2585 | 2663 | 2743 | 2824 | 2906 | 298[illegible] | 3074 | 3160 | 3248 | 3338 |
| 32 | 2210 | 2283 | 2358 | 2433 | 2509 | 2586 | 2665 | 2744 | 2825 | 2907 | 2991 | 3075 | 3162 | 3250 | 3340 |
| 33 | 2211 | 2285 | 2359 | 2434 | 2510 | 2588 | 2666 | 2746 | 2826 | 2908 | 2992 | 3077 | 3163 | 3251 | 3341 |
| 34 | 2213 | 2286 | 2360 | 2435 | 2512 | 2589 | 2667 | 2747 | 2828 | 2910 | 2993 | 3078 | 3165 | 3253 | 3343 |
| 35 | 2214 | 2287 | 2361 | 2437 | 2513 | 2590 | 2669 | 2748 | 2829 | 2911 | 2995 | 3080 | 3166 | 3254 | 3344 |
| 36 | 2215 | 2288 | 2363 | 2438 | 2514 | 2591 | 2670 | 2750 | 2830 | 2913 | 2996 | 3081 | 3168 | 3256 | 3346 |
| 37 | 2216 | 2290 | 2364 | 2439 | 2515 | 2593 | 2671 | 2751 | 2832 | 2914 | 2998 | 3083 | 3169 | 3257 | 3347 |
| 38 | 2217 | 2291 | 2365 | 2440 | 2517 | 2594 | 2673 | 2752 | 2833 | 2915 | 2999 | 3084 | 3171 | 3259 | 3349 |
| 39 | 2219 | 2292 | 2366 | 2442 | 2518 | 2595 | 2674 | 2754 | 2834 | 2917 | 3000 | 3085 | 3172 | 3260 | 3350 |
| 40 | 2220 | 2293 | 2368 | 2443 | 2519 | 2597 | 2675 | 2755 | 2836 | 2918 | 3002 | 3087 | 3173 | 3262 | 3352 |
| 41 | 2221 | 2295 | 2369 | 2444 | 2521 | 2598 | 2676 | 2756 | 2837 | 2919 | 3003 | 3088 | 3175 | 3263 | 3353 |
| 42 | 2222 | 2296 | 2370 | 2445 | 2522 | 2599 | 2678 | 2758 | 2839 | 2921 | 3005 | 3090 | 3176 | 3265 | 3355 |
| 43 | 2224 | 2297 | 2371 | 2447 | 2523 | 2601 | 2679 | 2759 | 2840 | 2922 | 3006 | 3091 | 3178 | 3266 | 3356 |
| 44 | 2225 | 2298 | 2373 | 2448 | 2524 | 2602 | 2680 | 2760 | 2841 | 2924 | 3007 | 3093 | 3179 | 3268 | 3358 |
| 45 | 2226 | 2299 | 2374 | 2449 | 2526 | 2603 | 2682 | 2762 | 2843 | 2925 | 3009 | 3094 | 3181 | 3269 | 3359 |
| 46 | 2227 | 2301 | 2375 | 2451 | 2527 | 2604 | 2683 | 2763 | 2844 | 2926 | 3010 | 3095 | 3182 | 3271 | 3361 |
| 47 | 2228 | 2302 | 2376 | 2452 | 2528 | 2606 | 2684 | 2764 | 2845 | 2928 | 3012 | 3097 | 3184 | 3272 | 3362 |
| 48 | 2230 | 2303 | 2378 | 2453 | 2530 | 2607 | 2686 | 2766 | 2847 | 2929 | 3013 | 3098 | 3185 | 3274 | 3364 |
| 49 | 2231 | 2304 | 2379 | 2454 | 2531 | 2608 | 2687 | 2767 | 2848 | 2931 | 3014 | 3100 | 3187 | 3275 | 3365 |
| 50 | 2232 | 2306 | 2380 | 2456 | 2532 | 2610 | 2688 | 2768 | 2849 | 2932 | 3016 | 3101 | 3188 | 3277 | 3367 |
| 51 | 2233 | 2307 | 2381 | 2457 | 2533 | 2611 | 2690 | 2770 | 2851 | 2933 | 3017 | 3103 | 3190 | 3278 | 3368 |
| 52 | 2235 | 2308 | 2383 | 2458 | 2535 | 2612 | 2691 | 2771 | 2852 | 2935 | 3019 | 3104 | 3191 | 3280 | 3370 |
| 53 | 2236 | 2309 | 2384 | 2459 | 2536 | 2614 | 2692 | 2772 | 2854 | 2936 | 3020 | 3105 | 3192 | 328[illegible] | 3371 |
| 54 | 2237 | 2311 | 2385 | 2461 | 2537 | 2615 | 2694 | 2774 | 2855 | 2937 | 3021 | 3107 | 3194 | 3283 | 3373 |
| 55 | 2238 | 2312 | 2386 | 2462 | 2538 | 2616 | 2695 | 2775 | 2856 | 2939 | 3023 | 3108 | 3195 | 3284 | 3374 |
| 56 | 2239 | 2313 | 2388 | 2463 | 2540 | 2617 | 2696 | 2776 | 2858 | 2940 | 3024 | 3110 | 3197 | 3286 | 3376 |
| 57 | 2241 | 2314 | 2389 | 2464 | 2541 | 2619 | 2698 | 2778 | 2859 | 2942 | 3026 | 3111 | 3198 | 3287 | 3378 |
| 58 | 2242 | 2316 | 2390 | 2466 | 2542 | 2620 | 2699 | 2779 | 2860 | 2943 | 3027 | 3113 | 3200 | 3289 | 3379 |
| 59 | 2243 | 2317 | 2391 | 2467 | 2544 | 2621 | 2700 | 2780 | 2862 | 2944 | 3029 | 3114 | 3201 | 3290 | 3381 |
| ′ | 34° | 35° | 36° | 37° | 38° | 39° | 40° | 41° | 42° | 43° | 44° | 45° | 46° | 47° | 48° |

## MERIDIONAL PARTS

LATITUDE

| ′ | 49° | 50° | 51° | 52° | 53° | 54° | 55° | 56° | 57° | 58° | 59° | 60° | 61° | 62° | 63° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 3382 | 3474 | 3569 | 3665 | 3764 | 3865 | 3968 | 4074 | 4183 | 4294 | 4409 | 4527 | 4649 | 4775 | 4905 |
| 1 | 3384 | 3476 | 3570 | 3667 | 3765 | 3866 | 3970 | 4076 | 4184 | 4296 | 4411 | 4529 | 4651 | 4777 | 4907 |
| 2 | 3385 | 3478 | 3572 | 3668 | 3767 | 3868 | 3971 | 4077 | 4186 | 4298 | 4413 | 4531 | 4653 | 4779 | 4909 |
| 3 | 3387 | 3479 | 3574 | 3670 | 3769 | 3870 | 3973 | 4079 | 4188 | 4300 | 4415 | 4533 | 4655 | 4781 | 4912 |
| 4 | 3388 | 3481 | 3575 | 3672 | 3770 | 3871 | 3975 | 4081 | 4190 | 4302 | 4417 | 4535 | 4657 | 4784 | 4914 |
| 5 | 3390 | 3482 | 3577 | 3673 | 3772 | 3873 | 3977 | 4083 | 4192 | 4304 | 4419 | 4537 | 4660 | 4786 | 4916 |
| 6 | 3391 | 3484 | 3578 | 3675 | 3774 | 3875 | 3978 | 4085 | 4194 | 4306 | 4421 | 4539 | 4662 | 4788 | 4918 |
| 7 | 3393 | 3485 | 3580 | 3677 | 3775 | 3877 | 3980 | 4086 | 4195 | 4308 | 4423 | 4541 | 4664 | 4790 | 4920 |
| 8 | 3394 | 3487 | 3582 | 3678 | 3777 | 3878 | 3982 | 4088 | 4197 | 4309 | 4425 | 4543 | 4666 | 4792 | 4923 |
| 9 | 3396 | 3488 | 3583 | 3680 | 3779 | 3880 | 3984 | 4090 | 4199 | 4311 | 4427 | 4545 | 4668 | 4794 | 4925 |
| 10 | 3397 | 3490 | 3585 | 3681 | 3780 | 3882 | 3985 | 4092 | 4201 | 4313 | 4429 | 4547 | 4670 | 4796 | 4927 |
| 11 | 3399 | 3492 | 3586 | 3683 | 3782 | 3883 | 3987 | 4094 | 4203 | 4315 | 4431 | 4549 | 4672 | 4798 | 4929 |
| 12 | 3400 | 3493 | 3588 | 3685 | 3784 | 3885 | 3989 | 4095 | 4205 | 4317 | 4433 | 4551 | 4674 | 4801 | 4931 |
| 13 | 3402 | 3495 | 3590 | 3686 | 3785 | 3887 | 3991 | 4097 | 4207 | 4319 | 4434 | 4553 | 4676 | 4803 | 4934 |
| 14 | 3403 | 3496 | 3591 | 3688 | 3787 | 3889 | 3992 | 4099 | 4208 | 4321 | 4436 | 4555 | 4678 | 4805 | 4936 |
| 15 | 3405 | 3498 | 3593 | 3690 | 3789 | 3890 | 3994 | 4101 | 4210 | 4323 | 4438 | 4557 | 4680 | 4807 | 4938 |
| 16 | 3407 | 3499 | 3594 | 3691 | 3790 | 3892 | 3996 | 4103 | 4212 | 4325 | 4440 | 4559 | 4682 | 4809 | 4940 |
| 17 | 3408 | 3501 | 3596 | 3693 | 3792 | 3894 | 3998 | 4104 | 4214 | 4327 | 4442 | 4562 | 4684 | 4811 | 4943 |
| 18 | 3410 | 3503 | 3598 | 3695 | 3794 | 3895 | 3999 | 4106 | 4216 | 4328 | 4444 | 4564 | 4687 | 4814 | 4945 |
| 19 | 3411 | 3504 | 3599 | 3696 | 3795 | 3897 | 4001 | 4108 | 4218 | 4330 | 4446 | 4566 | 4689 | 4816 | 4947 |
| 20 | 3413 | 3506 | 3601 | 3698 | 3797 | 3899 | 4003 | 4110 | 4220 | 4332 | 4448 | 4568 | 4691 | 4818 | 4949 |
| 21 | 3414 | 3507 | 3602 | 3699 | 3799 | 3901 | 4005 | 4112 | 4221 | 4334 | 4450 | 4570 | 4693 | 4820 | 4951 |
| 22 | 3416 | 3509 | 3604 | 3701 | 3800 | 3902 | 4006 | 4113 | 4223 | 4336 | 4452 | 4572 | 4695 | 4822 | 4954 |
| 23 | 3417 | 3510 | 3606 | 3703 | 3802 | 3904 | 4008 | 4115 | 4225 | 4338 | 4454 | 4574 | 4697 | 4824 | 4956 |
| 24 | 3419 | 3512 | 3607 | 3704 | 3804 | 3906 | 4010 | 4117 | 4227 | 4340 | 4456 | 4576 | 4699 | 4826 | 4958 |
| 25 | 3420 | 3514 | 3609 | 3706 | 3806 | 3907 | 4012 | 4119 | 4229 | 4342 | 4458 | 4578 | 4791 | 4829 | 4960 |
| 26 | 3422 | 3515 | 3610 | 3708 | 3807 | 3909 | 4014 | 4121 | 4231 | 4344 | 4460 | 4580 | 4703 | 4831 | 4963 |
| 27 | 3423 | 3517 | 3612 | 3709 | 3809 | 3911 | 4015 | 4122 | 4232 | 4346 | 4462 | 4582 | 4705 | 4833 | 4965 |
| 28 | 3425 | 3518 | 3614 | 3711 | 3811 | 3913 | 4017 | 4124 | 4234 | 4347 | 4464 | 4584 | 4707 | 4835 | 4967 |
| 29 | 3427 | 3520 | 3615 | 3713 | 3812 | 3914 | 4019 | 4126 | 4236 | 4349 | 4466 | 4586 | 4710 | 4837 | 4969 |
| 30 | 3428 | 3521 | 3617 | 3714 | 3814 | 3916 | 4021 | 4128 | 4238 | 4351 | 4468 | 4588 | 4712 | 4839 | 4972 |
| 31 | 3430 | 3523 | 3618 | 3716 | 3816 | 3918 | 4022 | 4130 | 4240 | 4353 | 4470 | 4590 | 4714 | 4842 | 4974 |
| 32 | 3431 | 3525 | 3620 | 3717 | 3817 | 3919 | 4024 | 4132 | 4242 | 4355 | 4472 | 4592 | 4716 | 4844 | 4976 |
| 33 | 3433 | 3526 | 3622 | 3719 | 3819 | 3921 | 4026 | 4133 | 4244 | 4357 | 4474 | 4594 | 4718 | 4846 | 4978 |
| 34 | 3434 | 3528 | 3623 | 3721 | 3821 | 3923 | 4028 | 4135 | 4246 | 4359 | 4476 | 4596 | 4720 | 4848 | 4981 |
| 35 | 3436 | 3529 | 3625 | 3722 | 3822 | 3925 | 4029 | 4137 | 4247 | 4361 | 4478 | 4598 | 4722 | 4850 | 4983 |
| 36 | 3437 | 3531 | 3626 | 3724 | 3824 | 3926 | 4031 | 4139 | 4249 | 4363 | 4480 | 4600 | 4724 | 4852 | 4985 |
| 37 | 3439 | 3532 | 3628 | 3726 | 3826 | 3928 | 4033 | 4141 | 4251 | 4365 | 4482 | 4602 | 4726 | 4855 | 4987 |
| 38 | 3440 | 3534 | 3630 | 3727 | 3827 | 3930 | 4035 | 4142 | 4253 | 4367 | 4484 | 4604 | 4728 | 4857 | 4990 |
| 39 | 3442 | 3536 | 3631 | 3729 | 3829 | 3932 | 4037 | 4144 | 4255 | 4369 | 4486 | 4606 | 4731 | 4859 | 4992 |
| 40 | 3443 | 3537 | 3633 | 3731 | 3831 | 3933 | 4038 | 4146 | 4257 | 4370 | 4488 | 4608 | 4733 | 4861 | 4994 |
| 41 | 3445 | 3539 | 3634 | 3732 | 3832 | 3935 | 4040 | 4148 | 4259 | 4372 | 4490 | 4610 | 4735 | 4863 | 4996 |
| 42 | 3447 | 3540 | 3636 | 3734 | 3834 | 3937 | 4042 | 4150 | 4260 | 4374 | 4492 | 4612 | 4737 | 4865 | 4999 |
| 43 | 3448 | 3542 | 3638 | 3736 | 3836 | 3938 | 4044 | 4152 | 4262 | 4376 | 4494 | 4614 | 4739 | 4868 | 5001 |
| 44 | 3450 | 3543 | 3639 | 3737 | 3838 | 3940 | 4045 | 4153 | 4264 | 4378 | 4495 | 4616 | 4741 | 4870 | 5003 |
| 45 | 3451 | 3545 | 3641 | 3739 | 3839 | 3942 | 4047 | 4155 | 4266 | 4380 | 4497 | 4618 | 4743 | 4872 | 5005 |
| 46 | 3453 | 3547 | 3643 | 3741 | 3841 | 3944 | 4049 | 4157 | 4268 | 4382 | 4499 | 4620 | 4745 | 4874 | 5008 |
| 47 | 3454 | 3548 | 3644 | 3742 | 3843 | 3945 | 4051 | 4159 | 4270 | 4384 | 4501 | 4623 | 4747 | 4876 | 5010 |
| 48 | 3456 | 3550 | 3646 | 3744 | 3844 | 3947 | 4052 | 4161 | 4272 | 4386 | 4503 | 4625 | 4750 | 4879 | 5012 |
| 49 | 3457 | 3551 | 3647 | 3746 | 3846 | 3949 | 4054 | 4162 | 4274 | 4388 | 4505 | 4627 | 4752 | 4881 | 5014 |
| 50 | 3459 | 3553 | 3649 | 3747 | 3848 | 3951 | 4056 | 4164 | 4275 | 4390 | 4507 | 4629 | 4754 | 4883 | 5017 |
| 51 | 3460 | 3555 | 3651 | [illegible] | 3849 | 3952 | 4058 | 4166 | 4277 | 4392 | 4509 | 4631 | 4756 | 4885 | 5019 |
| 52 | 3462 | 3556 | 3652 | [illegible] | 3851 | 3954 | 4060 | 4168 | 4279 | 4394 | 4511 | 4633 | 4758 | 4887 | 5021 |
| 53 | 3464 | 3558 | 3654 | 3752 | 3853 | 3956 | 4061 | 4170 | 4281 | 4396 | 4513 | 4635 | 4760 | 4890 | 5023 |
| 54 | 3465 | 3559 | 3655 | 3754 | 3854 | 3958 | 4063 | 4172 | 4283 | 4398 | 4515 | 4637 | 4762 | 4892 | 5026 |
| 55 | 3467 | 3561 | 3657 | 3755 | 3856 | 3959 | 4065 | 4173 | 4285 | 4399 | 4517 | 4639 | 4764 | 4894 | 5028 |
| 56 | 3468 | 3562 | 3659 | 3757 | 3858 | 3961 | 4067 | 4175 | 4287 | 4401 | 4519 | 4641 | 4766 | 4896 | 5030 |
| 57 | 3470 | 3564 | 3660 | 3759 | 3860 | 3963 | 4069 | 4177 | 4289 | 4403 | 4521 | 4643 | 4769 | 4898 | 5033 |
| 58 | 3471 | 3566 | 3662 | 3760 | 3861 | 3964 | 4070 | 4179 | 4291 | 4405 | 4523 | 4645 | 4771 | 4901 | 5035 |
| 59 | 3473 | 3567 | 3664 | 3762 | 3863 | 3966 | 4072 | 4181 | 4292 | 4407 | 4525 | 4647 | 4773 | 4903 | 5037 |
| ′ | 49° | 50° | 51° | 52° | 53° | 54° | 55° | 56° | 57° | 58° | 59° | 60° | 61° | 62° | 63° |

## MERIDIONAL PARTS

LATITUDE

| ′ | 64° | 65° | 66° | 67° | 68° | 69° | 70° | 71° | 72° | 73° | 74° | 75° | 76° | 77° | 78° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 5039 | 5179 | 5324 | 5474 | 5631 | 5795 | 5966 | 6146 | 6335 | 6534 | 6746 | 6970 | 7210 | 7467 | 7745 |
| 1 | 5042 | 5181 | 5326 | 5477 | 5633 | 5797 | 5969 | 6149 | 6338 | 6538 | 6749 | 6974 | 7214 | 7472 | 7749 |
| 2 | 5044 | 5184 | 5328 | 5479 | 5636 | 5800 | 5972 | 6152 | 6341 | 6541 | 6753 | 6978 | 7218 | 7476 | 7754 |
| 3 | 5046 | 5186 | 5331 | 5482 | 5639 | 5803 | 5975 | 6155 | 6345 | 6545 | 6757 | 6982 | 7222 | 7481 | 7759 |
| 4 | 5049 | 5188 | 5333 | 5484 | 5642 | 5806 | 5978 | 6158 | 6348 | 6548 | 6760 | 6986 | 7227 | 7485 | 7764 |
| 5 | 5051 | 5191 | 5336 | 5487 | 5644 | 5809 | 5981 | 6161 | 6351 | 6552 | 6764 | 6990 | 7231 | 7490 | 7769 |
| 6 | 5053 | 5193 | 5338 | 5489 | 5647 | 5811 | 5984 | 6164 | 6354 | 6555 | 6768 | 6994 | 7235 | 7494 | 7774 |
| 7 | 5055 | 5195 | 5341 | 5492 | 5650 | 5814 | 5986 | 6167 | 6358 | 6558 | 6771 | 6997 | 7239 | 7498 | 7778 |
| 8 | 5058 | 5198 | 5343 | 5495 | 5652 | 5817 | 5989 | 6170 | 6361 | 6562 | 6775 | 7001 | 7243 | 7503 | 7783 |
| 9 | 5060 | 5200 | 5346 | 5497 | 5655 | 5820 | 5992 | 6173 | 6364 | 6565 | 6779 | 7005 | 7247 | 7507 | 7788 |
| 10 | 5062 | 5203 | 5348 | 5500 | 5658 | 5823 | 5995 | 6177 | 6367 | 6569 | 6782 | 7009 | 7252 | 7512 | 7793 |
| 11 | 5065 | 5205 | 5351 | 5502 | 5660 | 5825 | 5998 | 6180 | 6371 | 6572 | 6786 | 7013 | 7256 | 7516 | 7798 |
| 12 | 5067 | 5207 | 5353 | 5505 | 5663 | 5828 | 6001 | 6183 | 6374 | 6576 | 6790 | 7017 | 7260 | 7521 | 7803 |
| 13 | 5060 | 5210 | 5356 | 5507 | 5666 | 5831 | 6004 | 6186 | 6377 | 6579 | 6793 | 7021 | 7264 | 7525 | 7808 |
| 14 | 5071 | 5212 | 5358 | 5510 | 5668 | 5834 | 6007 | 6189 | 6380 | 6583 | 6797 | 7025 | 7268 | 7530 | 7813 |
| 15 | 5074 | 5214 | 5361 | 5513 | 5671 | 5837 | 6010 | 6192 | 6384 | 6586 | 6801 | 7029 | 7273 | 7535 | 7817 |
| 16 | 5076 | 5217 | 5363 | 5515 | 5674 | 5839 | 6013 | 6195 | 6387 | 6590 | 6804 | 7033 | 7277 | 7539 | 7822 |
| 17 | 5078 | 5219 | 5366 | 5518 | 5676 | 5842 | 6016 | 6198 | 6390 | 6593 | 6808 | 7037 | 7281 | 7544 | 7827 |
| 18 | 5081 | 5222 | 5368 | 5520 | 5679 | 5845 | 6019 | 6201 | 6394 | 6597 | 6812 | 7041 | 7285 | 7548 | 7832 |
| 19 | 5083 | 5224 | 5371 | 5523 | 5682 | 5848 | 6022 | 6205 | 6397 | 6600 | 6815 | 7045 | 7289 | 7553 | 7837 |
| 20 | 5085 | 5226 | 5373 | 5526 | 5685 | 5851 | 6025 | 6208 | 6400 | 6603 | 6819 | 7048 | 7294 | 7557 | 7842 |
| 21 | 5088 | 5229 | 5376 | 5528 | 5687 | 5854 | 6028 | 6211 | 6403 | 6607 | 6823 | 7052 | 7298 | 7562 | 7847 |
| 22 | 5090 | 5231 | 5378 | 5531 | 5690 | 5856 | 6031 | 6214 | 6407 | 6610 | 6826 | 7056 | 7302 | 7566 | 7852 |
| 23 | 5092 | 5234 | 5380 | 5533 | 5693 | 5859 | 6034 | 6217 | 6410 | 6614 | 6830 | 7060 | 7306 | 7571 | 7857 |
| 24 | 5095 | 5236 | 5383 | 5536 | 5695 | 5862 | 6037 | 6220 | 6413 | 6617 | 6834 | 7064 | 7311 | 7576 | 7862 |
| 25 | 5097 | 5238 | 5385 | 5539 | 5698 | 5865 | 6040 | 6223 | 6417 | 6621 | 6838 | 7068 | 7315 | 7580 | 7867 |
| 26 | 5099 | 5241 | 5388 | 5541 | 5701 | 5868 | 6043 | 6226 | 6420 | 6624 | 6841 | 7072 | 7319 | 7585 | 7872 |
| 27 | 5102 | 5243 | 5390 | 5544 | 5704 | 5871 | 6046 | 6230 | 6423 | 6628 | 6845 | 7076 | 7323 | 7589 | 7877 |
| 28 | 5104 | 5246 | 5393 | 5546 | 5706 | 5874 | 6049 | 6233 | 6427 | 6631 | 6849 | 7080 | 7328 | 7594 | 7882 |
| 29 | 5106 | 5248 | 5395 | 5549 | 5709 | 5876 | 6052 | 6236 | 6430 | 6635 | 6853 | 7084 | 7332 | 7599 | 7887 |
| 30 | 5108 | 5250 | 5398 | 5552 | 5712 | 5879 | 6055 | 6239 | 6433 | 6639 | 6856 | 7088 | 7336 | 7603 | 7892 |
| 31 | 5111 | 5253 | 5401 | 5554 | 5715 | 5882 | 6058 | 6242 | 6437 | 6642 | 6860 | 7092 | 7341 | 7608 | 7897 |
| 32 | 5113 | 5255 | 5403 | 5557 | 5717 | 5885 | 6061 | 6245 | 6440 | 6646 | 6864 | 7096 | 7345 | 7612 | 7902 |
| 33 | 5115 | 5258 | 5406 | 5559 | 5720 | 5888 | 6064 | 6249 | 6443 | 6649 | 6868 | 7100 | 7349 | 7617 | 7907 |
| 34 | 5118 | 5260 | 5408 | 5562 | 5723 | 5891 | 6067 | 6252 | 6447 | 6653 | 6871 | 7104 | 7353 | 7622 | 7912 |
| 35 | 5120 | 5263 | 5411 | 5565 | 5725 | 5894 | 6070 | 6255 | 6450 | 6656 | 6875 | 7108 | 7358 | 7626 | 7917 |
| 36 | 5122 | 5265 | 5413 | 5567 | 5728 | 5896 | 6073 | 6258 | 6453 | 6660 | 6879 | 7112 | 7362 | 7631 | 7922 |
| 37 | 5125 | 5267 | 5416 | 5570 | 5731 | 5899 | 6076 | 6261 | 6457 | 6663 | 6883 | 7116 | 7366 | 7636 | 7927 |
| 38 | 5127 | 5270 | 5418 | 5573 | 5734 | 5902 | 6079 | 6264 | 6460 | 6667 | 6886 | 7120 | 7371 | 7640 | 7932 |
| 39 | 5129 | 5272 | 5421 | 5575 | 5736 | 5905 | 6082 | 6268 | 6463 | 6670 | 6890 | 7124 | 7375 | 7645 | 7937 |
| 40 | 5132 | 5275 | 5423 | 5578 | 5739 | 5908 | 6085 | 6271 | 6467 | 6674 | 6894 | 7128 | 7379 | 7650 | 7942 |
| 41 | 5134 | 5277 | 5426 | 5580 | 5742 | 5911 | 6088 | 6274 | 6470 | 6677 | 6898 | 7132 | 7384 | 7654 | 7948 |
| 42 | 5136 | 5280 | 5428 | 5583 | 5745 | 5914 | 6091 | 6277 | 6473 | 6681 | 6901 | 7136 | 7388 | 7659 | 7953 |
| 43 | 5139 | 5282 | 5431 | 5586 | 5747 | 5917 | 6094 | 6280 | 6477 | 6685 | 6905 | 7140 | 7392 | 7664 | 7958 |
| 44 | 5141 | 5284 | 5433 | 5588 | 5750 | 5919 | 6097 | 6283 | 6480 | 6688 | 6909 | 7145 | 7397 | 7668 | 7963 |
| 45 | 5143 | 5287 | 5436 | 5591 | 5753 | 5922 | 6100 | 6287 | 6483 | 6692 | 6913 | 7149 | 7401 | 7673 | 7968 |
| 46 | 5146 | 5289 | 5438 | 5594 | 5756 | 5925 | 6103 | 6290 | 6487 | 6695 | 6917 | 7153 | 7406 | 7678 | 7973 |
| 47 | 5148 | 5292 | 5441 | 5596 | 5758 | 5928 | 6106 | 6293 | 6490 | 6699 | 6920 | 7157 | 7410 | 7683 | 7978 |
| 48 | 5151 | 5294 | 5443 | 5599 | 5761 | 5931 | 6109 | 6296 | 6494 | 6702 | 6924 | 7161 | 7414 | 7687 | 7983 |
| 49 | 5153 | 5297 | 5446 | 5602 | 5764 | 5934 | 6112 | 6299 | 6497 | 6706 | 6928 | 7165 | 7419 | 7692 | 7989 |
| 50 | 5155 | 5299 | 5448 | 5604 | 5767 | 5937 | 6115 | 6303 | 6500 | 6710 | 6932 | 7169 | 7423 | 7697 | 7994 |
| 51 | 5158 | 5301 | 5451 | 5607 | 5770 | 5940 | 6118 | 6306 | 6504 | 6713 | 6936 | 7173 | 7427 | 7702 | 7999 |
| 52 | 5160 | 5304 | 5454 | 5610 | 5772 | 5943 | 6121 | 6309 | 6507 | 6717 | 6940 | 7177 | 7432 | 7706 | 8004 |
| 53 | 5162 | 5306 | 5456 | 5612 | 5775 | 5946 | 6124 | 6312 | 6511 | 6720 | 6943 | 7181 | 7436 | 7711 | 8009 |
| 54 | 5165 | 5309 | 5459 | 5615 | 5778 | 5948 | 6127 | 6315 | 6514 | 6724 | 6947 | 7185 | 7441 | 7716 | 8014 |
| 55 | 5167 | 5311 | 5461 | 5617 | 5781 | 5951 | 6130 | 6319 | 6517 | 6728 | 6951 | 7189 | 7445 | 7721 | 8020 |
| 56 | 5169 | 5314 | 5464 | 5620 | 5783 | 5954 | 6133 | 6322 | 6521 | 6731 | 6955 | 7194 | 7449 | 7725 | 8025 |
| 57 | 5172 | 5316 | 5466 | 5623 | 5786 | 5957 | 6136 | 6325 | 6524 | 6735 | 6959 | 7198 | 7454 | 7730 | 8030 |
| 58 | 5174 | 5319 | 5469 | 5625 | 5789 | 5960 | 6140 | 6328 | 6528 | 6738 | 6963 | 7202 | 7458 | 7735 | 8035 |
| 59 | 5176 | 5321 | 5471 | 5628 | 5792 | 5963 | 6143 | 6332 | 6531 | 6742 | 6966 | 7206 | 7463 | 7740 | 8040 |
| ′ | 64° | 65° | 66° | 67° | 68° | 69° | 70° | 71° | 72° | 73° | 74° | 75° | 76° | 77° | 78° |

## FOR FINDING THE DISTANCE OF AN OBJECT,

### BY TWO BEARINGS AND THE DISTANCE RUN BETWEEN THEM.

| Diff. between the Course and 2nd Bearing. | Difference between the Course and the 1st Bearing. | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Points. | | | | | | | | | | | | | | | | |
| Points. | 2 | 2¼ | 3 | 3½ | 4 | 4½ | 5 | 5½ | 6 | 6½ | 7 | 7½ | 8 | 8½ | 9 | 9½ | 10 |
| 3½ | 1·00 | | | | | | | | | | | | | | | | |
| 4 | 1·00 | | | | | | | | | | | | | | | | |
| 4½ | 0·81 | 1·23 | | | | | | | | | | | | | | | |
| 5 | 0·69 | 1·00 | 1·45 | | | | | | | | | | | | | | |
| 5½ | 0·60 | 0·85 | 1·17 | 1·66 | | | | | | | | | | | | | |
| 6 | 0·54 | 0·74 | 1·00 | 1·35 | 1·85 | | | | | | | | | | | | |
| 6½ | 0·49 | 0·67 | 0·88 | 1·14 | 1·50 | 2·02 | | | | | | | | | | | |
| 7 | 0·46 | 0·61 | 0·79 | 1·00 | 1·27 | 1·64 | 2·17 | | | | | | | | | | |
| 7½ | 0·43 | 0·57 | 0·72 | 0·90 | 1·11 | 1·39 | 1·77 | 2·30 | | | | | | | | | |
| 8 | 0·41 | 0·53 | 0·67 | 0·82 | 1·00 | 1·22 | 1·50 | 1·87 | 2·41 | | | | | | | | |
| 8½ | 0·40 | 0·51 | 0·63 | 0·76 | 0·92 | 1·09 | 1·31 | 1·58 | 1·96 | 2·50 | | | | | | | |
| 9 | 0·39 | 0·49 | 0·60 | 0·72 | 0·85 | 1·00 | 1·18 | 1·39 | 1·66 | 2·03 | 2·56 | | | | | | |
| 9½ | 0·38 | 0·48 | 0·58 | 0·69 | 0·80 | 0·93 | 1·08 | 1·25 | 1·46 | 1·72 | 2·08 | 2·60 | | | | | |
| 10 | 0·38 | 0·47 | 0·57 | 0·66 | 0·76 | 0·88 | 1·00 | 1·14 | 1·31 | 1·51 | 1·76 | 2·11 | 2·61 | | | | |
| 10½ | 0·38 | 0·47 | 0·56 | 0·65 | 0·74 | 0·84 | 0·94 | 1·06 | 1·19 | 1·35 | 1·55 | 1·79 | 2·12 | 2·60 | | | |
| 11 | 0·39 | 0·47 | 0·56 | 0·64 | 0·72 | 0·81 | 0·90 | 1·00 | 1·11 | 1·24 | 1·39 | 1·57 | 1·80 | 2·11 | 2·56 | | |
| 11½ | 0·40 | 0·48 | 0·56 | 0·63 | 0·71 | 0·79 | 0·87 | 0·95 | 1·05 | 1·15 | 1·27 | 1·41 | 1·58 | 1·79 | 2·08 | 2·50 | |
| 12 | 0·41 | 0·49 | 0·57 | 0·64 | 0·71 | 0·78 | 0·85 | 0·92 | 1·00 | 1·08 | 1·18 | 1·29 | 1·41 | 1·57 | 1·76 | 2·03 | 2·41 |
| 12½ | 0·43 | 0·51 | 0·58 | 0·65 | 0·71 | 0·77 | 0·83 | 0·90 | 0·97 | 1·03 | 1·11 | 1·20 | 1·29 | 1·41 | 1·55 | 1·72 | 1·96 |

## TABLE 8

### TRUE DEPRESSION OR DISTANCE OF THE SEA HORIZON

| Height | Dep. | Square | Height | Dep. | Square | Height | Dep. | Square | Dep. | Square |
|---|---|---|---|---|---|---|---|---|---|---|
| 1·1ft | 1′ | 1 | 3293ft | 61′ | 3721 | 12966ft | 121′ | 14641 | 181′ | 32761 |
| 3·5 | 2 | 4 | 3403 | 62 | 3844 | 13183 | 122 | 14884 | 182 | 33124 |
| 8·0 | 3 | 9 | 3513 | 63 | 3969 | 13397 | 123 | 15129 | 183 | 33489 |
| 14·2 | 4 | 16 | 3624 | 64 | 4096 | 13615 | 124 | 15376 | 184 | 33856 |
| 22·1 | 5 | 25 | 3740 | 65 | 4225 | 13836 | 125 | 15625 | 185 | 34225 |
| 31·9 | 6 | 36 | 3855 | 66 | 4356 | 14061 | 126 | 15876 | 186 | 34596 |
| 43·3 | 7 | 49 | 3974 | 67 | 4489 | 14282 | 127 | 16129 | 187 | 34969 |
| 56·6 | 8 | 64 | 4093 | 68 | 4624 | 14502 | 128 | 16384 | 188 | 35344 |
| 71·7 | 9 | 81 | 4213 | 69 | 4761 | 14737 | 129 | 16641 | 189 | 35721 |
| 88·5 | 10 | 100 | 4337 | 70 | 4900 | 14970 | 130 | 16900 | 190 | 36100 |
| 107 | 11 | 121 | 4461 | 71 | 5041 | 15197 | 131 | 17161 | 191 | 36481 |
| 127 | 12 | 144 | 4587 | 72 | 5184 | 15429 | 132 | 17424 | 192 | 36864 |
| 149 | 13 | 169 | 4716 | 73 | 5329 | 15664 | 133 | 17689 | 193 | 37249 |
| 173 | 14 | 196 | 4846 | 74 | 5476 | 15901 | 134 | 17956 | 194 | 37636 |
| 199 | 15 | 225 | 4976 | 75 | 5625 | 16139 | 135 | 18225 | 195 | 38025 |
| 226 | 16 | 256 | 5112 | 76 | 5776 | 16380 | 136 | 18496 | 196 | 38416 |
| 256 | 17 | 289 | 5249 | 77 | 5929 | 16622 | 137 | 18769 | 197 | 38809 |
| 287 | 18 | 324 | 5385 | 78 | 6084 | 16866 | 138 | 19044 | 198 | 39204 |
| 319 | 19 | 361 | 5524 | 79 | 6241 | 17111 | 139 | 19321 | 199 | 39601 |
| 354 | 20 | 400 | 5665 | 80 | 6400 | 17362 | 140 | 19600 | 200 | 40000 |
| 390 | 21 | 441 | 5808 | 81 | 6561 | 17608 | 141 | 19881 | 201 | 40401 |
| 428 | 22 | 484 | 5952 | 82 | 6724 | 17860 | 142 | 20164 | 202 | 40804 |
| 468 | 23 | 529 | 6098 | 83 | 6889 | 18111 | 143 | 20449 | 203 | 41209 |
| 510 | 24 | 576 | 6246 | 84 | 7056 | 18366 | 144 | 20736 | 204 | 41616 |
| 550 | 25 | 625 | 6394 | 85 | 7225 | 18622 | 145 | 21025 | 205 | 42025 |
| 598 | 26 | 676 | 6547 | 86 | 7396 | 18878 | 146 | 21316 | 206 | 42436 |
| 645 | 27 | 729 | 6700 | 87 | 7569 | 19140 | 147 | 21609 | 207 | 42849 |
| 694 | 28 | 784 | 6855 | 88 | 7744 | 19401 | 148 | 21904 | 208 | 43264 |
| 744 | 29 | 841 | 7012 | 89 | 7921 | 19664 | 149 | 22201 | 209 | 43681 |
| 797 | 30 | 900 | 7172 | 90 | 8100 | 19930 | 150 | 22500 | 210 | 44100 |
| 850 | 31 | 961 | 7332 | 91 | 8281 | 20197 | 151 | 22801 | 211 | 44521 |
| 906 | 32 | 1024 | 7492 | 92 | 8464 | 20465 | 152 | 23104 | 212 | 44944 |
| 964 | 33 | 1089 | 7656 | 93 | 8649 | 20736 | 153 | 23409 | 213 | 45369 |
| 1023 | 34 | 1156 | 7824 | 94 | 8836 | 21008 | 154 | 23716 | 214 | 45796 |
| 1084 | 35 | 1225 | 7987 | 95 | 9025 | 21282 | 155 | 24025 | 215 | 46225 |
| 1147 | 36 | 1296 | 8158 | 96 | 9216 | 21558 | 156 | 24336 | 216 | 46656 |
| 1211 | 37 | 1369 | 8330 | 97 | 9409 | 21836 | 157 | 24649 | 217 | 47089 |
| 1278 | 38 | 1444 | 8504 | 98 | 9604 | 22115 | 158 | 24964 | 218 | 47524 |
| 1346 | 39 | 1521 | 8678 | 99 | 9801 | 22397 | 159 | 25281 | 219 | 47961 |
| 1416 | 40 | 1600 | 8852 | 100 | 10000 | 22680 | 160 | 25600 | 220 | 48400 |
| 1487 | 41 | 1681 | 9032 | 101 | 10201 | 22964 | 161 | 25921 | 221 | 48841 |
| 1561 | 42 | 1764 | 9210 | 102 | 10404 | 23251 | 162 | 26244 | 222 | 49284 |
| 1636 | 43 | 1849 | 9393 | 103 | 10609 | 23540 | 163 | 26569 | 223 | 49729 |
| 1713 | 44 | 1936 | 9577 | 104 | 10816 | 23830 | 164 | 26896 | 224 | 50176 |
| 1792 | 45 | 2025 | 9760 | 105 | 11025 | 24121 | 165 | 27225 | 225 | 50625 |
| 1872 | 46 | 2116 | 9951 | 106 | 11236 | 24415 | 166 | 27556 | 226 | 51076 |
| 1954 | 47 | 2209 | 10135 | 107 | 11449 | 24711 | 167 | 27889 | 227 | 51529 |
| 2039 | 48 | 2304 | 10325 | 108 | 11664 | 25008 | 168 | 28224 | 228 | 51984 |
| 2124 | 49 | 2401 | 10518 | 109 | 11881 | 25307 | 169 | 28561 | 229 | 52441 |
| 2212 | 50 | 2500 | 10712 | 110 | 12100 | 25608 | 170 | 28900 | 230 | 52900 |
| 2301 | 51 | 2601 | 10908 | 111 | 12321 | 25911 | 171 | 29241 | 231 | 53361 |
| 2393 | 52 | 2704 | 11105 | 112 | 12544 | 26215 | 172 | 29584 | 232 | 53824 |
| 2485 | 53 | 2809 | 11304 | 113 | 12769 | 26521 | 173 | 29929 | 233 | 54289 |
| 2581 | 54 | 2916 | 11506 | 114 | 12996 | 26829 | 174 | 30276 | 234 | 54756 |
| 2677 | 55 | 3025 | 11709 | 115 | 13225 | 27139 | 175 | 30625 | 235 | 55225 |
| 2775 | 56 | 3136 | 11913 | 116 | 13456 | 27451 | 176 | 30976 | 236 | 55696 |
| 2875 | 57 | 3249 | 12120 | 117 | 13689 | 27764 | 177 | 31329 | 237 | 56169 |
| 2977 | 58 | 3364 | 12328 | 118 | 13924 | 28079 | 178 | 31684 | 238 | 56644 |
| 3081 | 59 | 3481 | 12538 | 119 | 14161 | 28396 | 179 | 32041 | 239 | 57121 |
| 3186 | 60 | 3600 | 12749 | 120 | 14400 | 28715 | 180 | 32400 | 240 | 57600 |

## TABLE 9

### No. of FEET SUBTENDING AN ANGLE OF 1′.

| Dist. in Miles. | Feet. |
|---|---|
| 1 | 1·77 |
| 2 | 3·54 |
| 3 | 5·31 |
| 4 | 7·08 |
| 5 | 8·84 |
| 6 | 10·61 |
| 7 | 12·38 |
| 8 | 14·15 |
| 9 | 15·92 |
| 10 | 17·69 |
| 11 | 19·46 |
| 12 | 21·23 |
| 13 | 23·00 |
| 14 | 24·77 |
| 15 | 26·53 |
| 16 | 28·30 |
| 17 | 30·07 |
| 18 | 31·84 |
| 19 | 33·61 |
| 20 | 35·38 |
| 21 | 37·15 |
| 22 | 38·92 |
| 23 | 40·69 |
| 24 | 42·46 |
| 25 | 44·23 |
| 26 | 46·00 |
| 27 | 47·76 |
| 28 | 49·53 |
| 29 | 51·30 |
| 30 | 53·07 |

# INDEX TO MARITIME POSITIONS.

## INDEX TO MARITIME POSITIONS

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MARITIME POSITIONS

# LATITUDES AND LONGITUDES

OF THE

## OBSERVATORIES AND SECONDARY MERIDIANS,

THE PRINCIPAL

## HEADLANDS, PORTS, ANCHORAGES, ISLANDS, AND MOUNTAINS IN THE WORLD.

| | (1) Places | Lat. N | Lon. |
|---|---|---|---|
| | **BRITISH ISLES.** | | |
| | | | West |
| | GREENWICH OBSERVATORY, ♦ $1^h$ | 51° 28′6 | 0° 0′ |
| | St. Paul's Cathedral | 51 30·8 | 0 5·7 |
| | | | East |
| | Greenhithe, ferry | 51 27·2 | 0 16·7 |
| | Sheerness, fl. st. | 51 26·8 | 0 44·7 |
| | Chatham Dk. yd., King's stairs | 51 23·8 | 0 35·0 |
| | Margate, ⊡$^{12}_{0}$, lt. $F^r$ 85f. N Ch. | 51 23·4 | 1 23·2 |
| | North Foreland, lt. F occ. 188f. | 51 22·5 | 1 26·7 |
| | Ramsgate, ⊡$^{18}_{8}$, S pier lt. $F^r$... | 51 19·7 | 1 25·5 |
| | Sandown Castle, centre | 51 14·3 | 1 24·2 |
| | Deal, Telegraph Tower, ♦ $1^h$... | 51 23·3 | 1 24·2 |
| | **ENGLAND, South Coast.** | | |
| ⊕ England, S. Coast | S. Foreland, 2 lts. S78°W 134-f., Fl. (electric) 374f., 290f. | 51 8·4 | 1 22·5 |
| | Dover, ⊡$^{18}_{0}$, Castle | 51 7·8 | 1 19·5 |
| | Folkestone, ⊡$^{14}_{0}$, (lt. $F^r$ or fl. 10f.), Ch. | 51 4·8 | 1 11·0 |
| | Dungeness, lt. F 107f. | 50 55·0 | 0 58·2 |
| | Varne shl., lt. v. *W-d* 15, R 20$^s$, 30f. | 50 56·2 | 1 16·2 |
| | Ridge shl., S pt. $\overline{6}$ | 50 49 | 1 17 |
| | Rye, ⊡$^{17}_{0}$, Church | 50 57·0 | 0 43·5 |
| | Hastings, 2 lights, 400f., F 60f. | 50 51·5 | 0 36·0 |
| | Beachy Hd., lt. Fl. 285f. | 50 44·4 | 0 12·7 |
| | Newhaven, ⊡$^{19}_{0}$, W pier lt. F 41f. | 50 46·9 | 0 3·5 |
| | | | West |
| | Brighton, pier lt. $F^s$ 35f. | 50 49 | 0 8 |
| | Shoreham, ⊡$^{16}_{0}$, 2 lts. N1°E 750f., F 42f., F 23f., nf. | 50 49·8 | 0 14·7 |
| | Selsea Bill, high ho. | 50 43·8 | 0 48·5 |
| | Chichester, ⊡$^{16}_{3}$, Ch. | 50 50·2 | 0 46·7 |
| | Portsmouth, ⊞, R. N. Coll., OBSERVATORY, ♦ $1^h$ | 50 48·0 | 1 6 |
| | Southampton, St. Mich. spire | 50 54·0 | 1 24·2 |
| | Hurst, 2 lts. N38°E 750f., F 76f. | 50 42·4 | 1 32·7 |
| I. of Wight | Cowes Castle | 50 46·0 | 1 17·7 |
| | St. Catherine's Pt., lt. Fl. (electric) 178f. | 50 34·5 | 1 17·7 |
| | Needles lt. Occ. 80f. | 50 39·7 | 1 35·5 |
| | Christchurch, ⊡$^{n}_{0}$, N entr. | 50 43·9 | 1 44·2 |
| | Poole, ⊡$^{15}_{6}$, Branksea Castle... | 50 41·7 | 1 58·0 |
| | St. Alban's Hd. | 50 35 | 2 3 |
| | Weymouth, ⊡$^{12}_{6}$, lt. $F^r$ 23f.... | 50 36·6 | 2 26·7 |
| | Portland, 2 lts. N53°W 1509f., F 210f., 136f. | 50 31·2 | 2 27·5 |

| | (2) Places | Lat. N | Lon. W |
|---|---|---|---|
| ⊕ England, S. Coast | Bridport, ⊡ entr. | 50° 42′7 | 2° 44′5 |
| | Exmouth, ⊡$^{20}_{6}$, lt F 100f. | 50 37 | 3 23 |
| | Torquay, lt. $F^r$ 15f. | 50 28 | 3 30 |
| | Berry Hd., fl. st. | 50 24 | 3 28 |
| | Dartmouth, ⊞, 3 lts. F | 50 21 | 3 33 |
| | Start Pt., lt. Fl. $1^m$ 204f. | 50 13·4 | 3 38·5 |
| | Prawle Pt. | 50 12 | 3 43 |
| | Salcombe, ⊡$^{23}_{4}$, Fort Charles | 50 19·3 | 3 48·0 |
| | Bolt Hd., 430f., fl. st. | 50 13·2 | 3 48·7 |
| | Eddystone lt. Fl. 72f. | 50 10·9 | 4 16·0 |
| | Plymouth, ⊞, Mt. Wise, fl. st. | 50 22·0 | 4 10·2 |
| | ——brkw., W end, lt. Occ., bell | 50 20·3 | 4 9·5 |
| | Rame Hd. | 50 19 | 4 13 |
| | Looe Id., sum. | 50 26 | 4 27 |
| | Fowey, ⊞, Castle | 50 19·7 | 4 38·7 |
| | Gribbin's Hd., beac. 324f. | 50 19·1 | 4 40·2 |
| | Dodman, 379f. | 50 13 | 4 48 |
| | Gerran, spire | 50 10·7 | 4 58·7 |
| | Falmouth, ⊞, Pendennis Castle | 50 8·8 | 5 2·7 |
| | —— St. Anthony, lt. R 20$^s$ 65f. | 50 8·3 | 5 1·0 |
| | Black Hd., fl. st. | 50 0·4 | 5 6·5 |
| | Manacles, sum. | 50 2·6 | 5 2·7 |
| | Lizard, 2 lts., F N72°E, 230f. | 49 57·7 | 5 12·0 |
| | St. Michael's Mt. | 50 7·0 | 5 28·5 |
| | Penzance, ⊡, lt. pier, $F^r$ at 10f. | 50 7·1 | 5 31·5 |
| | St. Leven's Pt., fl. st. | 50 2·3 | 5 40·7 |
| | Rundlestone beacon | 50 1·1 | 5 40·2 |
| | Wolf rk., lt. R | 49 56·7 | 5 48·2 |
| | Longship's lt. Int. 88f. | 50 4·1 | 5 44·7 |
| Scilly | St. Agnes, lt. R $1^m$ 138f. | 49 53·6 | 6 20·7 |
| | St. Martin's, Day Mk. | 49 58·0 | 6 16·0 |
| | St. Mary's, fl. st... | 49 55·0 | 6 19·0 |
| | Bishop rk., lt. Fl. 110f. | 49 52·4 | 6 26·7 |
| | **West Coast.** | | |
| ⊕ England, W. Coast | C. Cornwall | 50 7·7 | 5 42·5 |
| | St Ives, ⊡, Steeple | 50 12·8 | 5 26·5 |
| | Godrevy Id., T, sum | 50 14·6 | 5 24·0 |
| | St. Agnes, beac. 621f. | 50 18·5 | 5 13·0 |
| | Trevose Hd., lt. Occ. 204f. | 50 33 | 5 2 |
| | Padstow, ⊡, Ch. | 50 32·5 | 4 56·0 |
| | Pentire Pt. | 50 35·4 | 4 55·7 |
| | Tintagel, Ch. | 50 39·8 | 4 45·5 |
| | Hartland Pt., ⊥, 330f., lt. Fl. | 51 1·4 | 4 31·5 |
| | Lundy I., $\frac{4}{5}$ 2½m., 2 lts. R $2^m$ 540f., F 470f. | 51 10·1 | 4 40·2 |
| | Bideford, ⊡, or Braunton, lts. S70°E 933f., Occ. 93f., 44f. | 51 4·5 | 4 12·0 |
| | Mort Pt. | 51 11·4 | 4 13·7 |
| | Ilfracombe, ⊡$^{20}_{0}$, lt. $F^r$ 127f. | 51 12·8 | 4 7·0 |
| | Bridgewater ⊡, or Burnham, 2 lts. S70°W 1500f., Occ. F 23f. | 51 15·0 | 3 0·0 |
| | Flatholm I., S pt., lt. Occ. 156f. | 51 22·6 | 3 7·0 |

For Index to Maritime Positions, see p. 540.

## MARITIME POSITIONS

| | (3) Places | Lat. N | Lon. W |
|---|---|---|---|
| | Great Hangman Hill, 1160f. | 51° 13′ | 3° 59′ |
| | Bristol, ⊞, Cathedral | 51 26·8 | 2 35·5 |
| | Newport, ◫, Usk lt F 39f. | 51 32·4 | 2 59·7 |
| | Cardiff, ⊞, Custom ho. | 51 28·6 | 3 10·0 |
| | Nash Pt., 2 lts. N85°W, F 182f. | 51 24·0 | 3 33·0 |
| | Mumbles, lt. F 114f. | 51 34·0 | 3 58·2 |
| | Swansea, ◫, pier lt. Fr 35f., ⅛f. | 51 37·0 | 3 56·0 |
| | Worms Hd., ⊥, 164f | 51 34 | 4 20 |
| | Pembrey, ◫, lt. F 35f., 1/8f | 51 40·7 | 4 15·0 |
| | Cal'dy I., 1¼m., S pt., lt. F 210f. | 51 37·9 | 4 41·0 |
| | St. Govan's Hd., 142f. | 51 35·8 | 4 55·5 |
| | St. Ann's lts. N41°W 610f., 2F 192f., 159f. | 51 41·0 | 5 10·5 |
| ⊕ Coast of Wales | Milford, ⊞, Ch. | 51 42·7 | 5 1·5 |
| | Pembroke Dk. yd., NW corner | 51 41·8 | 4 57·2 |
| | Smalls rks., NS 2c., lt. Int. 125f. | 51 43·3 | 5 40·0 |
| | Grasholm I., 3c., sum. 146f. | 51 43·9 | 5 28·7 |
| | Ramsey I., NS 1½m., sum. 444f. | 51 51·7 | 5 20·7 |
| | South Bishop rk., lt. R 144f. | 51 51·4 | 5 24·5 |
| | St. David's Cath. | 51 52·9 | 5 16·0 |
| | Strumble Hd | 52 1·7 | 5 3·5 |
| | Precelly Top, 1754f. | 51 56·8 | 4 46·2 |
| | Cardigan I., 4c., sum. 195f. | 52 7·9 | 4 41·5 |
| | ——— Steeple | 52 5·2 | 4 39·5 |
| | Aberystwith, ◫ $^{11}_{0}$, lt. F, Castle | 52 24·9 | 4 5·2 |
| | Cader Idris, 3549f. | 52 42·0 | 3 54·5 |
| | Snowdon, 3580f. | 53 4·1 | 4 4·5 |
| | Bardsey I. 1½m., lt. Occ. 129f. | 52 45·0 | 4 48·0 |
| | Caernarvon, ◫ $^{21}_{5}$, lt. Fr 50f. | 53 8·5 | 4 24·7 |
| | S. Stack lt. R 1½m 197f. | 53 18·3 | 4 42·0 |
| | Holyhead, ◫, lt. F 20f., bell | 53 20·0 | 4 37·0 |
| | Skerries, 1½m., lts. Int. 117f. | 53 25·3 | 4 36·5 |
| | Pt. Lynus, lt. Occ. 128f. | 53 25·0 | 4 17·2 |
| | Beaumaris, ◫ | 53 15·9 | 4 5·2 |
| | Great Orme's Hd., lt. F 325f. | 53 20·0 | 3 51·2 |
| | Hoylake, lt. F 31f. | 53 23·7 | 3 11·0 |
| | Bidston, lt. F 228f. | 53 24·1 | 3 4·7 |
| | Leasowe, lt. F 94f. | 53 24·9 | 3 7·7 |
| | Black rk., lt. Rr 77f. | 53 26·7 | 3 2·7 |
| ⊕ England, W. Coast | Liverpool, ⊞, St. Paul's Ch. | 53 24·6 | 2 59·5 |
| | —— Observatory, ● 1h | 53 24·8 | 3 0·0 |
| | Crosby, lt. F 95f. | 53 31·4 | 3 3·5 |
| | Formby SE mark | 53 32·3 | 3 4·0 |
| | Rossell sea mark | 53 55·2 | 3 3·0 |
| | Wyre, lt. F 30f., bell | 53 57·3 | 3 1·7 |
| | Fleetwood, ◫ $^{8}_{0}$, lt. F 90f. NW extr. | 53 55·6 | 3 1·0 |
| | Lancaster, Castle | 54 3·0 | 2 48·2 |
| | Walney I., 7m., S pt., lt. R 70f. | 54 2·9 | 3 10·5 |
| | Black Comb, 1919f. | 54 15·5 | 3 19·5 |
| | S. pt., Calf of Man | 54 3·2 | 4 50·0 |
| | Castleton, lt. F 22f. | 54 4·4 | 4 39·0 |
| ⊕ I. of Man | Douglas, lt. F 104f. | 54 9·0 | 4 28·0 |
| | N. pt., Ayre Pt., lt. R 106f. | 54 25·0 | 4 22·0 |
| | Peel, lt. F 27f. | 54 13·6 | 4 42·0 |
| | St. Bees Hd., lt. Occ. 333f. | 54 30·8 | 3 38·0 |
| | Whitehaven, ◫ $^{23}_{0}$, lt. R 52f. | 54 33·2 | 3 35·7 |
| | Harrington, ◫, pier lt. F 44f., ⅛f. | 54 36·7 | 3 34·2 |
| | Workington, ◫, lt. F 42f. at ⅛f. | 54 38·9 | 3 34·5 |
| | Maryport, ◫, S pier, F 52f. | 54 43·0 | 3 30·5 |
| | Carlisle, Cathedral | 54 53·8 | 2 56·0 |
| | Annan, Church | 54 59·2 | 3 15·5 |

| | (4) Places | Lat. N | Lon. W |
|---|---|---|---|
| | Southerness | 54° 52′·4 | 3° 35′·5 |
| | Ross I., Fl. 175f. | 54 46 | 4 5 |
| | Burrow Hd. | 54 41 | 4 23 |
| | Mull of Galloway, lt. Int. 325f. | 54 38·1 | 4 51·2 |
| | Port Patrick, ◫, lt. F 38f. | 54 50·3 | 5 6·7 |
| | Corsewall Pt., lt. R 112f. | 55 0·5 | 5 9·5 |
| | Lough Ryan, ⊞, lt. F 46f. | 54 58·5 | 5 1·7 |
| | Stranraer, ◫ $^{33}_{14}$, Church | 54 54·5 | 5 2·0 |
| | Ayr, ◫ $^{14}_{2}$, 3 lts. S84°E 850f., Fr 53f./35f., F 5f. | 55 28 | 4 38 |
| | **SCOTLAND, West Coast.** | | |
| | Ailsa Craig, 1098f., lt. Fl. 60f. | 55 15·2 | 5 7·0 |
| | Pladda, lts. 2F 130f., 77f. | 55 25·6 | 5 7·0 |
| | Ardrossan, ◫ $^{20}_{16}$, lt. Fl. 25f. | 55 38·7 | 4 50·5 |
| | Irvine, ◫, Ch. | 55 36·8 | 4 39·7 |
| | Cumbræ, lt. F 115f. | 55 43 | 4 57·8 |
| | Greenock, ⊞, spire | 55 56·9 | 4 45·2 |
| | Port Glasgow, ⊞, basin | 55 56·2 | 4 41 |
| | Glasgow, new bridge | 55 51·9 | 4 16 |
| | —— Observatory | 55 52·7 | 4 17·7 |
| | Campbelton, ⊞, lt. Fr 18f. | 55 25·0 | 5 35·5 |
| ⊕ W. Coast of Scotland | Mull of Cantire, lt. F 297f. | 55 18 | 5 48 |
| | Ben Tuirck, 1516f. | 55 34 | 5 34 |
| | Maol Na Ho, Dun Ard | 55 35 | 6 18 |
| | Rhynns of Isla, lt. on Oersa I. Fl. 150f. | 55 40 | 6 31 |
| | Colonsay I., 6m., N pt. | 56 8 | 6 9 |
| | Oban, ⊞, Church | 56 24·5 | 5 28 |
| | Lismore I., 9m., lt. F 103f. | 56 27·5 | 5 36 |
| | Fort William | 56 48 | 5 5 |
| | Ben Nevis, 4368f. | 56 48 | 5 0 |
| | Dubh Artach rk. | 56 8 | 6 38 |
| | Iona I., 3 m., W pt. | 56 18·7 | 6 26·7 |
| | I. of Mull, Caliack Pt. | 56 36·4 | 6 19 |
| | Ben More, 3168f. | 56 25·5 | 6 0·7 |
| | Skerryvore rks., lt. R 150f. | 56 19·4 | 7 7 |
| | Tirey I., 11m., S extr. | 56 26 | 6 55 |
| | Dubh Sgeir rk. | 56 31·5 | 7 2·7 |
| | Coll. I., 10m., N.& E pt., rks. | 56 41·5 | 6 27 |
| | Muke Id., Innerah lt. | 56 50 | 6 16·5 |
| | Rum I., NS 7m., S pt. | 56 56·2 | 6 19·5 |
| | ——— W pt. | 57 0·5 | 6 27·2 |
| | Canna I., 4m., W pt. | 57 3 | 6 36·5 |
| | Skye I., Neist Pt. | 57 25·2 | 6 47·2 |
| | —— Dunveggan Hd. | 57 30·8 | 6 43 |
| | Fladdachuan Islet, N end | 57 44·8 | 6 26·5 |
| | Skeir Grartich | 57 47·1 | 6 28 |
| | Ru Hunish | 57 42·5 | 6 21 |
| | Ru Rea | 57 51·6 | 5 48·7 |
| | Ru Coygach | 58 6·5 | 5 26 |
| | Ru Stoer | 58 16 | 5 22 |
| | Handa I., [1½m]. 400f. sum. | 58 23·0 | 5 11·7 |
| | Bulgie I., [¼m.]. 146f. | 58 32·7 | 5 7 |
| | C. Wrath lt. Rwr 400f. | 58 37·5 | 4 59·7 |
| | Far-out Hd. | 58 36·2 | 4 45·0 |
| ⊕ N. Coast of Scotland | Roan I., 1¼m., mid. | 58 33·3 | 4 19·2 |
| | Strathy Hd. | 58 36·0 | 4 9·5 |
| | Thurso | 58 33 | 3 31 |
| | Holburn Hd. | 58 35 | 3 31 |
| | Dunnet Hd., lt. F 346f. | 58 40·4 | 3 21·2 |
| | Duncansby Hd. | 58 39 | 3 1 |
| | Pentland Skerries, 1½m., lts. N pt., 2F 140f., 170f. | 58 41·2 | 2 55·0 |

## MARITIME POSITIONS

| | (5) Places | Lat. N | Lon. W |
|---|---|---|---|
| | **Hebrides.** | | |
| ⊕ Hebrides | Barra Hd., lt. Int. 683f. | 56°47′·1 | 7°39′·2 |
| | Barra I., N pt. of Fiaray | 57 4 | 7 26·7 |
| | Eris Kay I., NS 3m., S end | 57 3 | 7 17·5 |
| | S. Uist I., NS 17m., E pt., Ushinish, lt. Occ. 176f. | 57 18 | 7 11·5 |
| | ——- Ru ard Vula, W pt. | 57 14·5 | 7 27·5 |
| | Monach Is., EW 4m. lt. Fl 150f. | 57 31·6 | 7 41·7 |
| | Haskier Is., N Loch, 120f. | 57 42·3 | 7 40·7 |
| | N. Uist I., EW 15m., W pt. | 57 36·2 | 7 33 |
| | Berneray I., ♯ 3m., N pt. | 57 44 | 7 11·5 |
| | Pabbay I., EW 2m., S pt. | 57 45·3 | 7 14·5 |
| | Scalpay. Glas I. EW 2½m., lt. F 130f. | 57 51·4 | 6 38·2 |
| | Shiant Is., 1m., NW one, Wend | 57 54·5 | 6 23 |
| | Stornaway, lt. R 56f. | 58 11·5 | 6 22·2 |
| | Chicken Hd. | 58 10·8 | 6 15 |
| | Tiumpan Hd. | 58 15·7 | 6 8 |
| | Butt of Lewis, lt. F 170f. | 58 30·8 | 6 15·7 |
| | Gallon Hd. | 58 14·6 | 7 1·5 |
| | Scarpa I., W pt. | 58 1·7 | 7 10 |
| | Rona I., SE sum. 360f. | 59 7·0 | 5 48·5 |
| | Sulisker I., S sum | 59 5·4 | 6 8·7 |
| | Flannen Is., Rodorheim | 58 17 | 7 39 |
| | St. Kilda, pk. 1220f. | 57 49·0 | 8 34·7 |
| | Rockal [2c.], (a rk. N73°E, 1·7m.) | 57 36·3 | 13 41·5 |
| | **Orkneys.** | | |
| ⊕ Orkney Is. | Old Hd. | 58 44·3 | 2 55·5 |
| | Kirkness | 58 48·2 | 2 54·5 |
| | Grimness Hd | 58 49·4 | 2 52·2 |
| | Burra Ness | 58 51·4 | 2 51·0 |
| | Roseness | 58 52·5 | 2 49·5 |
| | Mull Hd | 58 58·6 | 2 42·0 |
| | Kirkwall, pier lt. F 31f. | 58 59·2 | 2 57·5 |
| | Brough of Birsa, ½m. | 59 8·2 | 3 20·0 |
| | Stromness, ⊡[16], Church | 58 57·8 | 3 17·5 |
| | Copinsha I., ♯ 1m., mid. | 58 54 | 2 40 |
| | Auskery I. | 59 2 | 2 34 |
| | Stronsa I., ♯ 7m., Lamb Hd. | 59 4·9 | 2 32·0 |
| | Sanday I., ♯ 11m., Treness | 59 13 | 2 28·5 |
| | Start lt. F 80f. | 59 16·7 | 2 22·5 |
| | N. Ronaldsha I., ♯ 3m., lt. F 140f. | 59 23·4 | 2 23·7 |
| | ———— Stromness, or S pt. | 59 20 | 2 26 |
| | Runebrake shl. | 59 21 | 2 37 |
| | Moul Hd. | 59 23·0 | 2 53 |
| | Noup Hd. | 59 20·0 | 3 4·0 |
| | Sacquoy Hd. | 59 12·0 | 3 4·2 |
| | Stour Roray | 58 52·4 | 3 25·5 |
| | S. pt., or Brims Ness | 58 46·4 | 3 13·5 |
| | **Shetlands.** | | |
| Shetland Is. | Fair I., ♯ 2m., h, T. pk. 711f. | 59 33 | 1 37·7 |
| | Sumburgh Hd., lt. F 300f. | 59 51·3 | 1 17·0 |
| | Mousa I., ♯ 1½m., sum. | 60 0 | 1 11 |
| | Bard Hd. | 60 6·1 | 1 4·5 |
| | Lerwick, ⊞, fort | 60 9·4 | 1 8·7 |
| | Noss Hd., 557f. | 60 8·3 | 1 0·5 |
| | Halsey I., ♯ 5m., S sum. 376f. | 60 20 | 1 0 |
| | Out Skerries, lt. R 145f. | 60 25·4 | 0 44·5 |
| | Burra Voe Ness | 60 29·5 | 1 2·0 |

| | (6) Places | Lat. N | Lon. W |
|---|---|---|---|
| Shetland Is. | Fetlar I., ♯ 6m., E pt. | 60 35′·2 | 0°46′·0 |
| | Balta I., NS 1½m., S pt. | 60 44·4 | 0 47·7 |
| | N. extr. outer Stack rk. | 60 51·5 | 0 52·5 |
| | Gloup Holm, 3c., sum. | 60 44·2 | 1 6·5 |
| | Uya, or NE pt. | 60 37 | 1 26 |
| | Roeness Hill, 1476f. W end | 60 32 | 1 27 |
| | Ossa Skerry. rks. ♯ 4c. | 60 33·0 | 1 35·5 |
| | Esha Ness Skerry | 60 28·5 | 1 37·2 |
| | Fugloe Skerry | 60 20·4 | 1 45·0 |
| | Ve Skerries, ♯ 1m., mid. | 60 22·5 | 1 49 |
| | Skelda Ness | 60 8·8 | 1 28·0 |
| | Fitfull Hd., 929f. | 59 54 | 1 24 |
| | Foula I., ♯ 3m., ⌒, sum. 1369f. | 60 8·5 | 2 5·5 |
| | **Faero Islands.** | | |
| Faero Is. | Monk rk., 30f. | 61 23 | 6 45·7 |
| | Suderoe I., ♯ 5 l., S pt. | 61 26·5 | 6 48·5 |
| | Grt. Diamond | 61 43 | 6 49 |
| | Myggenoes I., EW 4m., W extr. ○ | 62 8 | 7 37 |
| | Fugloe I., NS 2½m., E pt. ○ | 62 20 | 6 13 |
| | Nalsoe I., ♯ 5m., S pt. | 61 58·5 | 6 39 |
| | Thorshavn, lt. F 35f. | 62 2·5 | 6 45·2 |
| | Haldervig Church | 62 18·3 | 7 2 |
| | **SCOTLAND, East Coast.** | | |
| ⊕ Scotland, E. Coast | Noss Hd., 577f., lt. R 175f. | 58 28·6 | 3 3 |
| | Ord of Caithness, needle | 58 10·2 | 2 31·0 |
| | Tain, ⊡ $^{26}_{12}$, spire | 57 48·7 | 4 3·2 |
| | Tarbetness, lt. Int. 175f. | 57 51·9 | 3 46·5 |
| | Cromarty, ⊞, spire | 57 40·7 | 4 0·0 |
| | Cromarty Pt., lt. Fr 60f. | 57 41·0 | 4 2·0 |
| | Fort George | 57 35·1 | 4 4·5 |
| | Chanonry Pt., lt. F 40f. | 57 34·5 | 4 5·5 |
| | Inverness, ⊞, jail | 57 28·6 | 4 13·5 |
| | Burgh Hd. | 57 42·1 | 3 30·0 |
| | Coversea Skerries, lt. R 160f | 57 43·4 | 3 20·2 |
| | Cullen, Castle hill | 57 41·4 | 2 49·5 |
| | Banff, ⊡ $^{n}_{0}$, N pier, lt. Fr 28f. | 57 40·3 | 2 31 |
| | Troup Hd., pt. | 57 41·7 | 2 17·2 |
| | Kinnaird's Hd., lt. Fwr 120f. | 57 41·9 | 2 0·2 |
| | Fraserburgh, 2 lts. Fr 20f., 35f. | 57 41·5 | 2 0·0 |
| | Rattray Pt. | 57 37 | 1 49 |
| | Peterhead, S ⊡ $^{11}_{0}$, Keith Inch | 57 30·1 | 1 46·0 |
| | Buchanness, lt. Fl. 130f. | 57 28·2 | 1 46·5 |
| | Aberdeen, ⊡ $^{21}_{2}$, Observatory | 57 8·9 | 2 5·7 |
| | Girdleness, 2 lts. F $\frac{185}{115}$f. | 57 8·5 | 2 4 |
| | Stonehaven, ⊡ $^{n}_{0}$, 2 lts. $F^{r}_{w}$ $\frac{24}{18}$f. | 56 58·0 | 2 12·7 |
| | Montrose, ⊡ $^{23}_{10}$, Scurdy Ness. lt. Int 124f. | 56 42 | 2 27 |
| | Red Hd., 255f. | 56 37 | 2 29 |
| | Arbroath, ⊡, Abbey | 56 33·7 | 2 35·0 |
| | Buddonness, 2 lts. N49°W 1122f., F 103f., 61f. | 56 28·1 | 2 45·0 |
| | Port-on-Craig, 2 lts. S88°E 1321f., F 80f., 30f. | 56 27 | 2 49 |
| | Dundee, ⊡, lts. N80°W 390f., 2 Fr 25f. | 56 27·6 | 2 57·7 |
| | Bell rk., lt. Rwr 93f. | 56 26·0 | 2 23·0 |
| | St. Andrews, ⊡, Ch. | 56 20·4 | 2 47·5 |
| | Fifeness, fl. st. | 56 16·7 | 2 35·0 |
| | May I., ♯ 1m., lt. Fl. 240f. | 56 11·1 | 2 33·2 |
| | Leith, ⊡, pier lts. F | 55 58·9 | 3 10·5 |
| | Edinburgh, Obs. Blackford | 55 55·5 | 3 11·0 |

## MARITIME POSITIONS

| (7) Places | Lat. N | Lon. |
|---|---|---|
| | | West |
| Incl. Keith lt. R 220f. | 56° 2'0 | 3° 8'0 |
| N. Berwick, Church | 56 3·4 | 2 43·2 |
| Bass rock | 56 4·7 | 2 38·2 |
| Dunbar, ⊞, Church | 55 59·9 | 2 31·0 |
| **ENGLAND. East Coast.** (⊕ *England, E. Coast*) | | |
| St. Abb's Hd., lt. Fl. 224f. | 55 55 | 2 8 |
| Eyemouth, Church | 55 52·3 | 2 5·5 |
| Berwick, ⊞$^{21}_{0}$, spire | 55 45·8 | 1 59·0 |
| Holy I., Castle | 55 40·2 | 1 47·0 |
| Farn Is., 2 lts. N36°W 560f., R 30', 87f., Fl. 45f. | 55 37·0 | 1 39·2 |
| Cheviot hill, 2658f. | 55 29 | 2 9 |
| N. Sunderland Pt., mill | 55 34·7 | 1 38·2 |
| Coquet I., lt. F 83f. | 55 20·1 | 1 32·0 |
| Blyth, ⊞$^{n}_{0}$, 2 lts. F | 55 7·5 | 1 30·0 |
| Tynemouth, lt. R 154f., Castle | 55 1·3 | 1 25·0 |
| N. Shields, ⊞, Ch. | 55 0·7 | 1 26·7 |
| Newcastle, bridge, N end | 54 58·7 | 1 35·5 |
| Sunderland, ⊞, Church | 54 54·5 | 1 21·5 |
| Hartlepool, ⊞$^{16}_{0}$, Church | 54 41·8 | 1 10·7 |
| Seaton, ⊞, 2 lts., high lt. F 89f. | 54 40·3 | 1 12·2 |
| Tees River, entrance | 54 37·1 | 1 8·7 |
| Stockton, Church | 54 34·0 | 1 18·7 |
| Redcar, Church | 54 36·9 | 1 3·5 |
| Whitby, ⊞, 2 lts. F 240f. | 54 28·7 | 0 34·2 |
| Scarborough, ⊞$^{n}_{0}$ lt. F$^{r}$ 58f. | 54 17·0 | 0 23·5 |
| Flamborough Head, lt R$^{2wr}$ 214f. | 54 7·0 | 0 5·0 |
| Bridlington Quay, Mill, ⊞$^{n}_{0}$ | 54 5·2 | 0 11·7 |
| Hull, ⊞, citadel | 53 44·6 | 0 20·0 |
| Killingholme, 3 lts. F 68f., outer | 53 38·7 | 0 12 |
| | | East |
| Spurn lts., N66°W, Occ. & F 93f, 54f. | 53 34·7 | 0 7·2 |
| Inner Dowsing, beacon | 53 18·4 | 0 33·2 |
| Smith's Knoll, 7m., 1, S pt. | 52 48 | 2 14 |
| Hunstanton Pt., lt. Occ. 109f. | 52 57 | 0 29·7 |
| Cromer, lt. R 274f. | 52 55·5 | 1 19·0 |
| Hasborough, lt. F 136f. | 52 49·2 | 1 32·2 |
| Winterton, lt. F 110f. | 52 43·0 | 1 41·5 |
| Yarmouth, ⊞, spire | 52 36·8 | 1 43·7 |
| Lowestoft, 2 lts. N28W 2490f. Rev. and F 123f., 40f. | 52 29·2 | 1 45·5 |
| Southwold, Church | 52 19·7 | 1 40·7 |
| Alborough, steeple | 52 9·2 | 1 36·0 |
| Orfordness, lt. Int. 91f. | 52 4·8 | 1 34·5 |
| Orford, steeple | 52 5·7 | 1 32·2 |
| Landguard Fort | 51 56·3 | 1 19·2 |
| Harwich, ⊞$^{24}_{15}$ lts. F N62°W 680f., 45f., 27f. | 51 55·8 | 1 16·7 |
| Walton, tower | 51 51·8 | 1 17·2 |
| Maplin, SE pt., Occ. 36f., bell | 51 35 | 1 3 |
| **IRELAND, West Coast.** | | West |
| Cape Clear, I. 3m., SW point | 51 25·3 | 9 31 |
| Fastnet rk., 92f., lt. R 148f. | 51 23·3 | 9 36·2 |
| Crookhaven, ⊞, N entr. lt. F 67f. | 51 28·6 | 9 42·7 |
| Mizen Hd. | 51 27 | 9 49·5 |
| Sheep Hd. | 51 32·5 | 9 51·2 |
| Bear Haven, ⊞, Bear I., sum. 887f. | 51 37·5 | 9 52·2 |

| (8) Places | Lat. N | Lon. W |
|---|---|---|
| Hungry Hill, 181f. | 51°41' | 9°47'5 |
| Bantry, Ch. | 51 40·8 | 9 27·2 |
| Roancarrig I., lt. F 55f. | 51 39·2 | 9 44·7 |
| Calf rk. | 51 34 | 10 16 |
| Bull rk., lt. Fl. 271f. | 51 35·5 | 10 18 |
| Cod's Head | 51 39·7 | 10 6·2 |
| Scarriff I., summit | 51 43·6 | 10 15·5 |
| Bolus Hd. | 51 47 | 10 20·7 |
| Skelligs, lt. F 175f. | 51 46·2 | 10 32·7 |
| Bray Hd | 51 53 | 10 26 |
| Valentia, ⊞, Cromwell's Fort, lt. F 54f. | 51 56 | 10 19·2 |
| Great Foze rk. | 52 1·2 | 10 41·2 |
| Tearaght rk., lt. Fl. 275f. | 52 4·5 | 10 40 |
| Grt. Blaskett, 3m, N pt. | 52 6·7 | 10 31·2 |
| Brandon Hill, 3126f. | 52 14 | 10 15 |
| Tralee Lit. Samphire I., lt. F 56f. | 52 16·2 | 9 52·7 |
| *⊕ Ireland, W. Coast* | | |
| R. Shannon, ⊞, Kerry Hd. | 52 25·3 | 9 56·5 |
| Tarbert, lt. F 58f. | 52 35·5 | 9 21·7 |
| Limerick, ⊞, Cathedral | 52 40 | 8 37·5 |
| Kilcradan, lt. F$^{r}$ 133f. | 52 34·8 | 9 42·5 |
| Loop Hd., lt. Occ. 277f. | 52 33·6 | 9 56 |
| Ballard Pt., tower | 52 44 | 9 37 |
| Hags Hd. | 52 57 | 9 28 |
| Arran Is., Eeragh I., lt. R 115f. | 53 9 | 9 51·5 |
| —— Inisheer I., lt. F 110f. | 53 2·7 | 9 31·5 |
| Black Hd. | 53 9 | 9 16 |
| Galway, ⊞, Mutton I., lt. F 33f. | 53 15·2 | 9 3·2 |
| Skird rks., 1m. Skirdmore | 53 15·3 | 10 0 |
| Slyne Hd., 2 lts. S18°E 415f., R$^{2wr}$ 115f., F 104f. | 53 24·0 | 10 14·0 |
| Inishark Hd. | 53 36 | 10 18 |
| Clare I., N pt., lt. F 340f. | 53 49·5 | 9 59·5 |
| Inishgort, lt. F 36f. | 53 49·5 | 9 40·2 |
| Westport | 53 48 | 9 31 |
| Newport, ⊞ | 53 53 | 9 33 |
| Bills rk. | 53 53 | 10 12·7 |
| Achil Hd., 2222f., pt. | 53 58·5 | 10 15·2 |
| Black rk., lt. R 283f. | 54 4·2 | 10 19·2 |
| Eagle I., 2 lts. N49°E 395f., F 220f. | 54 17 | 10 5·5 |
| Erris Hd. | 54 18·5 | 10 0 |
| Stag rks., Nst. | 54 22 | 9 47·7 |
| Downpatrick Hd. | 55 19·6 | 9 20·7 |
| Killala, ⊞ | 54 11 | 9 13 |
| Ballina, ⊞, spire | ·4 6·6 | 9 9·5 |
| Sligo Black rk., lt. F 79f. | 54 18 | 8 37 |
| Innis Murray I., W end | 54 25·7 | 8 40 |
| Ballyshannon, ⊞$^{12}_{3}$, Ch. | 54 30·2 | 8 11·7 |
| Donegal, ⊞$^{21}_{9}$ | 54 39·5 | 8 7 |
| St. John's Pt., Killibegs, lt. F 98f. | 54 34·1 | 8 27·5 |
| *⊕ Ireland, N. W. Coast* | | |
| Rathlin O Birne Is., lt. F 116f. | 54 33·7 | 8 50 |
| Dawros Hd., pt. | 54 49·6 | 8 34·0 |
| Aran I., Rinrawros lt. R 233f. | 55 0·9 | 8 33·7 |
| Stag rks. | 55 4·6 | 8 29·0 |
| Bloody Foreland Hill, 1059f. | 55 8·2 | 8 15·7 |
| **North Coast.** | | |
| Tory I., 2·5m., lt. on N & W pt. Fl. 130 | 55 16·5 | 8 15 |
| Horn Hd., E sum. 824f. | 55 12·5 | 7 57·2 |
| Melmore Pt., tower | 55 15·2 | 7 47·2 |

## MARITIME POSITIONS

| (9) Places | Lat. N | Lon. W |
|---|---|---|
| *N. E. of Ireland* | | |
| Limeburner shl. | 55°18′ | 7°48′ |
| Fanad Pt., lt. Occ. 127f. | 55 16·6 | 7 37·7 |
| Buncrana, ⊞, Ch. | 55 8·1 | 7 27·2 |
| Dunaff Hd. | 55 17·1 | 7 32 |
| Malin Hd., tower | 55 22·8 | 7 22·2 |
| Innistrahul, lt. R 181f. | 55 25·9 | 7 13·7 |
| Slieve Sneacht, 2009f. | 55 12 | 7 20 |
| Innishowen Hd., 2 lts. S62°E 460f., F 67f. & 92f. | 55 13·6 | 6 55·5 |
| Londonderry, ⊡, Cathedral | 54 59·6 | 7 19·5 |
| Portrush, ⊡$^{23}_{17}$, pier | 55 12·4 | 6 39·2 |
| Giant's Causeway, pt. | 55 14·7 | 6 30·7 |
| Rathlin I., 2 lts. Int. 243f., F 182f. | 55 18·2 | 6 10·2 |
| Fair Hd., sum. 626f. | 55 13·3 | 6 8·7 |
| Torr Pt., rk. | 55 11·8 | 6 3·5 |
| Knocklayd, Mt., 1675f. | 55 9·7 | 6 15·2 |
| **East Coast.** | | |
| *East Coast of ⊕ Ireland* | | |
| Maiden rks., 2 lts. N84°W 1920f., F 95f., 82f. | 54 55·8 | 5 44·2 |
| Black Hd. | 54 46·1 | 5 41·2 |
| Carrickfergus, ⊡$^{8}_{0}$ | 54 43·5 | 5 48·5 |
| Belfast, ⊡$^{12}_{0}$, spire | 54 36·4 | 5 56·2 |
| Divis, Mt., 1800f. | 54 36·7 | 6 1·0 |
| Donaghadee, ⊡$^{23}_{12}$, lt. F$^{r}$ 56f. | 54 38·7 | 5 32 |
| Ardglass, ⊡$^{23}_{12}$, lt. F$^{r}$ | 54 15·4 | 5 36·0 |
| Downpatrick, ⊞, Cathedral | 54 19·6 | 5 43·0 |
| St. John's Pt., lt. Int. 62f. | 54 13·2 | 5 40 |
| Slieve Donard, 2796f. | 54 10·8 | 5 55·2 |
| Carlingford, ⊡$^{23}_{9}$, lt. R 29f. | 54 2·0 | 6 7·7 |
| Newry, Church | 54 10·6 | 6 19·7 |
| Dundalk, ⊡$^{19}_{2}$, lt. Fl. 33f. | 53 58·7 | 6 17·7 |
| Clogher Hd., pt | 53 47·6 | 6 13 |
| Drogheda, ⊡$^{14}_{2}$, 3 lts. F, bridge | 53 42·8 | 6 15 |
| Balbriggan, ⊡$^{12}_{0}$, lt. F 42f. | 53 36·8 | 6 10·7 |
| Rockabil Is., 2 rks., lt. Fl. 148f. | 53 35·8 | 6 0·2 |
| Lambay I., sum. | 53 29·6 | 6 1·0 |
| Howth Bailey, lt. F 134f. | 53 21·7 | 6 3·0 |
| Dublin Observatory | 53 23·2 | 6 20·5 |
| —— Poolbeg, lt. F 66f. | 53 20·5 | 6 9 |
| Kingstown, ⊞, E lt. R$^{w}$ 41f. | 53 18·1 | 6 7·7 |
| Grt. Sugar Loaf, 1651f. | 53 9·2 | 6 9·0 |
| Wicklow Hd., lt. Occ. 121f. | 52 57·9 | 6 0·0 |
| Wexford College, tower | 52 20·1 | 6 28·2 |
| **South Coast.** | | |
| *S.E. of Ireland* | | |
| Tuskar rk., lt. R$^{rw}$ 108f. | 52 12·1 | 6 12·5 |
| Carnsore Pt. | 52 10·3 | 6 21·7 |
| Hook lt. F 152f. | 52 7·4 | 6 55·7 |
| Waterford, ⊡$^{28}_{13}$ bridge | 52 16 | 7 6 |
| Duncannon fort, 2 lts. F vert. 53f. and 43f. | 52 13·2 | 6 56 |
| Dunmore, ⊡, pier lt. F$^{r}$ 44f. | 52 9 | 6 59·5 |
| Brownstown Hd., 102f., 2 tow. | 52 7 | 7 7 |
| Helwick Hd. | 52 3 | 7 32 |
| Dungarvan, Ballinacourty Pt., lt. F 52f., w | 52 4·5 | 7 33 |
| Minehead, lt. Int. 285f. | 51 59·5 | 7 35·2 |
| Ballycottin I., lt. Fl. 195f. | 51 49·5 | 7 59 |
| Youghal, ⊡, lt. F 78f. | 51 56·6 | 7 50·5 |
| Roche Pt., 2 lts. Occ. and F 98f., 60f. | 51 47·5 | 8 15·2 |
| Haulbowline I., tower | 51 50·5 | 8 18·2 |
| Cork, Custom house | 51 53·8 | 8 27·7 |

| (10) Places | Lat. N | Lon. |
|---|---|---|
| | | West |
| Barry Hd. | 51°42′·1 | 8°23′·2 |
| Charles Fort, fl st., lt. F 98f | 51 41·8 | 8 29·7 |
| Kinsale, ⊞, Old Hd., lt. F 236f. | 51 36·2 | 8 32 |
| Seven Hds., Telegr. | 51 34·2 | 8 42·7 |
| Galley Hd., S pt. | 51 31·8 | 8 57·0 |
| Stags, off Toe Hd., large rk. | 51 28·1 | 9 13·5 |
| Baltimore, ⊡ | 51 29 | 9 22 |
| **EUROPE.** | | |
| **BELGIUM.** | | East |
| *Belgium ⊕* | | |
| Dunkirk, ⊡, lt. F, Fl. 193f. | 51 3·1 | 2 22·0 |
| Nieuport, ⊡$^{a}_{0}$, lt. F$^{r}$ 98f., (NW of town) | 51 8·6 | 2 44 |
| Ostend, ⊡, 4 lts., E one F 189f. | 51 14·3 | 2 56·2 |
| Blankenberg, lt. F 83f. | 51 19·0 | 3 7·0 |
| Heijst, lt. F 26f. | 51 20·4 | 3 14·2 |
| Flushing, ⊡, lt. F 49f. | 51 26·4 | 3 34 |
| Middelburg | 51 30·0 | 3 37·0 |
| Schouwen, W end of I., lt. Fl. 171f. | 51 42 | 3 41 |
| Bergen op Zoom, Ch. | 51 29·7 | 4 17·5 |
| Goedereede, lt. on Ch. F 148f. | 51 49·2 | 3 58·5 |
| Antwerp, ⊞, Cath. | 51 13·2 | 4 24·2 |
| Helvoetsluys, lt. F 49f. | 51 49·2 | 4 8·0 |
| Brielle, ⊡, Church | 51 54·2 | 4 10·0 |
| Rotterdam, ⊡, Cath. | 51 55·3 | 4 29·5 |
| The Hague, St. James' Ch. | 52 4·3 | 4 18·7 |
| **HOLLAND.** | | |
| *Holland ⊕* | | |
| Scheveningen, lt. Rev. 157f. | 52 6·3 | 4 16·5 |
| Katwyk, Coast lt. F 82f. | 52 12·0 | 4 23·7 |
| Nordwyk, lt. F 66f. | 52 14·6 | 4 26·0 |
| Alkmaar | 52 37·9 | 4 45·2 |
| Zandvort, lt. F 75f. | 52 22·3 | 4 32·0 |
| Egmont lts., 2F 125f., 120f. | 52 37·2 | 4 37 |
| Kyk duin, lts. F 187f. and 45f. | 52 57·1 | 4 43·5 |
| Helder, ⊞ | 52 57·7 | 4 45·0 |
| Texel I., ⚓ 11m., W pt. | 53 3 | 4 42 |
| Medemblik, Ch. | 52 46·4 | 5 6·5 |
| Marken I., lt. F 52f. | 52 27·6 | 5 8 |
| Amsterdam, ⊞, W stee le | 52 22·5 | 4 53·2 |
| Haarlem, Grt. Ch. tower | 52 22·9 | 4 38·5 |
| Leyden, Observatory | 52 9·5 | 4 29·5 |
| Vlieland, lt. F 151f. | 53 17·8 | 5 3·7 |
| Ter Schelling, lt. R 1$^{m}$ 177f. | 53 21·6 | 5 13·2 |
| Ameland, beacon | 53 27·0 | 5 42·0 |
| Schiermonikoog, 2 lts. F 139f. and 147f. | 53 29·3 | 6 9·0 |
| Rottum I., beac. | 53 32·0 | 6 32·0 |
| Borcum, lt. F, Fl. 207f. | 53 35 | 6 40 |
| **PRUSSIA.** | | |
| *Prussia* | | |
| Emden, Hotel de Ville | 53 22·1 | 7 12·7 |
| Wangeroog I., *l*, lt. Fl 108f. | 53 47·6 | 7 54 |
| Bremer or Weser lt. v., fl. F 28f., bell, guns | 53 48 | 8 8 |
| Bremen, Observatory | 53 4·6 | 8 49·0 |
| Wilhelmshaven, Observatory | 53 31·9 | 8 8·7 |
| Heligoland I., lt. F 225f. | 54 10·8 | 7 53·0 |
| Neuwerk I., lt. F, Fl. 126f. | 53 55·2 | 8 30·0 |
| Cuxhaven, lt. F, Fl. 70f. | 53 52·5 | 8 42·0 |
| Gluckstadt, pier lt. F$^{r}$ 30f. | 53 47·1 | 9 24·5 |

## MARITIME POSITIONS

| (11) | Places | Lat N | Lon. E |
|---|---|---|---|
| | Altona, Observatory | 53°32′·7 | 9°56′·5 |
| | Hamburg, OBSERVATORY | 53 33·1 | 9 58·5 |
| | **DENMARK.** | | |
| Denmark ⊕ | Horn Pt., rf., outer shl. | 55 35 | 7 40 |
| Denmark ⊕ | Hantsholmen Pt., lt. R 218f. | 57 6·8 | 8 36·2 |
| Denmark ⊕ | Harshails Nist | 57 35 | 9 56 |
| Denmark ⊕ | The Skaw, pt., *l*, lt. F 144f. | 57 43·8 | 10 38·5 |
| Denmark ⊕ | Hirtsholmen, lt. F, Fl. 95f. | 57 29·2 | 10 37·5 |
| Denmark ⊕ | Fladstrand, Church | 57 27·0 | 10 33·7 |
| Denmark ⊕ | Niningen, lts, 2 F 66f., bell | 57 18 | 11 54 |
| Denmark ⊕ | Leso I., 10m., Byrum Ch. | 57 15·4 | 11 0·2 |
| Denmark ⊕ | Anholt I., E pt., lt. Fl. 133f. | 56 44·3 | 11 39·2 |
| Denmark ⊕ | Hesselo, lt. F 118f. | 56 11·7 | 11 43 |
| Denmark ⊕ | Aalborg | 57 2·7 | 9 55 |
| Denmark ⊕ | Fornas, lt. Fl. 69f. | 56 26·7 | 10 57·5 |
| Denmark ⊕ | Aarhus, Cath. | 56 9·5 | 10 13·0 |
| Denmark ⊕ | Thunö I., lt. F 100f. | 55 56·9 | 10 27·0 |
| Denmark ⊕ | Bango. lt., S pt., F 39f. | 55 17·7 | 9 48·0 |
| Denmark ⊕ | Apenrade | 55 2·6 | 9 25·2 |
| Denmark ⊕ | Assens, Church | 55 16·1 | 9 53·7 |
| Denmark ⊕ | Flensburg | 54 46·9 | 9 26·2 |
| Denmark ⊕ | Sicellands rf., N and W pt. | 56 5 | 11 15 |
| Denmark ⊕ | Kyholm | 55 56·0 | 10 40·7 |
| Denmark ⊕ | Reef-ness, lt. F 79f. | 55 44·7 | 10 52·5 |
| Denmark ⊕ | Sprogo, lt. R 134f. | 55 20 | 10 58 |
| Denmark ⊕ | Nyeborg, Ch. | 55 18·7 | 10 47·7 |
| Denmark ⊕ | Fakkeberg, lt. S pt. Langeland, F 129f. | 54 44·4 | 10 42·0 |
| Denmark ⊕ | Spotsbierg, lt. Fl. 123f. | 55 58·6 | 11 52·0 |
| Denmark ⊕ | Nakkehead, 2 lts. N89°W, F 147f., 98f. | 56 7·2 | 12 21·0 |
| Denmark ⊕ | Elsineur, Kronborg, lt. F, Fl. 110f. | 56 2·2 | 12 37·5 |
| Denmark ⊕ | COPENHAGEN, ⊞, University, OBSERVATORY | 55 41·2 | 12 34·7 |
| Denmark ⊕ | Stevns Cape, lt. Fl. 209f. | 55 17 | 12 27 |
| Denmark ⊕ | Moen I., E pt., lt. F 82f. | 54 57 | 12 33 |
| Denmark ⊕ | Gedser point, lt. F 64f. | 54 33·8 | 11 58·0 |
| Denmark ⊕ | Trindelen, shl. | 54 30·5 | 12 4 |
| Bornholm | Eartholms, or Christiansö, lt. N pt., Fl. 94f. | 55 19 | 15 12 |
| Bornholm | Bornholm, N pt. | 55 17·7 | 14 46 |
| Bornholm | — S pt. | 54 59 | 15 5 |
| Bornholm | — Rönne, 2 lts., F 76f., 29f. | 55 6 | 14 42 |
| | **PRUSSIA in the Baltic.** | | |
| Prussia ⊕ | Kiel, OBSERVATORY | 54 20·5 | 10 8·7 |
| Prussia ⊕ | Fermom I., Marien, lt. R 94f. | 54 29·7 | 11 14·2 |
| Prussia ⊕ | Staberhuk I. | 54 24 | 11 19 |
| Prussia ⊕ | Lubeck, St. Mary's Church | 53 52·1 | 10 41·5 |
| Prussia ⊕ | Wismar. St. Mary's Church | 53 53·5 | 11 27·7 |
| Prussia ⊕ | Warnemunde, lt. F 59f. | 54 10·7 | 12 5·7 |
| Prussia ⊕ | Rostock | 54 5·5 | 12 9·0 |
| Prussia ⊕ | Dars Hd., pt., 2 lts. F & R 108f. & 41f. | 54 28·6 | 12 30·5 |
| Prussia ⊕ | Stralsund | 54 18·3 | 13 5·5 |
| Prussia ⊕ | Arkona, lt. F 200f. | 54 40·9 | 13 26·2 |
| Prussia ⊕ | Bergen, Church | 54 25·5 | 13 28·0 |
| Prussia ⊕ | E. pt. of Rugen I. | 54 21 | 13 48 |
| Prussia ⊕ | Greifswald, lt. Rev. 154f. | 54 15·1 | 13 55·7 |
| Prussia ⊕ | Swinemünde, lt. F 207f. | 53 55·0 | 14 18·0 |

| (12) | Places | Lat. N | Lon. E |
|---|---|---|---|
| | Stettin | 53°25′·1 | 14°34′·0 |
| | Colberg, fort | 54 10·8 | 15 35 |
| | Jershöft, lt. R 165f. | 54 32·5 | 16 33·0 |
| | Hela, lt. R 120f. | 54 36·1 | 18 49·2 |
| | Rixhöft, lt. F 231f. | 54 49·9 | 18 20·5 |
| | Neufahrwasser, lt. F 78f. | 54 24·2 | 18 40·2 |
| | Dantzig. Observatory | 54 21·3 | 18 41·2 |
| | Pillau. ⊞, lt. F 96f. | 54 38·4 | 19 54·0 |
| | Konigsberg, Observatory | 54 42·8 | 20 30·2 |
| | Brüster Ort, lt. R 164f. | 54 57·6 | 19 59·2 |
| | Memel, ⊞, lt. F 98f. | 55 42 | 21 6·2 |
| | **RUSSIA.** | | |
| Russia ⊕ | Libau, ⊞, Pilot's Tower, lt. F, Fl. 103f. | 56 30·9 | 21 0 |
| Russia ⊕ | Windau, Church | 57 23·9 | 21 34·0 |
| Russia ⊕ | Lyser Ort, lt. F 118f. | 57 34 | 21 43 |
| Russia ⊕ | Domesness, lt. F, Fl. 64f. | 57 48 | 22 39 |
| Russia ⊕ | Runo I., lt. F 210f. | 57 48 | 23 15 |
| Russia ⊕ | Riga, ⊞, Cathedral | 56 57·0 | 24 6·5 |
| Russia ⊕ | Pernau, Germ. Church | 58 23·2 | 24 30 |
| Russia ⊕ | Arensberg | 58 15·1 | 22 30 |
| Russia ⊕ | Swalfer Ort, lt. Osel I. S pt., Rev. 114f. | 57 54·6 | 22 4 |
| Russia ⊕ | Filsand, W pt. of grt. Id., F 136f. | 58 23 | 21 50 |
| Russia ⊕ | Dager Ort, lt. 5m. Ed. of pt., F, Fl. 334f. | 58 55 | 22 13 |
| Russia ⊕ | Winkova | 59 12 | 22 18 |
| Russia ⊕ | Odensholm, lt. Fl. 115f. | 59 18·3 | 23 23·0 |
| Russia ⊕ | Parker Ort, lt. F 147f. | 59 23·5 | 24 3 |
| Russia ⊕ | Sourop, lt. F 135f. | 59 27·9 | 24 24 |
| Russia ⊕ | Nargen I., lt. N pt., R 126f. | 59 36·4 | 24 32·0 |
| Russia ⊕ | Revel, St. Olaus Church | 59 26·6 | 24 47 |
| Russia ⊕ | Wolf beacon | 59 35 | 24 48 |
| Russia ⊕ | Kokskar, lt. F 106f. | 59 42·0 | 25 3 |
| Russia ⊕ | Ekholm, lt. F, Fl. 108f. | 59 41 | 25 49 |
| Russia ⊕ | Stoneskar beacon | 59 49·5 | 20 21 |
| Russia ⊕ | Rodskar I., lt. Fl. 65f. | 59 58·2 | 26 42·0 |
| Russia ⊕ | Little Tiouters, W pt. | 59 50·0 | 26 53·0 |
| Russia ⊕ | Great Tiouters, E sum | 59 51·0 | 27 14·5 |
| Gulf of Finland | Hogland, 6m., N. pt. 2 lts. S′ by W′ ½ 6m., F 384f., 33f. lower | 60 6·3 | 26 58·5 |
| Gulf of Finland | Lavenskar I, N pt. | 60 2·3 | 27 51·0 |
| Gulf of Finland | Peni I., E pt. | 60 1·1 | 28 5·0 |
| Gulf of Finland | Seskar I., NW pt., lt. Fl. 97f. | 60 2·1 | 28 23·5 |
| Gulf of Finland | C. Kolganpia, Church | 59 50·9 | 28 34·7 |
| Gulf of Finland | Dolgoi Noss Pt. | 59 54·8 | 29 0·5 |
| Gulf of Finland | Tolboukin, lt. Rev. 95f. | 60 2·6 | 29 33·0 |
| Gulf of Finland | Kronstadt, ⊞, St Andrew Ch. | 59 59·7 | 29 46 |
| Gulf of Finland | St. PETERSBURG. Acad. of Science, OBSERVATORY | 59 56·5 | 30 18·2 |
| Gulf of Finland | POULKOVA, OBSERVATORY | 59 46·3 | 30 19·7 |
| Gulf of Finland | Stirs Pt., lt. F 117f. | 60 11·0 | 29 3 |
| Gulf of Finland | Biorko I., S pt., tower | 60 15·7 | 28 43·2 |
| Gulf of Finland | Grekova rk., beacon | 60 11·6 | 28 42·5 |
| Gulf of Finland | Wiborg | 60 42·7 | 28 46 |
| Gulf of Finland | Aspo beacon | 60 17·7 | 27 13 |
| Gulf of Finland | Nerva tower | 60 14·8 | 27 58·5 |
| Gulf of Finland | Sommars I., lt. Rev. 89f. | 60 12·4 | 27 39·5 |
| Gulf of Finland | Lippu I., beacon | 60 14·3 | 27 3·0 |
| Gulf of Finland | Frederickshamm | 60 34 | 27 12 |
| Gulf of Finland | Lovisa, ⊞ | 60 27·6 | 26 16 |
| Gulf of Finland | Orrengrund, beac. 103f. | 60 16·6 | 26 27·2 |
| Gulf of Finland | Grt. Pellinge, or Glosholm | 60 11·2 | 25 50 |

## MARITIME POSITIONS

| (13) Places | Lat. N | Lon. E |
|---|---|---|
| ***Gulf of Bothnia*** | | |
| Soderskar tow. pilots, lt. F, Fl. 124f. | 60° 7 | 25° 26′ |
| Helsingfors, OBSERVATORY | 60 9·7 | 24 57·2 |
| Sveaborg | 60 8·4 | 24 59·7 |
| Renskar, lt. F 164f. | 59 56 | 24 25 |
| Jussari, pilot's ho. | 59 49 7 | 23 34 |
| Segelskar, beac. | 59 46 | 23 22 |
| Hango, lt. F. Fl. 112f. | 59 46·0 | 22 57 |
| Abo, Observatory | 60 27 0 | 22 17·5 |
| Uto, lt. F 130f. | 59 46·5 | 21 22 |
| Bogskar | 60 4 | 20 55 |
| Lagskar, lt. F 100f. | 59 50·5 | 19 55·2 |
| Nyhamn, beacon | 59 58 | 19 57 |
| Hogsten, beacon | 60 21 | 19 25 |
| Nystad, Enskar, lt. F 152f. | 60 43 | 21 1 |
| Lökö, beacon | 60 56 | 21 9 |
| Sabbskar, beacon | 61 27·7 | 21 22 |
| Bjorneborg | 61 29·0 | 21 48 |
| Torngrund, beacon | 62 13·0 | 21 20 |
| Christinestad | 62 16 2 | 21 23 |
| Storkalle shl., S pt. sf. | 62 45 | 20 50 |
| Moikepää, beacon | 62 54·0 | 21 6 |
| Fallskar, beacon | 63 4·0 | 20 49 |
| Wasa, Church | 63 4 3 | 21 43 |
| Korsören, beacon | 63 11·8 | 21 10 |
| Norrskar, lt. R 105f. | 63 14 | 20 37 |
| Walsorarne Is., N pt. | 63 27 | 21 6 |
| Helsingkall, rk, sf. | 63 35 | 21 53 |
| Ny Carleby. Church | 63 32 0 | 22 32 |
| Kejsarsklubb, beacon | 63 43 | 22 34 |
| Tankar, beacon | 63 57·3 | 22 52 |
| Gamla Carleby, Xpili, lt. F, Fl. 21f. | 63 51 | 23 1 |
| Kalla rk., lt. F 58f. | 64 20·0 | 23 27 |
| Nahkiainen shl., sf. | 64 36 | 23 54 |
| Brahestad. Church | 64 41·5 | 24 31 |
| Carlö I.. W lt. F. Fl 101f. | 65 2·0 | 24 34 |
| Uleaborg, Church | 65 1·0 | 25 30 |
| Ulkogrunni, beacon | 65 24 | 24 51 |
| Maloren, lt. F 78f. | 65 32 | 23 34 |
| Torneo | 65 50 8 | 24 10 |
| **SWEDEN.** | | |
| Rodkallen rks., grt., mid. lt. R 84 | 65 19 | 22 22 |
| Pitea | 65 19·2 | 21 30 0 |
| Stor Rebben. beacon | 65 12 | 21 58 |
| Bjuroklubb, beacon | 64 28 | 21 35 |
| Grt. Fjäd-räg I., mid. lt. R 101f. | 63 48 | 21 1 |
| Gadd, lt. on S pt. of Is. F 70f. | 63 36 0 | 20 46 |
| Umea | 63 49·5 | 20 18 |
| Bonden, beacon | 63 26 | 20 4 |
| Skagsudde, beacon | 63 12·0 | 19 0 |
| Hernöklubb, beacon | 62 36·0 | 18 0 |
| Hernosand. Church | 62 37·9 | 17 57 |
| Bramo I., N pt., beacon | 62 14 | 17 44 |
| Huddiksvall | 61 43·7 | 17 7·7 |
| Hornsudde, pt. | 61 37 | 16 30 |
| Soderhamm | 61 17 7 | 17 5 |
| Stor Jungfrun, lt. E pt. F 86f. | 61 10 | 17 21 |
| Gefle | 60 40·3 | 17 9 |
| Eggegrund, lt. F 61f. | 60 44 | 17 33 |
| Orskär, lt. R 120f. | 60 31·5 | 18 23 |
| Nygrund, 16f. | 60 29·5 | 18 41 |
| S. Quarken, Understen, lt. F 78f. | 60 16·2 | 18 54·5 |
| Svartklubben, lt. R 68f. | 60 9 8 | 18 50 |

| (14) Places | Lat. N | Lon. E |
|---|---|---|
| ***E. Coast of Sweden*** | | |
| Arholma, beacon | 59° 51′·0 | 19° 7′ |
| Söderarm, lt. R 99f. | 59 45·2 | 19 24 |
| Svenska Hogarne | 59 27 | 19 31 |
| Stockholm, ⊞, OBSERVATORY | 59 20 6 | 18 3·5 |
| Grönskär, lt. F 111f. | 59 17 | 19 2 |
| Landsort lt. F, Fl. 146f. | 58 44·5 | 17 52 |
| Enskar, beacon | 58 42 | 17 25 |
| Hafringe, beacon | 58 35 | 17 19 |
| Haradskar, beacon | 58 8·9 | 16 59 |
| Sparo, beacon | 57 42·9 | 16 44 |
| Westerwyk | 57 45 6 | 16 38 |
| Kalmar, Church | 56 39·5 | 16 22 |
| Gottska Sando, W pt. | 58 24 | 19 11 |
| Faro I., Holm Hd., lt. R 100f. | 57 57 | 19 22 |
| Gothland, S pt. Hoborg, lt. Rev. 190f. | 56 55·2 | 18 11 |
| Ostergarnsholm | 57 26·5 | 18 59 |
| Wisby | 57 38·6 | 18 16 |
| South Carlso | 57 19 | 17 59 |
| Oland, N. Hd., lt. F 103f. | 57 22 | 17 6 |
| — S Hd., lt. F 132f. | 56 11·8 | 16 24 |
| Christianopel | 56 15·5 | 16 3·0 |
| Utklippor rks., lt. F, Fl. 100f. | 55 56·5 | 15 42 |
| Carlscrona, ⊞, lt. F, Fl. 58f. | 56 8 | 15 36 |
| Carlshamn, 2 lts. F 58f., 17f. | 56 10·3 | 14 52·0 |
| Hano I., lt. F, Fl. 218f. | 56 1 0 | 14 51 |
| Ahus | 55 55·5 | 14 18 |
| Cimrishamn, lt. Alt. 30f. | 55 33 5 | 14 22 |
| Ystad, Church | 55 25·8 | 13 49 5 |
| ***W. Coast of Sweden*** | | |
| Falsterbo, lt. F 78f. | 55 23·1 | 12 49·2 |
| Malmö. lt. F, Fl. 68f., Ch. | 55 37 | 13 0·0 |
| Landskrona, 2 lts. F 39f., 48f | 55 52·4 | 12 50·0 |
| Helsingborg, lt. F 29f. | 56 2·7 | 12 41 |
| Kullen, lt. Rev. 288f. | 56 18 0 | 12 27·5 |
| Engelholm. lt. Alt. 13f. | 56 16 | 12 50 |
| Hallands Waderö, lt. F, Fl. 67f. | 56 27·1 | 12 33 |
| Halmstadt, fort | 56 40·4 | 12 51 7 |
| Falkenberg, Ch. | 56 54·0 | 12 30·0 |
| Morup-tange. lt. F 95f. | 56 55 2 | 12 21 7 |
| Warberg. Castle | 57 6·4 | 12 14 5 |
| Niddingen, 2 lts., 2 F 66f., bell. | 57 18·2 | 11 54 3 |
| Vanguard shl., 1 | 57 32 | 11 39 |
| Winga, 2 lts, F, Fl. & F. 87f. | 57 38·0 | 11 36·2 |
| Buskar, lt. F 82f. | 57 38 6 | 11 40 7 |
| Gottenburg | 57 42·3 | 11 56·5 |
| Paternoster Is., lt. Rev. 117f. | 57 53 5 | 11 28 |
| Hallo, lt. Fl. 128f. | 58 20 2 | 11 14 |
| Nord Koster, 2 lts. F, Fl. 214f. | 58 54 | 11 0 |
| **NORWAY.** | | |
| Rock, 7f. | 58 42 | 10 53 |
| Torbjornskar. lt. F, Fl. 84f. | 59 0 | 10 47 |
| Færder, lt. F 154f. | 59 1·7 | 10 32 |
| Fülehük, lt. F, Fl. 57f., bell | 59 11·5 | 10 36·2 |
| Friederiksteen | 59 7·5 | 11 24 |
| Frederikstadt | 59 13 | 10 57 |
| Christiania, ⊞. new Observ. | 59 54·7 | 10 43·5 |
| Svenoe Langö Sound, ent. | 58 58 | 9 46 |
| Tvesteen | 58 56 | 9 57 |
| Reierskar rk., a gun | 58 10·1 | 8 27 |
| Jomfrueland, lt. Rev. 144f. | 58 52 | 9 36 |
| Arendal, Terungen I., lt. 2F 130f. | 58 24 | 8 48 |
| Oxö, lt. F 139f. | 58 4·4 | 8 4 |
| Christiansand, 2 ⊞, Ch. | 58 9 | 8 0 |

## MARITIME POSITIONS

| Region | (15) Places | Lat. N | Lon. E |
|---|---|---|---|
| Norway | Flekkero I., ⊞, rks. to S | 58° 2′ | 7° 57′ |
| | Ryvingen I., lt. F. Fl. 129f. | 57 58·0 | 7 29·5 |
| | Naze, lt. F, Fl 163f. | 57 58·8 | 7 3·2 |
| | Listersteen, lt. Fl. 128f. | 58 6 | 6 34 |
| | Jedderens, rf. W pt. | 58 46 | 5 24 |
| | Tungenæs, lt. F 29f. | 59 2 | 5 35 |
| | Hvidingso, lt. Occ. 149f. | 59 3 | 5 24 |
| | Skudesnæs, lt. F 75f. | 59 8 | 5 18 |
| | Hoievarde, lt. F 65f. | 59 19 | 5 19 |
| | Udsire, 2 lts, N 8° W, 255f. F | 59 18·3 | 4 53·5 |
| | Sor Hango rk., lt. F, Fl. 72f. | 59 25·2 | 5 15·2 |
| | Bommelöe, S pt. | 59 35 | 5 11 |
| | Fuglöe | 60 1 | 4 59 |
| | Lervig. lt. F 47f. | 59 47 | 5 33 |
| | Odde, Church | 60 4 | 6 33·2 |
| | Kors fiord, I. entr. | 60 8 | 4 57 |
| | Bergen, ⊞ | 60 24 | 5 18 |
| | Blomöe I. | 60 32 | 4 46 |
| | Udvær Is., W pt. | 62 2 | 4 28 |
| | Aspo I., NW pt. | 61 13 | 4 44 |
| | Veragrund | 61 17 | 4 27 |
| | Senning skar rk. | 61 39 | 4 35 |
| | Stadtland, NW pt. | 62 11 | 5 8 |
| | Svinöe | 62 20 | 5 17 |
| | Rundo, lt. F 158f. | 62 24·6 | 5 35·5 |
| | Aalesund, Church | 62 28·2 | 6 9 |
| | Lepsorev, lt. F 23f. | 62 35·5 | 6 16·5 |
| | Molde, Church | 62 44·3 | 7 10 |
| | Kvitholm, lt. F, Fl. 128f. | 63 1 | 7 14 |
| | Christiansund, lt. F 65f. | 63 7 | 7 39 |
| | Nightingale rks., outer | 63 23 | 7 8 |
| | Grip. lt. | 63 14 | 7 37 |
| | Hav flue, rk. | 62 51 | 6 11 |
| | Munk Holm, lt. F 38f. | 63 27 | 10 24 |
| | Trondhiem, Cathedral | 63 25·8 | 10 23·7 |
| | Titter Hd. | 63 40 | 8 19 |
| | Vigten Is, W extr rks. | 64 46 | 10 24 |
| | ——— NW extr. rks. | 65 2 | 10 37 |
| | Prœstöe, lt. F 39f. | 64 47·4 | 11 8 |
| | Leköe, sum. | 65 5 | 11 37 |
| | Heilhornet, pk. | 65 5 | 12 9 |
| | Hoibraken rk. | 65 24 | 11 0 |
| | Torghatten Pk. | 65 24 | 12 7 |
| | Sola I., sum. | 65 40 | 11 45 |
| | Svingleboen rk. | 65 38 | 11 17 |
| | Skal svee, rk. | 65 59 | 11 21 |
| | Trœn Is, Soholm, lt. Fl. 118f. | 66 26 | 12 0 |
| | Hestmando Pk. | 66 32 | 12 50 |
| | Kunna, sum. | 66 57 | 13 32 |
| | Lofoten Ids., Skomvær, lt. Fl. 159f. | 67 24·2 | 11 54 |
| | Lofoten Pt. | 67 49·5 | 12 50 |
| | Skraaven, sum. 600f. | 68 9 | 14 44 |
| | Trano I., N pt. | 68 11·3 | 15 39 |
| | W. Vago I., N pt. | 68 20·5 | 13 59 |
| | Lango I., W pt., rks. off. | 68 37 | 14 14 |
| | Andöe, N pt. | 69 20 | 16 8 |
| | Tromsöe, Observatory | 69 39·2 | 18 57·0 |
| | Hvalöe, NW pt. | 70 14·6 | 19 16 |
| | Hammerfest, Meridian pillar | 70 40·1 | 25 40·5 |
| | Vandö, N pt. | 70 17·6 | 19 36 |
| | Arnö, NE pt. | 70 13 | 20 49 |
| | Soroen I., W pt. | 70 39 | 21 55 |
| | ——— N pt., or Tarhalsen | 70 53 | 23 19 |
| | Rolfso Is., N pt., lt. F 141f. | 71 6 | 23 59 |
| | Knivskierodden Pt. | 71 11·0 | 25 40·0 |
| | North Cape | 71 10·3 | 25 46·0 |

| Region | (16) Places | Lat. N | Lon. E |
|---|---|---|---|
| | **LAPLAND.** | | |
| Lapland | Svœrholt Klubb | 70° 59′ | 26° 41′ |
| | Nord Kyn | 71 6·8 | 27 41 |
| | Vardo I. | 70 23 | 31 7 |
| | Rybatschi I., C. Nometski | 69 58 | 32 0 |
| | Kola, town | 68 52·5 | 33 1 |
| | —— R. Kildin I., E pt. | 69 19 | 33 30 |
| | **RUSSIA.** | | |
| White Sea | Sviatoi Noss., lt. F 298f. | 68 9·0 | 39 49·0 |
| | C. Orlov, lt. F 222f. | 67 11·5 | 41 22·2 |
| | Sosnovets, lt. F 139f. | 66 29·5 | 40 43 |
| | Tetrina, vill., Chap. | 66 3·9 | 38 17·5 |
| | Kouzomen, vill., mid. | 66 17·2 | 36 53·5 |
| | C. Touria | 66 33 | 34 28 |
| | Kandalaks, Monastery | 67 10 | 32 32 |
| | Kyem, Church | 64 56·5 | 34 38·7 |
| | Onega, St. Michael Church | 63 53·6 | 38 8·5 |
| | Jijghinsk I., N pt., lt. F 140f | 65 12·3 | 36 51·5 |
| | Arkhangel, ⊞, Trinity Ch. | 64 32·1 | 40 33·5 |
| | Moudinga I., lt. Dvina R. F 130f. | 64 55·8 | 40 16·2 |
| | C. Kerets | 65 19·9 | 39 45 |
| | C. Voronov | 66 31·1 | 42 19·7 |
| | Mezen, Epiphany Ch. | 65 50·3 | 44 17·0 |
| | C. Kanushin, near brook | 67 11·5 | 43 48·7 |
| | C. Kanin Noss | 68 39·2 | 43 32·5 |
| | Kolguyev I., NS 50m., N pt. | 69 30 | 49 20 |
| | C. Russian | 68 55 | 54 40 |
| | C. Medinski | 68 58 | 59 10 |
| | Waigatch I., Balvanski Pt. | 70 29 | 58 58 |
| | Samoyedes Peninsula, C. Vengani | 70 45 | 66 16 |
| | — Beli Ostrov I., C. Ivanoff | 73 24 | 71 35 |
| | **NOVAYA ZEMLYA.** | | |
| | C. Menchikoff | 70 45 | 57 42 |
| | North Goose Cape | 72 13 | 51 50 |
| | Suchoi Noss | 73 41 | 53 30 |
| | C. Speedwell | 74 57 | 55 35 |
| | C. Nassau | 76 20 | 61 39 |
| | Orange Is. | 77 2 | 67 43 |
| | C. Bismarck | 76 19 | 68 56 |
| | Matotchkin Strait, E entr. | 73 8 | 56 30 |
| | Gessen Point | 72 10 | 55 34 |
| | **FRANCE, North Coast.** | | |
| | Gravelines lt F 95f. | 51 0·3 | 2 6·7 |
| | Calais, ⊞, F, 8f., bell, lt. Fl. (electric) 190f. | 50 57·6 | 1 51·2 |
| | C. Grisnez, lt. Fl. (electric) 226f. | 50 52·2 | 1 35·2 |
| | Boulogne, ⊞$^{24}_{0}$, Column | 50 44·5 | 1 37·2 |
| | Pt. Alpreck, lt. F, Fl. 161f. | 50 41·9 | 1 34·0 |
| | Etaples, ⊞$^{n}_{0}$ | 50 32·9 | 1 38·7 |
| | Pt. de Touquet, 2 lts. F 174f. | 50 31·7 | 1 35·7 |
| | Pt. de Berck lt. Occ. 115f. | 50 24·0 | 1 33·7 |
| | Abbeville, Ch. of Notre Dame | 50 7·1 | 1 50·0 |
| | St. Valery sur Somme, ⊞ | 50 11·4 | 1 38·0 |
| | Cayeux, lt. F, Fl. 92f. | 50 11·7 | 1 31·0 |
| | Tréport, ⊞, lt. F 44f., 8f. | 50 3·9 | 1 22·2 |
| | Dieppe, ⊞$^{n}_{0}$, W jetty, lt. F 43f., 10f. | 49 56·0 | 1 5·2 |
| | C. Ailly, lt. R 305f. | 49 55·1 | 0 57·7 |

## MARITIME POSITIONS

| (17) Places | Lat. N | Lon. |
|---|---|---|
| **France, N. W. Coast ⊕** | | East |
| St. Valery en Caux, ⊡, F, Fl. 43f. | 49°52'.4 | 0°42'.7 |
| Fecamp, ⊡, Mt. de la Vierge, F 374f. | 49 46.1 | 0 22.2 |
| C. de la Heve, 2 lts. N19°E 207f., F 396f. | 49 30.7 | 0 4.2 |
| Havre, ⊞, lt. N jetty, bell | 49 29.3 | 0 6.7 |
| Pt. du Hoc, lt. F 39f. | 49 28.7 | 0 11.5 |
| Paris Observatory | 48 50.2 | 2 20.2 |
| Quillebœuf, lt. F 33f. | 49 28.4 | 0 31.7 |
| Honfleur, ⊡, lt. F 92f. | 49 26 | 0 14 |
| | | West |
| Mouth of the Orne, Church | 49 16.6 | 0 15.2 |
| Port Corseulles, ⊡, lt. F 30f. | 49 20.3 | 0 27.2 |
| Cæn, Abbey | 49 11.2 | 0 21.0 |
| Pt. de Ver, lt. F, Fl. 138f. | 49 20.5 | 0 31.0 |
| Carentan | 49 18.4 | 1 14.5 |
| St. Marcouf Is., ⚓ ¾m., lt. Occ. 56f. | 49 29.9 | 1 8.7 |
| La Hougue, ⊡ 15/0, lt. F 36f. | 49 34.3 | 1 16.2 |
| Reville Redoubt, lt. F 36f. | 49 36.4 | 1 13.7 |
| C. Barfleur, lt. R 236f. | 49 41.8 | 1 15.7 |
| Pelée I., fort, lt. F 85f. | 49 40.3 | 1 34.7 |
| Cherbourg, ⊞, Ch. | 49 38.6 | 1 37.2 |
| C. La Hague, ℓ, lt. F 154f. | 49 43.4 | 1 57.0 |
| **Channel Is. ⊕** | | |
| Alderney I., ⚓ 3m., St. Anne Ch. | 49 42.9 | 2 12.2 |
| Pierre au Vrack, rk | 49 41.6 | 2 17.0 |
| Caskets, T, lt. Fl. 120f., bell | 49 43.4 | 2 22.5 |
| Guernsey, Jerbourg tow. 390f. | 49 25.3 | 2 33.0 |
| — Pleinmont, SW pt., guard ho. | 49 25.3 | 2 41.0 |
| — St. Pierre, lt., S jetty, F 46f. | 49 27.0 | 2 32.0 |
| Herm I, NS 1¼m., mid. | 49 28.0 | 2 27.7 |
| Sercq I., ⚓ 3m., Telegraph | 49 25.5 | 2 22.7 |
| Islet S, or Etat de Sercq | 49 23.6 | 2 23.0 |
| Jersey, St. Pierre, Ch. | 49 12.5 | 2 11.7 |
| — St. Helier's ⊡ n/0 | 49 11.3 | 2 7.0 |
| — C. Grosnez, ruin | 49 15.2 | 2 15.5 |
| — NE pt., or Pt. de la Coupe | 49 15.9 | 2 2.3 |
| — SE pt., Seymour tower | 49 9.4 | 2 1.1 |
| Roches Douvres, EW 2m. rk., mid. | 49 6.5 | 2 49 |
| Barnonic rks., EW 2m. | 49 1 | 2 48 |
| Chausey Is. [6m.], Grt. I., lt. F, Fl. 121f. | 48 52.2 | 1 49.2 |
| Minquiers rks., ⚓ 5 l., NW breakers | 48 59 | 2 19 |
| Maitresse Id. | 48 58.3 | 2 37 |
| **France, N. W. Coast ⊕** | | |
| St. Germain | 49 14.2 | 1 35.7 |
| C. Carteret, ⊥, lt. R 262f. | 49 22.4 | 1 48.2 |
| Coutances, Cath., 302f. | 49 2.9 | 1 26.5 |
| Granville, ⊡ 31, C. Lihou, lt. F 154f. | 48 50.1 | 1 36.7 |
| Mt. St. Michel | 48 38.2 | 1 30.5 |
| Canalle, Church | 48 40.7 | 1 50.7 |
| Herpin rk. | 48 43 | 1 50 |
| St. Malo, ⊡ 25/0, Church | 48 39.0 | 2 1.5 |
| La Conchée rk. | 48 41 | 2 3 |
| C. Frehel, T, sum., lt. R 259f. | 48 41.1 | 2 19.0 |
| Grand Léjon rk. | 48 45.0 | 2 39.7 |
| St. Brièuc, Cathedral | 48 30.9 | 2 45.7 |
| Horaine rk., beacon | 48 53.6 | 2 55.0 |
| Heaux de Brehat, lt. F 148f. | 48 54.5 | 3 5.0 |
| Treguier, Cathedral | 48 47.3 | 3 13.7 |
| Seven Is., ⚓ 4m., lt. F, Fl. 184f. | 48 52.8 | 3 30 |
| Triagoz, shl., EW 4m., W extr. | 48 53 | 3 44 |

| (18) Places | Lat. N | Lon. W |
|---|---|---|
| Morlaix, ⊞, lt. F 285f. | 48°40' | 3°53' |
| St. Pol de Léon, ⊡, Cath. | 48 41.0 | 3 59.0 |
| I. de Bas, EW 3m., lt., W side, Rev 223f. | 48 44.8 | 4 1.5 |
| I. Vierge, lt. F, Fl. 108f. | 48 38.4 | 4 34.0 |
| Abervrach, W lt. Fr 59f. | 48 36.9 | 4 34.5 |
| **West Coast.** | | |
| **France, W. Coast ⊕** | | |
| Ushant, ⚓ 4m., lt. Fl. (electric) 272f. | 48 28.5 | 5 4 |
| Kermorvan, lt. F 72f. | 48 21.7 | 4 48 |
| Pt. St. Matthew, lt. R 177f. | 48 19.8 | 4 46.2 |
| Brest, Observatory | 48 23.6 | 4 29.2 |
| I. de Sein, lt. F, Fl. 148f. | 48 2.7 | 4 52.0 |
| Outer, or Wst. rk. | 48 3 | 5 15 |
| Audierne, Church | 48 1.4 | 4 32.5 |
| Penmarc'h rks., lt. R 134f. | 47 47.9 | 4 23 |
| Glenan I., Penfret I., lt. F, Fl. 118f. | 47 44 | 3 57.0 |
| Quimper Riv., Benodet, Ch. | 47 52.6 | 4 6.7 |
| L'Orient, tower | 47 44.7 | 3 21.0 |
| Port Louis, Church | 47 42.5 | 3 21.0 |
| I. de Groix, ⚓ 4m., lt. F 193f. | 47 38.9 | 3 30.5 |
| Port Haliguen, lt. E jetty, F 39f. | 47 29.2 | 3 6.0 |
| Teignouse, lt. F, Fl. 59f. | 47 27.5 | 3 2.5 |
| Port Navalo, pt., lt. F 72f. | 47 32.9 | 2 55.0 |
| Peulan Pt., lt. F 68f. | 47 31.0 | 2 30.0 |
| Belle Isle, ⚓ 10m., lt. Goulfar Bay, R 276f. | 47 18.7 | 3 13.5 |
| — Port de Palais, lt. F 30f. | 47 20.9 | 3 9.0 |
| Hoedic I., ⚓ 1½m. | 47 20.5 | 2 52.0 |
| Le Four rk., lt. R 79f. | 47 17.9 | 2 38.0 |
| Vannes, St. Peter's | 47 39.5 | 2 45.2 |
| Guérande, Ch., 177f. | 47 19.7 | 2 25.5 |
| Croisic, Church | 47 17.7 | 2 30.7 |
| Aiguillon tow., (on with the tour de Commerce, N32°E) | 47 14.6 | 2 15.7 |
| Port St. Nazaire, Mole, lt. Occ. 26f. | 47 16.3 | 2 11.7 |
| Paimbœuf, Church | 47 17.3 | 2 2.0 |
| Nantes, Cathedral | 47 13.1 | 1 33.0 |
| Le Pilier I., lt. F, Fl. 105f. | 47 2.6 | 2 21.5 |
| Noirmoustier I., S pt. | 46 53.8 | 2 8.7 |
| I. d'Yeu, ⚓ 5½m., St. Sauveur Church | 46 42.4 | 2 19.7 |
| ——— Lt. NW part, F 177f. | 46 43.1 | 2 22.7 |
| St. Gilles sur Vie, Church | 46 41.7 | 1 56.0 |
| Sables d'Olonne, Church | 46 29.8 | 1 47.0 |
| La Chaume, lt. F 105f. | 46 29.7 | 1 47.5 |
| Roche bonne, W, or La Congrée | 46 13 | 2 29 |
| Pt. de Grouin du Cou, lt. F 92f. | 46 20.8 | 1 28.0 |
| Pt. de l'Aiguillon, lt. F 43f. | 46 16.1 | 1 12.5 |
| I. Rhe, ⚓ 14m., Baleines, lt. on N pt. Fl. 166f. | 46 14.7 | 1 33.5 |
| — Port St. Martin, lt. Fr 56f. | 46 12.4 | 1 21.7 |
| — S pt., de Chauveau, lt. F 59f. | 46 8.0 | 1 16.2 |
| Rochelle, 2 lts. F 79f., 46f. | 46 9.4 | 1 9.2 |
| Oleron I., ⚓ 16m., N pt., Chassiron, lt. F 164f. | 46 2.8 | 1 24.5 |
| Aix I., lt. Fl. 66f. | 46 0.6 | 1 10.5 |
| Rochefort, Hospital | 45 56.6 | 0 57.7 |

## MARITIME POSITIONS

| (19) Places | Lat. N | Lon. W |
|---|---|---|
| Pt. de la Coubre, lt. F 121f. | 45° 41'5 | 1° 15'7 |
| Cordouan. lt. (Riv. Gironde) Rev. 194f. | 45 35·2 | 1 10·7 |
| Pte. de Grave, lt. Occ. 85f. | 45 34·1 | 1 3·5 |
| Bordeaux, St. André | 44 50·3 | 0 34·5 |
| — Observatory | 44 50·3 | 0 31·7 |
| Bassin d'Arcachon, C Ferret, lt. F 167f. | 44 38·7 | 1 15·0 |
| Bayonne, Cath. | 43 29·5 | 1 28·5 |
| Pt. St. Martin de Biarritz, lt. Fl. 240f. | 43 29·6 | 1 33·0 |
| St. Jean de Luz, Church | 43 23·3 | 1 39·7 |
| Socoa, lt. F 115f. | 43 23·7 | 1 41·0 |
| **SPAIN, North Coast.** (Spain, N. Coast ⊕) | | |
| Fuenterabia, Ch. | 43 21·7 | 1 47·7 |
| C. Higuiera. lt. R 197f. | 43 23·7 | 1 48 |
| Port Passage, ⊞, C. La Plata, lt. F 484f. | 43 19·7 | 1 57·7 |
| C. Machichaco, ⊥, lt. F, Fl. 268f. | 43 27·0 | 2 50 |
| C. Villano, ⊥, *h* | 43 27 | 2 58 |
| Bilbao, St. Nicholas Church | 43 15·8 | 2 54 |
| Portugalete, ⊡ | 43 20·2 | 3 3 |
| Mt. Serantes | 43 21 | 3 5 |
| Santona, ⊞, Caballo Pt., lt. F 85f. | 43 28·0 | 3 27 |
| C. Ajo, pt. | 43 31·4 | 3 36 |
| Santander, ⊞, mole | 43 27·9 | 3 48·7 |
| C. Mayor, E pt., lt. R 298f. | 43 30 | 3 48 |
| C. Oyhambre | 43 25 | 4 21 |
| C. Prieto | 43 28·7 | 4 51·5 |
| Pt. Samos, lt. F, Fl 370f. | 43 30·7 | 5 7·7 |
| C. Lastres | 43 34·2 | 5 18·7 |
| Gijon, lt. F 167f. | 43 35·5 | 5 38 |
| C. Peñas, ⊥, lt. R ½m 343f. | 43 42·0 | 5 49·5 |
| C. Busto, *h*. ⊥, lt. F. Fl. 307f | 43 36 | 6 27·5 |
| Tapia I., lt. F, Fl. 77f | 43 35·5 | 6 55·7 |
| Rivadeo, ⊞, I. Pancha, lt. F 79f. | 43 34·7 | 7 2 |
| Mondigo Mt., 1890f. | 43 32 | 7 8 |
| San Ciprian, lt. F 121f. | 43 43 | 7 25·7 |
| Mt. Faro, 1790f. | 43 43 | 7 35 |
| Port Barquero, ⊞, La Estaca, lt. R 306f. | 43 47·2 | 7 41·5 |
| Port Vivero, ⊞, town | 43 40·5 | 7 36 |
| C. Ortegal, *h*, ⊥, tow. (S 1' 4 of pt.) | 43 46 | 7 54·7 |
| C. Prior, ⊥, lt. F 416f. | 43 34·1 | 8 18·5 |
| Monte Ventoso, 785f. | 43 29 | 8 19 |
| Ferrol, ⊞, mole | 43 28·5 | 8 14·7 |
| Coruña, ⊞, lt. F, Fl. 332f. | 43 22·5 | 8 24·5 |
| Sisargas Is., EW 1¼m., lt. F. Fl. 351f. | 43 21·5 | 8 50·7 |
| C. Villano, ⊥, NE pt., lt. F 243f. | 43 10 | 9 13·7 |
| C. Toriñana, ⊥, pt. | 43 4 | 9 18 |
| C. Finisterre, lt. R 466f. | 42 53 | 9 15·5 |
| Queijal Pt., lt. F 88f. | 42 44 | 9 4 |
| C. Corrobedo, lt. F 106f. | 42 34 | 9 5 |
| Ons I., ⊥ 3m., lt. F, Fl. 421f. | 42 22·5 | 8 55·5 |
| Cies Is., NS 4m., lt. F, Fl. 604f. | 42 12·5 | 8 54·5 |
| C. Silleiro, *h*, lt. F 72f. | 42 6 | 8 53 |
| Vigo, lt. R 102f. | 42 15 | 8 41 |

| (20) Places | Lat. N | Lon. W |
|---|---|---|
| Mt. Nossa Señora del alba, 1670f. | 42° 10' | 8° 43' |
| Mt. Peneda, 4542f. | 41 58 | 8 21 |
| **PORTUGAL.** (Portugal ⊕) | | |
| R. Mino, Pt. Picos, lt. F 56f. | 41 52 | 8 52 |
| Viana, ⊡, 2 lts. F 107f. | 41 41 | 8 50 |
| Mt. Destrello de Malhada, 3602f. | 40 53 | 8 11 |
| Oporto, ⊡ $\frac{23}{12}$, Fort St. Joas da Foz | 41 8·8 | 8 40·5 |
| Aveiro, New Bar, ⊡ $\frac{21}{15}$ | 40 39 | 8 44 |
| Mt. Caramullo, 3274f. | 40 32·5 | 8 12·5 |
| Mount Busaco, 1795f. | 40 23 | 8 22 |
| Coimbra, University | 40 12·5 | 8 25·5 |
| C. Mondego, lt. F 302f. | 40 11 | 8 55 |
| Figueira, ⊡ $\frac{16}{11}$, lt. F 36f. | 40 9 | 8 51·5 |
| Nazareth | 39 36 | 9 5·7 |
| Burlings, lt. R 365f. | 39 25·0 | 9 30·5 |
| C. Carvoeiro, pt., lt. F 180f. | 39 21·8 | 9 24·7 |
| Monte Junto, 2185f. | 39 11 | 9 3 |
| Mafra | 38 56 | 9 19 |
| C. Roca, lt. Rrw 596f. | 38 47 | 9 30 |
| Mt. Cintra, sum. 1600f. | 38 46 | 9 26·5 |
| Da Guia, lt. F 167f. | 38 41·8 | 9 27 |
| St. Julian, fort, lt. F 128f. | 38 40·4 | 9 19·5 |
| Lisbon, ⊞, Marine Obs., ⊡ | 38 42·2 | 9 8·5 |
| Royal Observatory | 38 42·5 | 9 11·7 |
| C. Espichel, ⊥, *h*, lt. Fl. 535f. | 38 24·9 | 9 13 |
| Setubal, ⊞ | 38 32 | 8 53 |
| C. Sines, *l*, ⊥, lt. F 130f. | 37 57·5 | 8 53 |
| Monchique Mtns., sum Foia, 2959f. | 37 18 | 8 34 |
| C. St. Vincent, ⊥, lt. R 221f. | 37 1 | 8 57·7 |
| Sagres Pt., Semaphore | 36 59·7 | 8 55 |
| Lagos, Piedade Pt. | 37 4·7 | 8 38·7 |
| C. Carvoeiro, tower | 37 5·2 | 8 24·7 |
| C. Sta. Maria, *l*, lt. F 109f. | 36 58·5 | 7 49·7 |
| Mt. Figo, 1365f. | 37 6 | 7 48·7 |
| **SPAIN, South Coast.** (Spain, S Coast) | | |
| R. Guadiana, ⊡ $\frac{n}{10}$, Canela I., 2 lts. F 109f., 43f. | 37 11·5 | 7 24 |
| Palos | 37 13·5 | 6 53 |
| R. Guadalquiver, San Lucar Lookout | 36 46·2 | 6 21 |
| Rota, pier | 36 36·6 | 6 21·5 |
| Cadiz, ⊞, Observatory | 36 32·0 | 6 17·7 |
| ——— S Fernando | 36 27·7 | 6 12·5 |
| St. Sebastian, lt. F, Fl. 146f. | 36 31·6 | 6 19 |
| C. Trafalgar, lt. F, Fl. 168f. | 36 10·8 | 6 2 |
| Tarifa, lt. F 130f. | 36 0 | 5 36·7 |
| Palomos I. | 36 3·7 | 5 26·7 |
| Algeciras, mole | 36 7·5 | 5 26·7 |
| Gibraltar, Dockyard Flagstaff | 36 7·3 | 5 21·5 |
| Europa Pt., lt. F 150f. | 36 6·2 | 5 20·7 |

## MARITIME POSITIONS

| | (21) Places | Lat. N | Lon. |
|---|---|---|---|
| | **SPAIN.** | | West |
| | Torre Nueva | 36° 12′·3 | 5° 19′·7 |
| | C. Sardinia, tower | 36 18·7 | 5 16 |
| | Doncella, lt F, Fl. 59f. | 36 25 | 5 9 |
| | Sierra Bermeja, Mt., 4728f. | 36 29 | 5 13 |
| | Fuengiro, Castle | 36 33 | 4 37 |
| | Sierra de Mijas | 36 38 | 4 40 |
| | Malaga, ⊞, mole, lt. F, Fl. 125f. | 36 43 | 4 24 |
| | Velez Malaga, ⚓ n, lt. F 41f. | 36 43 | 4 7 |
| | C. Sacratif, h, ⊥, lt. F, Fl. 320f. | 36 42 | 3 28 |
| | Adra, fort, lt. F 55f. | 36 44 | 3 1 |
| | Alboran I., lt. F 115f. | 38 58 | 3 2 |
| | Pt Sabinel, lt. F, Fl 105f. | 36 41·2 | 2 42 |
| | Almeria, Citadel | 36 50·3 | 2 28·6 |
| | C. de Gata, lt. R 194f. | 36 43 | 2 11·2 |
| | Port Genoves, ⚓, Castle | 36 45 | 2 6·2 |
| | Pt. Mesa, lt. F, Fl. 725f. | 30 56 | 1 54·5 |
| | Port Aguilas, Castle | 37 23·4 | 1 34·5 |
| | C. de Cope, 823f. | 37 25·3 | 1 28 |
| | C. Tinoso, h, ⊥, lt. F 480f. | 37 32 | 1 7 |
| Spain. E. Coast ⊕ | Cartagena, Escombrera I., lt. F. 223f. | 37 33·5 | 0 58 |
| | C. de Palos, lt. R 263f. | 37 37·5 | 0 41 |
| | C. Cervera | 38 0 | 0 40 |
| | I. Plana, E extr. of rks., ⅘ ⊥, F, Fl. 90f. | 38 10 | 0 28 |
| | Alicante, Castle, (lt. Fr 26f.) | 38 20·3 | 0 28·7 |
| | Mt Roldan, gap | 38 36 | 0 12 |
| | | | East |
| | C. Nao, E pt. | 38 43 | 0 14 |
| | C. St. Antonio, lt. R 571f. | 38 48·5 | 0 12 |
| | Mongó, Mt., 2497f. | 38 48 | 0 8 |
| | | | West |
| | C. Cullera, tow., lt. F 91f. | 39 11 | 0 12·7 |
| | Valencia, lt. Fr 39f., mole | 39 26·8 | 0 19 |
| | C. Canet, tower | 39 43·0 | 0 9 |
| | | | East |
| | C. Oropesa, lt. F, Fl 74f. | 40 4 | 0 9 |
| | Peñiscola tow. | 40 23·0 | 0 25 |
| | Columbretes Is., lt. F 262f. | 39 54 | 0 42 |
| | Port Alfaques, Pt. de la Baña | 40 33·5 | 0 39 |
| | Ebro R., S passage | 40 41·0 | 0 53 |
| | C. Rock, tower | 40 49·0 | 0 45 |
| | C. Tortosa, Buda, lt. Rev. 174f. | 40 42·4 | 0 54 |
| | C. Salou, pt., lt. F, Fl. 139f. | 41 3·0 | 1 10 |
| | Tarragona, lt. F 54f. | 41 7 | 1 15 |
| | Barcelona, ⊞ n 1h, mole lt. F, Fl. 43f. | 41 22·6 | 2 11 |
| | Mt. Jui, fort | 41 21·8 | 2 10 |
| | Mataro | 41 32·4 | 2 27 |
| | C. Tosa, tower | 41 43·2 | 2 58 |
| | Pt. Molino | 41 49·6 | 3 8 |
| | C. St. Sebastian, h sum., lt. F, Fl. 548f. | 41 53 | 3 12 |
| | Medas Is., ⅘ 1m., S & E extr. | 42 3·2 | 3 14 |
| | La Escala | 42 7 | 3 8 |
| | C. Norfeo, h, ⊥, E pt. | 42 14 | 3 17 |
| | Cadaqués, ⊞, Church | 42 17 | 3 17 |
| | C. de Creux, lt. F, Fl. 285f. | 42 19·2 | 3 19 |

| | (22) Places | Lat. N | Lon. E |
|---|---|---|---|
| | **FRANCE.** | | |
| | St. Pedro de Roda, fort | 42° 19′·0 | 3° 10′ |
| | C. Sernella | 42 21·0 | 3 13 |
| | C. Bearn, lt F 751f. | 42 31·0 | 3 7·5 |
| | Port Vendres, lt. Fl. 98f. | 42 31·3 | 3 7·0 |
| | Perpignan | 42 43 | 2 53 |
| | La Nouvelle, lt. F 50f. | 43 0·8 | 3 4·0 |
| | Narbonne, Cathedral | 43 11·1 | 3 0·2 |
| | Fort Brescou, lt SE bast., F 59f. | 43 15·5 | 3 30·0 |
| | Agde, Mt., lt. R 413f. | 43 17·9 | 3 30·2 |
| | Cette, ⊞, Ft. Louis, lt. F 105f. | 43 23·8 | 3 42·2 |
| | Montpelier | 43 37 | 3 53 |
| | Aigues Mortes, lt. F 33f. | 43 32·0 | 4 8·0 |
| | W. Mo. of Rhone, Camargue, 2 lts. F 125f., 38f | 43 20·7 | 4 41·0 |
| | P. de Bouc, ⊞, 2 lts. ent. F 49f., 95f. | 43 23·6 | 4 59·2 |
| | C. Couronne | 43 19 | 5 3 |
| | Marseille, St. Jean Ft., F 30f. | 43 17·7 | 5 21·7 |
| | —— Observatory | 43 18·3 | 5 23·7 |
| | Planier I., lt. Fl. 207f. | 43 11·9 | 5 14·0 |
| France, S. Coast ⊕ | Mt. St. Michael, Semaph., 1341f. | 43 13 | 5 22 |
| | I. Riou, EW 1m., tower | 43 10 | 5 23 |
| | Cassis, ⊞, Port, 2 lts. F 92f., 31f. | 43 12·8 | 5 32·0 |
| | Cassidaigne rk | 43 8·7 | 5 33·0 |
| | Ciotat Port, lt. F 40f. | 43 10·3 | 5 36·7 |
| | Bandol, Church | 43 8·2 | 5 45·5 |
| | C. Sicie, Semaphore | 43 3·2 | 5 51·0 |
| | Toulon, ⊞, Observatory | 43 7·5 | 5 56·0 |
| | Grd. Ribeau, lt. F 112f. | 43 1 | 6 8 |
| | Porquerolles I., ⅝ 4m., S pt., lt. F, Fl. 262f. | 42 59·0 | 6 12·5 |
| | Port Cross I., ⅝ 2½m., Fort Vigie | 42 59·9 | 6 24·2 |
| | Titan I., ⅝ 4½m., NE part, lt. F 246f. | 43 2·8 | 6 30·7 |
| | C. Camarat, lt. R 426f. | 43 12·0 | 6 40·7 |
| | St. Tropez | 43 14 | 6 34 |
| | Frejus, ⚓ | 43 25 | 6 46 |
| | C. Roux, ⊥, ✱, sum. 1600f. | 43 28 | 6 55 |
| | Cannes, S tower | 43 32·9 | 7 1·0 |
| | Lerin Is., EW 2m., S extr. rks. | 43 30 | 7 3 |
| | C. Garoupe, lt. F 338f. | 43 33·8 | 7 8 |
| | Antibes, ⊞ 10, harb. lt. F, Fl. 49f. | 43 35·1 | 7 7·7 |
| | St. Laurent du Var | 43 40·7 | 7 11·0 |
| | Nice, St. Francis Church | 43 42·0 | 7 17·0 |
| | — Observatory, Mont-gros | 43 43·3 | 7 18 |
| | Villa Franca, ⊞ | 43 42 | 7 18 |
| | C Ferrat, lt. Rev. 229f. | 43 40·0 | 7 19·5 |
| | Monaco | 43 43·0 | 7 27·0 |
| | **BALEARIC ISLES.** | | |
| | Formentera I., ⅚ 3m., SE pt., lt. F 450f. | 38 39 | 1 35 |
| | —— S pt., or Pt. Anguila, ⊥ | 38 38 | 1 23 |
| | Iviza, Port St. Antonio, ⊞, Conejera I., lt. Rev. 289f. | 38 59·4 | 1 13·0 |
| | — Grossa Pt., lt. Int. 180f. | 39 5 | 1 36 |
| Iviza | Iviza, ⊞, Castle | 38 54·3 | 1 26·7 |
| | Cabrera I., ⅝ 3½m., 564f., Pt. Ansiola, lt. Rev. 404f. | 39 7·2 | 2 55 |

MARITIME POSITIONS

| | (23) Places | Lat. N | Lon. E |
|---|---|---|---|
| *Majorca* | Majorca, C. Salinas, *l*, ✝, lt. F 50f. | 39° 16′ | 3° 4′ |
| *Majorca* | C. Blanco, ⊥, lt. F 292f. | 39 22 | 2 47 |
| *Majorca* | Palma, mole, lt. F 35f. | 39 34·1 | 2 38·5 |
| *Majorca* | C. Cala Figuera, T, lt. F 115f. | 39 28 | 2 32 |
| *Majorca* | Dragonera I., ⚓ 2m., lt. F, Fl. 1180f. | 39 35 | 2 19 |
| *Majorca* | Mt. Galatzo, 3363f. | 39 39 | 2 31 |
| *Majorca* | C. Formenton, ⊥, lt. R 592f. | 39 58 | 3 13 |
| *Majorca* | C. Pera, ⊥, lt. F, Fl. 241f. | 39 43 | 3 28·5 |
| *Minorca* | Minorca, C. Dartuch, *l*, T, lt. F, Fl. 71f. | 39 55 | 3 49·5 |
| *Minorca* | C. Bajoli, ⊥, tow. 256f. | 40 1 | 3 48 |
| *Minorca* | C. Cavalleria, *h*, ⊥, lt. F 309f. | 40 5·8 | 4 5·5 |
| *Minorca* | Mahon, ⊞, lt. F 73f. | 39 52·5 | 4 18·0 |
| *Minorca* | Ayre I., EW ¾m., lt. Rev. 171f | 39 48 | 4 17 |
| | **SARDINIA.** | | |
| Sardinia ⊕ | Razzoli I., lt. F 282f. | 41 18·3 | 9 20·7 |
| Sardinia ⊕ | C. della Testa, T, lt. F, Fl. 220f. | 41 15 | 9 9·2 |
| Sardinia ⊕ | Port Torres, ⊞, lt. F 47f. | 40 50·2 | 8 24·7 |
| Sardinia ⊕ | Asinara I., ⚓ 10m., 1239f. | 41 5·8 | 8 18·2 |
| Sardinia ⊕ | C. Falcone, tow. 610f. | 40 57·3 | 8 12·2 |
| Sardinia ⊕ | C. Argentera, sum. | 40 43·7 | 8 9·0 |
| Sardinia ⊕ | C. Caccia, T, P. Conte, ⊞, sum. | 40 33·5 | 8 10·2 |
| Sardinia ⊕ | Alghero, Cathedral | 40 33·5 | 8 19·2 |
| Sardinia ⊕ | C. Marargiu, rk. | 40 19·7 | 8 23·5 |
| Sardinia ⊕ | C. Mannu, tow. on N pt. | 40 2·5 | 8 24·0 |
| Sardinia ⊕ | Mal di ventre, rks. ⚓ 3m., mid. | 39 59 | 8 18 |
| Sardinia ⊕ | Coscio di Donna, rk. [½ c.] | 39 52·8 | 8 17·2 |
| Sardinia ⊕ | C. St. Marco, tower | 39 51·2 | 8 26·5 |
| Sardinia ⊕ | C. Frasca | 39 46 | 8 27 |
| Sardinia ⊕ | Oristano, grt. tower | 39 54·3 | 8 31·7 |
| Sardinia ⊕ | Mt. Arcuento (or finger of Oristano), 2713f. | 39 35·7 | 8 33·5 |
| Sardinia ⊕ | C. Pecora, pt., tow. | 39 27·1 | 8 25·2 |
| Sardinia ⊕ | St. Pietro I., NS 5½m., 702f. | 39 9·7 | 8 17·7 |
| Sardinia ⊕ | St Antioco I., NS 9m., S sum. 781f. | 38 58·3 | 8 26·0 |
| Sardinia ⊕ | Toro rk., T, 500f. | 38 51·6 | 8 25·2 |
| Sardinia ⊕ | C. Teulada, ⊥, T, sum. 725f. | 38 51·9 | 8 39·2 |
| Sardinia ⊕ | Port Malfatano, ⊞, tow. | 38 53·1 | 8 48·7 |
| Sardinia ⊕ | C. Spartivento, lt. F 264f. | 38 52·5 | 8 52·5 |
| Sardinia ⊕ | Cagliari, ✝, St. Pancras Ch. | 39 13·2 | 9 7·7 |
| Sardinia ⊕ | Cavoli I. (off C. Carbonara), tow. | 39 6·1 | 9 31·5 |
| Sardinia ⊕ | C Ferrato, ⊥, 80f. pt. | 39 17·5 | 9 40·0 |
| Sardinia ⊕ | Mt. Seven Brothers, 3186f. | 39 18·5 | 9 26·5 |
| Sardinia ⊕ | C Bellavista, lt. F 541f. | 39 55·8 | 9 43·5 |
| Sardinia ⊕ | Mt. Gennargentu, 6102f. | 40 1 | 9 19 |
| Sardinia ⊕ | C. Comino, pt. | 40 31·4 | 9 50·5 |
| Sardinia ⊕ | Limbarra, pk. 4331f. | 40 51·0 | 9 11·0 |
| Sardinia ⊕ | Tavolara I., ⚓ 3½m., E pt. | 40 54·8 | 9 45·0 |
| Sardinia ⊕ | C. Figari, sum. | 40 59·9 | 9 39·7 |
| Sardinia ⊕ | Rock | 41 16·9 | 9 29·0 |
| Sardinia ⊕ | Caprera I., NS 5m., sum. | 41 12·9 | 9 29·0 |
| Sardinia ⊕ | Madalena I., old fort | 41 13·4 | 9 24·0 |
| | **CORSICA.** | | |
| | C. Corso, Giraglia I., lt. R 269f. | 43 1·8 | 9 24·2 |
| | St. Fiorenza, centre of town | 42 41·0 | 9 18·0 |
| | Pt. Perallo | 42 44·1 | 9 13·4 |

| | (24) Places | Lat. N | Lon. E |
|---|---|---|---|
| *Corsica* ⊕ | Calvi, Pt. Rivellata, lt. F 289f. | 42° 35′·2 | 8° 43′·5 |
| *Corsica* ⊕ | C. Rosso, W pt. | 42 14·3 | 8 32·5 |
| *Corsica* ⊕ | Sanguinares Is., ⚓ 1m., lt. F, Fl. 321f. | 41 52·8 | 8 35·7 |
| *Corsica* ⊕ | Ajaccio, Cathedral | 41 55·0 | 8 44·7 |
| *Corsica* ⊕ | C. Muro, SW pt. | 41 44·5 | 8 39·5 |
| *Corsica* ⊕ | C. Campo Moro, ⊞, tower | 41 38·5 | 8 48·5 |
| *Corsica* ⊕ | Pt. Seneteso, *h*, extr. | 41 34·0 | 8 47·0 |
| *Corsica* ⊕ | C. Feno, lt. F 65f. | 41 23·8 | 9 5·7 |
| *Corsica* ⊕ | Bonifacio, ⊞, lt. F 98f. | 41 23·8 | 9 9·2 |
| *Corsica* ⊕ | Pertusato, lt. R 325f. | 41 22·2 | 9 11·2 |
| *Corsica* ⊕ | Port. Sta. Manza, ⊞, Pt. Capicciolo, tower | 41 25·1 | 9 15·7 |
| *Corsica* ⊕ | Porto Vecchio, ⊞, Chiape Pt., lt. F, Fl. 217f. | 41 36 | 9 22 |
| *Corsica* ⊕ | E. extr. Fiorentina, tower | 42 17·0 | 9 33·7 |
| *Corsica* ⊕ | Bastia, ⊞, Dragon bastion, lt. F 82f. | 42 41·8 | 9 27·0 |
| *Corsica* ⊕ | Monte Stello, 4532f. | 42 47·5 | 9 25·0 |
| *Corsica* ⊕ | Finocchiarola, tower | 42 59·3 | 9 28·0 |
| | **ITALY.** **West Coast.** | | |
| *G. of Genoa* ⊕ | C. St. Martin | 43 43 | 7 33 |
| *G. of Genoa* ⊕ | Ventimiglia Pt. | 43 45 | 7 43 |
| *G. of Genoa* ⊕ | Mt. Grande, 3100f. | 43 50 | 7 37 |
| *G. of Genoa* ⊕ | C. del Armi | 43 49 | 7 54 |
| *G. of Genoa* ⊕ | Port Maurizio, mole hd. | 43 53·2 | 7 59·0 |
| *G. of Genoa* ⊕ | C. de la Mele, *h* | 43 58 | 8 11 |
| *G. of Genoa* ⊕ | Gallinara I., tower | 44 2·1 | 8 13 |
| *G. of Genoa* ⊕ | Finale, Church | 44 9·9 | 8 19·0 |
| *G. of Genoa* ⊕ | Noli, Conv. St. Francisco | 44 11·9 | 8 22·7 |
| *G. of Genoa* ⊕ | Vado, Fort St. Lorenzo | 44 15·5 | 8 24·5 |
| *G. of Genoa* ⊕ | Savona, ⊞[12], Citadel | 44 18·4 | 8 27·7 |
| *G. of Genoa* ⊕ | Polla rk. | 44 25·0 | 8 46·0 |
| *G. of Genoa* ⊕ | Genoa, ⊞, 3 lts., Int. 340f., F 92f., F 69f. | 44 24 | 8 54·0 |
| *G. of Genoa* ⊕ | Pt. Chiapa, sum. | 44 20·0 | 9 10·5 |
| *G. of Genoa* ⊕ | C. Porto Fino, fort | 44 18·2 | 9 14·2 |
| *G. of Genoa* ⊕ | Sestri di Levante, fort | 44 16·4 | 9 25·5 |
| *G. of Genoa* ⊕ | Port Venere, ⊞, N entr. | 44 3·2 | 9 52·7 |
| *G. of Genoa* ⊕ | Tino I., lt. Fl. (electric) 384f. | 44 1 | 9 51·0 |
| *G. of Genoa* ⊕ | Spezzia, ⊞, Castle | 44 6·3 | 9 52·2 |
| *G. of Genoa* ⊕ | Monte Altissimo, 5213f. | 44 3 | 10 14 |
| *G. of Genoa* ⊕ | Viareggio, Sanità | 43 51·8 | 10 15·7 |
| *G. of Genoa* ⊕ | Arno R., mouth, fort | 43 40·8 | 10 16·7 |
| *G. of Genoa* ⊕ | Pisa, leaning tow. | 43 43·5 | 10 24·0 |
| *G. of Genoa* ⊕ | Florence, Duomo | 43 46·6 | 11 15·5 |
| | Malora, shoal, lt. F 60f. | 43 32·6 | 10 12·7 |
| | Leghorn, ⊞, lt. Rwr 154f. | 43 32·7 | 10 17·7 |
| | Gorgona I., NS 1½m., *h*, mid. | 43 25·8 | 9 53·5 |
| | Val di Vetro rf., ⚓ 3m., W pt. | 43 18·2 | 10 21·7 |
| | Castagnetto, fort | 43 10·7 | 10 32·7 |
| | C. Buia, tower | 42 59·7 | 10 29·7 |
| | Piombino, palace | 42 55·7 | 10 31·7 |
| | C. Troja, tower | 42 48·1 | 10 44·5 |
| | Castiglione, fort | 42 46·0 | 10 53·0 |
| | R. Ombrone, mouth | 42 39 | 11 0·5 |
| | Formiche, ⚓ 2m., N one 32f. | 42 34·6 | 10 53 |
| | Talamone | 42 32·3 | 11 8 |
| | St. Stefano, centre of town | 42 26·4 | 11 7·2 |
| | Mt. Argentario, telegraph | 42 23·2 | 11 10·5 |
| | Capraia I., ⚓ 4m., fort | 43 3·2 | 9 50·5 |
| | Palmajola I., NS ½m., lt. F, Fl. 334f. | 42 51·9 | 10 28·7 |
| | Elba, N extr., or C. Vita | 42 52·6 | 10 24·7 |

## MARITIME POSITIONS

*Spain, E. Coast ⊕*

| (21) Places | Lat. N | Lon. |
|---|---|---|
| **SPAIN.** | | West |
| Torre Nueva | 36° 12'3 | 5°19'7 |
| C. Sardinia, tower | 36 18·7 | 5 16 |
| Doncella, lt F, Fl. 59f. | 36 25 | 5 9 |
| Sierra Bermeja, Mt., 4728f. | 36 29 | 5 13 |
| Fuengiro, Castle | 36 33 | 4 37 |
| Sierra de Mijas | 36 38 | 4 40 |
| Malaga, ⊞, mole, lt. F, Fl. 125f. | 36 43 | 4 24 |
| Velez Malaga, ⚓ п, lt. F 41f. | 36 43 | 4 7 |
| C. Sacratif, *h*, ⊥, lt. F, Fl. 320f. | 36 42 | 3 28 |
| Adra, fort, lt. F 55f. | 36 44 | 3 1 |
| Alboran I., lt. F 115f. | 38 58 | 3 2 |
| Pt Sabinel, lt. F, Fl 105f. | 36 41·2 | 2 42 |
| Almeria, Citadel | 36 50·3 | 2 28·6 |
| C. de Gata, lt. R 194f. | 36 43 | 2 11·2 |
| Port Genoves, ⚓, Castle | 36 45 | 2 6·2 |
| Pt. Mesa, lt. F, Fl. 725f. | 36 56 | 1 54·5 |
| Port Aguilas, Castle | 37 23·4 | 1 34·5 |
| C. de Cope, 823f. | 37 25·3 | 1 28 |
| C. Tinoso, *h*, ⊥, lt. F 480f. | 37 32 | 1 7 |
| Cartagena, Escombrera I., lt. F. 223f. | 37 33·5 | 0 58 |
| C. de Palos, lt. R 263f. | 37 37·5 | 0 41 |
| C. Cervera | 38 0 | 0 40 |
| I. Plana, E ex r. of rks., ⚓ ⊥, F, Fl. 90f. | 38 10 | 0 28 |
| Alicante, Castle, (lt. Fr 26f.) | 38 20·3 | 0 28·7 |
| Mt Roldan, gap | 38 36 | 0 12 |
| | | East |
| C. Nao, E pt. | 38 43 | 0 14 |
| C St. Antonio, lt. R 571f. | 38 48·5 | 0 12 |
| Mongó, Mt., 2497f. | 38 48 | 0 8 |
| | | West |
| C. Cullera, tow., lt. F 91f. | 39 11 | 0 12·7 |
| Valencia, lt. Fr 39f., mole | 39 26·8 | 0 19 |
| C. Canet, tower | 39 43·0 | 0 9 |
| | | East |
| C. Oropesa, lt. F, Fl 74f. | 40 4 | 0 9 |
| Peñiscola tow | 40 23·0 | 0 25 |
| Columbretes Is., lt. F 262f. | 39 54 | 0 42 |
| Port Alfaques, Pt. de la Baña | 40 33·5 | 0 39 |
| Ebro R., S passage | 40 41·0 | 0 53 |
| C. Rock, tower | 40 49·0 | 0 45 |
| C. Tortosa, Buda, lt. Rev. 174f. | 40 42·4 | 0 54 |
| C. Salou, pt., lt. F, Fl. 139f. | 41 3·0 | 1 10 |
| Tarragona, lt. F 54f. | 41 7 | 1 15 |
| Barcelona, ⊡ⁿ₁₈, mole lt. F, Fl. 43f. | 41 22·6 | 2 11 |
| Mt. Jui, fort | 41 21·8 | 2 10 |
| Mataro | 41 32·4 | 2 27 |
| C. Tosa, tower | 41 43·2 | 2 58 |
| Pt. Molino | 41 49·6 | 3 8 |
| C. St. Sebastian, *h* sum., lt. F, Fl. 548f. | 41 53 | 3 12 |
| Medas Is., ⚓ 1m., S & E extr. | 42 3·2 | 3 14 |
| La Escala | 42 7 | 3 8 |
| C. Norfeo, *h*, ⊥, E pt. | 42 14 | 3 17 |
| Cadaqués, ⊞, Church | 42 17 | 3 17 |
| C. de Creux, lt. F, Fl. 285f. | 42 19·2 | 3 19 |

*France, S. Coast ⊕* / *Iviza*

| (22) Places | Lat. N | Lon. E |
|---|---|---|
| **FRANCE.** | | |
| St. Pedro de Roda, fort | 42°19'0 | 3°10' |
| C. Sernella | 42 21·0 | 3 13 |
| C. Bearn, lt F 751f. | 42 31·0 | 3 7·5 |
| Port Vendres, lt. Fl. 98f. | 42 31·3 | 3 7·0 |
| Perpignan | 42 43 | 2 53 |
| La Nouvelle, lt. F 50f. | 43 0·8 | 3 4·0 |
| Narbonne, Cathedral | 43 11·1 | 3 0·2 |
| Fort Brescou, lt SE bast., F 59f. | 43 15·5 | 3 30·0 |
| Agde, Mt., lt. R 413f. | 43 17·9 | 3 30·2 |
| Cette, ⊞, Ft. Louis, lt. F 105f. | 43 23·8 | 3 42·2 |
| Montpelier | 43 37 | 3 53 |
| Aigues Mortes, lt. F 33f. | 43 32·0 | 4 8·0 |
| W. Mo. of Rhone, Camargue, 2 lts. F 125f., 38f. | 43 20·7 | 4 41·0 |
| P. de Bouc, ⊡, 2 lts. ent. F 49f., 95f. | 43 23·6 | 4 59·2 |
| C. Couronne | 43 19 | 5 3 |
| Marseille, St. Jean Ft., F 30f. | 43 17·7 | 5 21·7 |
| ——— Observatory | 43 18·3 | 5 23·7 |
| Planier I., lt. Fl. 207f. | 43 11·9 | 5 14·0 |
| Mt. St. Michael, Semaph., 1341f. | 43 13 | 5 22 |
| I. Riou, EW 1m., tower | 43 10 | 5 23 |
| Cassis, ⊡, Port, 2 lts. F 92f., 31f. | 43 12·8 | 5 32·0 |
| Cassidaigne ⚑ | 43 8·7 | 5 33·0 |
| Ciotat Port, lt. F 40f. | 43 10·3 | 5 36·7 |
| Bandol, Church | 43 8·2 | 5 45·5 |
| C. Sicie, Semaphore | 43 3·2 | 5 51·0 |
| Toulon, ⊞, Observatory | 43 7·5 | 5 56·0 |
| Grd. Ribeau, lt. F 112f. | 43 1 | 6 8 |
| Porquerolles I., ⚓ 4m., S pt., lt. F, Fl. 262f. | 42 59·0 | 6 12·5 |
| Port Cross I., ⚓ 2½m., Fort Vigie | 42 59·9 | 6 24·2 |
| Titan I., ⚓ 4½m., NE part, lt. F 246f. | 43 2·8 | 6 30·7 |
| C. Camarat, lt. R 426f. | 43 12·0 | 6 40·7 |
| St. Tropez | 43 14 | 6 34 |
| Frejus, ⚓ | 43 25 | 6 46 |
| C. Roux, ⊥, ✝, sum. 1600f. | 43 28 | 6 55 |
| Cannes, S tower | 43 32·9 | 7 1·0 |
| Lenin Is., EW 2m., S extr. rks. | 43 30 | 7 3 |
| C. Garoupe, lt. F 338f. | 43 33·8 | 7 8 |
| Antibes, ⊡¹⁰, harb. lt. F, Fl. 49f. | 43 35·1 | 7 7·7 |
| St. Laurent du Var | 43 40·7 | 7 11·0 |
| Nice, St. Francis Church | 43 42·0 | 7 17·0 |
| — Observatory, Mont-gros | 43 43·3 | 7 18 |
| Villa Franca, ⊞ | 43 42 | 7 18 |
| C Ferrat, lt. Rev. 229f. | 43 40·0 | 7 19·5 |
| Monaco | 43 43·0 | 7 27·0 |
| **BALEARIC ISLES.** | | |
| Formentera I., ⚓ 3m., SE pt., lt. F 450f. | 38 39 | 1 35 |
| ——— S pt., or Pt. Anguila, ⊥ | 38 38 | 1 23 |
| Iviza, Port St. Antonio, ⊞, Conejera I., lt. Rev. 289f. | 38 59·4 | 1 13·0 |
| — Grosa Pt., lt. Int. 180f. | 39 5 | 1 36 |
| Iviza, ⊞, Castle | 38 54·3 | 1 26·7 |
| Cabrera I., ⚓ 3½m., 564f., Pt. Ansiola, lt. Rev. 404f. | 39 7·2 | 2 55 |

## MARITIME POSITIONS

| (23) | Places | Lat. N | Lon. E |
|---|---|---|---|
| *Majorca* | Majorca, C. Salinas, *l*, ✠, lt. F 50f. | 39° 16′ | 3° 4′ |
| | C. Blanco, ⊥, lt. F 292f. | 39 22 | 2 47 |
| | Palma, mole, lt. F 35f. | 39 34·1 | 2 38·5 |
| | C. Cala Figuera, T. lt. F 115f. | 39 28 | 2 32 |
| | Dragonera I., ♯ 2m., lt. F, Fl. 1180f. | 39 35 | 2 19 |
| | Mt. Galatzo, 3363f. | 39 39 | 2 31 |
| | C. Formenton, ⊥, lt. R 592f. | 39 58 | 3 13 |
| | C. Pera, ⊥, lt. F, Fl. 241f. | 39 43 | 3 28·5 |
| *Minorca* | Minorca, C. Dartuch, *l*, T, lt. F, Fl. 71f. | 39 55 | 3 49·5 |
| | C. Bajoli, ⊥, tow. 256f. | 40 1 | 3 48 |
| | C. Cavalleria, *h*, ⊥. lt. F 309f. | 40 5·8 | 4 5·5 |
| | Mahon, ⊞, lt. F 73f. | 39 52·5 | 4 18·0 |
| | Ayre I., EW ¾m., lt. Rev. 171f | 39 48 | 4 17 |
| | **SARDINIA.** | | |
| Sardinia ⊕ | Razzoli I., lt. F 282f. | 41 18·3 | 9 20·7 |
| | C. della Testa, T, lt. F, Fl. 220f. | 41 15 | 9 9·2 |
| | Port Torres, ⊞, lt. F 47f. | 40 50·2 | 8 24·7 |
| | Asinara I., ♯ 10m., 1239f. | 41 5·8 | 8 18·2 |
| | C. Falcone, tow. 610f. | 40 57·3 | 8 12·2 |
| | C. Argentera, sum. | 40 43·7 | 8 9·0 |
| | C. Caccia, T, P. Conte, ⊞, sum. | 40 33·5 | 8 10·2 |
| | Alghero, Cathedral | 40 33·5 | 8 19·2 |
| | C. Marargiu, rk. | 40 19·7 | 8 23·5 |
| | C. Mannu, tow. on N pt. | 40 2·5 | 8 24·0 |
| | Mal di ventre, rks. ♯ 3m., mid. | 39 59 | 8 18 |
| | Coscio di Donna, rk. [½ c.] | 39 52·8 | 8 17·2 |
| | C. St. Marco, tower | 39 51·2 | 8 26·5 |
| | C. Frasca | 39 46 | 8 27 |
| | Oristano, grt. tower | 39 54·3 | 8 31·7 |
| | Mt. Arcuento (or finger of Oristano), 2713f. | 39 35·7 | 8 33·5 |
| | C. Pecora, pt., tow. | 39 27·1 | 8 25·2 |
| | St. Pietro I., NS 5½m., 702f. | 39 9·7 | 8 17·7 |
| | St. Antioco I., NS 9m., S sum. 781f. | 38 58·3 | 8 26·0 |
| | Toro rk., T, 500f. | 38 51·6 | 8 25·2 |
| | C. Teulada, ⊥, T, sum. 725f. | 38 51·9 | 8 39·2 |
| | Port Malfatano, ⊞, tow. | 38 53·1 | 8 48·7 |
| | C. Spartivento, lt. F 264f. | 38 52·5 | 8 52·5 |
| | Cagliari, ✝, St. Pancras Ch. | 39 13·2 | 9 7·7 |
| | Cavoli I. (off C. Carbonara), tow. | 39 6·1 | 9 31·5 |
| | C. Ferrato, ⊥, 80f. pt. | 39 17·5 | 9 40·0 |
| | Mt. Seven Brothers, 3186f. | 39 18·5 | 9 26·5 |
| | C. Bellavista, lt. F 541f. | 39 55·8 | 9 43·5 |
| | Mt. Gennargentu, 6102f. | 40 1 | 9 19 |
| | C. Comino, pt. | 40 31·4 | 9 50·5 |
| | Limbarra, pk. 4331f. | 40 51·0 | 9 11·0 |
| | Tavolara I., ♯ 3½m., E pt. | 40 54·8 | 9 45·0 |
| | C. Figari, sum. | 40 59·9 | 9 39·7 |
| | Rock | 41 16·9 | 9 29·0 |
| | Caprera I., NS 5m., sum. | 41 12·9 | 9 29·0 |
| | Madalena I., old fort | 41 13·4 | 9 24·0 |
| | **CORSICA.** | | |
| | C. Corso, Giraglia I., lt. R 269f. | 43 1·8 | 9 24·2 |
| | St. Fiorenza, centre of town | 42 41·0 | 9 18·0 |
| | Pt. Perallo | 42 44·1 | 9 13·4 |

| (24) | Places | Lat. N | Lon. E |
|---|---|---|---|
| *Corsica* ⊕ | Calvi, Pt. Rivellata, lt. F 289f. | 42° 35′·2 | 8° 43′·5 |
| | C. Rosso, W pt. | 42 14·3 | 8 32·5 |
| | Sanguinares Is., ♯ 1m., lt. F, Fl. 321f. | 41 52·8 | 8 35·7 |
| | Ajaccio, Cathedral | 41 55·0 | 8 41·7 |
| | C. Muro, SW pt. | 41 44·5 | 8 39·5 |
| | C. Campo Moro, ⊞, tower | 41 38·5 | 8 48·5 |
| | Pt. Seneteso, *h*, extr. | 41 34·0 | 8 47·0 |
| | C. Feno, lt. F 63f. | 41 23·8 | 9 5·7 |
| | Bonifacio, ⊞, lt. F 98f. | 41 23·8 | 9 9·2 |
| | Pertusato, lt. R 325f. | 41 22·2 | 9 11·2 |
| | Port Sta. Manza, ⊞, Pt. Capicciolo, tower | 41 25·1 | 9 15·7 |
| | Porto Vecchio, ⊞, Chiape Pt., lt. F, Fl. 217f. | 41 36 | 9 22 |
| | E. extr. Fiorentina, tower | 42 17·0 | 9 33·7 |
| | Bastia, ⊞, Dragon bastion, lt. F 82f. | 42 41·8 | 9 27·0 |
| | Monte Stello, 4532f. | 42 47·5 | 9 25·0 |
| | Finocchiarola, tower | 42 59·3 | 9 28·0 |
| | **ITALY. West Coast.** | | |
| | C. St. Martin | 43 43 | 7 33 |
| | Ventimiglia Pt. | 43 45 | 7 43 |
| | Mt. Grande, 3100f. | 43 50 | 7 37 |
| | C. del Armi | 43 49 | 7 54 |
| | Port Maurizio, mole hd. | 43 53·2 | 7 59·0 |
| | C. de la Mele, *h* | 43 58 | 8 11 |
| | Gallinara I., tower | 44 2·1 | 8 13 |
| | Finale, Church | 44 9·9 | 8 19·0 |
| | Noli, Conv. St. Francisco | 44 11·9 | 8 22·7 |
| | Vado, Fort St. Lorenzo | 44 15·5 | 8 24·5 |
| | Savona, ⊞[12], Citadel | 44 18·4 | 8 27·7 |
| | Polla rk. | 44 25·0 | 8 46·0 |
| | Genoa, ⊞. 3 lts., Int. 340f., F 92f., F 69f. | 44 24 | 8 54·0 |
| *G. of Genoa* ⊕ | Pt. Chiapa, sum. | 44 20·0 | 9 10·5 |
| | C. Porto Fino, fort | 44 18·2 | 9 14·2 |
| | Sestri di Levante, fort | 44 16·4 | 9 25·5 |
| | Port Venere, ⊞, N entr. | 44 3·2 | 9 52·7 |
| | Tino I., lt. Fl. (electric) 384f. | 44 1 | 9 51·0 |
| | Spezzia, ⊞, Castle | 44 6·3 | 9 52·2 |
| | Monte Altissimo, 5213f. | 44 3 | 10 14 |
| | Viareggio, Sanità | 43 51·8 | 10 15·7 |
| | Arno R., mouth, fort | 43 40·8 | 10 16·7 |
| | Pisa, leaning tow. | 43 43·5 | 10 24·0 |
| | Florence, Duomo | 43 46·6 | 11 15·5 |
| | Malora, shoal, lt. F 60f. | 43 32·6 | 10 12·7 |
| | Leghorn, ⊞, lt. Rwr 154f. | 43 32·7 | 10 17·7 |
| | Gorgona I., NS 1½m., *h*, mid. | 43 25·8 | 9 53·5 |
| | Val di Vetro rf., ♯ 3m., W pt. | 43 18·2 | 10 21·7 |
| | Castagnetto, fort | 43 10·7 | 10 32·7 |
| | C. Buia, tower | 42 59·7 | 10 29·7 |
| | Piombino, palace | 42 55·7 | 10 31·7 |
| | C. Troja, tower | 42 48·1 | 10 44·5 |
| | Castiglione, fort | 42 46·0 | 10 53·0 |
| | R. Ombrone, mouth | 42 39 | 11 0·5 |
| | Formiche, ♯ 2m., N one 32f. | 42 34·6 | 10 53 |
| | Talamone | 42 32·3 | 11 8 |
| | St. Stefano, centre of town | 42 26·4 | 11 7·2 |
| | Mt. Argentario, telegraph | 42 23·2 | 11 10·5 |
| | Capraia I., ♯ 4m., fort | 43 3·2 | 9 50·5 |
| | Palmajola I., NS ½m., lt. F, Fl. 334f. | 42 51·9 | 10 28·7 |
| | Elba, N extr., or C. Vita | 42 52·6 | 10 24·7 |

## MARITIME POSITIONS

| (35) | Places | Lat. N | Lon. E |
|---|---|---|---|
| *Elba and Is. adjacent* | Elba, Porto Ferrajo, ⊞, lt. F, Stella fort, 200f. | 42° 48′·3 | 10° 20′·5 |
| | — W. extr., or Pt. Mortigliano | 42 46·2 | 10 6·2 |
| | — Port Longone, Citad. Ch. | 42 45·8 | 10 24·2 |
| | — Mt. Calamità | 42 43·8 | 10 23·7 |
| | Pianosa I., NS 3m., *l*, lt. Rev. 140f. | 42 35 | 10 6 |
| | Africa rk., or W. Formiche, 6f. | 42 21·5 | 10 3·7 |
| | Montecristo I., ⚓ 3m., 2076f. | 42 20·3 | 10 18·5 |
| | Giglio I., ⚓ 5m., S pt. | 42 19·2 | 10 55·1 |
| | Gianuti I., ⚓ 2m., S pt. | 42 14·2 | 11 6·5 |
| | Formica di Burano | 42 23·0 | 11 13·5 |
| *Italy, W. Coast* ⊕ | Civita Vecchia, ⊞, lt. F, Fl. 121f. | 42 5·7 | 11 47 |
| | C. Linaro, rf. [¾m.] | 42 2 | 11 50 |
| | Tiber, R. Fiumicino, 2 lts. F. | 41 46 | 12 13·5 |
| | Rome, St. Peter's, dome | 41 54·2 | 12 27·2 |
| | —— Observatory | 41 53·9 | 12 28·7 |
| | Port Anzio, ⊞, lt. F, Fl. 92f. | 41 26·9 | 12 37·5 |
| | Monte Circello, lt. F 125f. | 41 13·4 | 13 4·5 |
| | Terracina, lt. F 26 | 41 17 | 13 15·7 |
| | Gaeta, lt. F, Fl., St. Catherine tow., 237f. | 41 12·4 | 13 34·7 |
| | Mola, watering pl. | 41 15·0 | 13 36·0 |
| | Castel Volturno | 41 2·5 | 13 57·0 |
| | Parmarola I., NS 1¾m., N pt. | 40 56·7 | 12 51·5 |
| | Ponza I., ⚓ 4m., (lt. F 200f.) | 40 54·0 | 12 58·2 |
| | Zannone I., EW 1m., lt. F, Fl. 3?f. | 40 58·2 | 13 3·7 |
| | Botte, rks. | 40 50·4 | 13 6·2 |
| | Vandotena I., ⚓ 1½m., T, Fort St. Nicola | 40 47·5 | 13 26·0 |
| | Ischia I., ⚓ 5½m., Castle, E pt. | 40 43·9 | 13 57·7 |
| | Procida I., NS 2m., N pt., lt. F 76f. | 40 46·2 | 14 1·0 |
| | Baia, Castle | 40 48·7 | 14 5·0 |
| | C. Miseno, pt., lt. F, Fl. 292f. | 40 46·5 | 14 5·2 |
| | Pozzuoli, Church | 40 49·2 | 14 7·2 |
| | Naples, Obs. Capo di Monte | 40 51·8 | 14 14·7 |
| | ——, mole lt. F, Fl. 161f. | 40 50·3 | 14 15·7 |
| | Torre del Greco, W extr. | 40 47·2 | 14 21·7 |
| | Mt. Vesuvius, 3900f. | 40 49 | 14 26 |
| | Castelamare, lt. F, Fl. 105f. | 40 41·5 | 14 28·2 |
| | Sorrento, Fort St. Anton | 40 37·6 | 14 22·5 |
| | Pt. Campanella, lt. Int. 85f. | 40 34·0 | 14 19·5 |
| | Capri I., EW 3m., S or Carena Pt., lt. F, Fl. 238f. | 40 32·0 | 14 11·7 |
| | Mt. St. Angelo, 4680f. | 40 39 | 14 31 |
| | Galli rks., tower | 40 34·0 | 14 26·5 |
| | Salerno, 2 lts. F 28f., 13f. | 40 39 | 14 45 |
| | C. Licosa | 40 14 | 14 53 |
| | C. Palinuro, lt. F 675f. | 40 0 | 15 18 |
| | Policastro | 40 1 | 15 33 |
| | Dino I., EW 3c., tower | 39 48·0 | 15 48·7 |
| | Cirella I., tower | 39 37 | 15 50 |
| | Mt. Cocuzza | 39 16 | 16 16 |
| | St. Eufemia | 39 3 | 16 15 |
| | C. Vaticano, lt. F, Fl. 354f. | 38 37·2 | 15 50 |
| | Gioja | 38 24 | 15 56 |
| | Scylla | 38 14·5 | 15 45·0 |
| *Lipari Is.* | Reggio Church, lt. F 72f. | 38 7 | 15 39 |
| | Stromboli, 3090f. | 38 48·2 | 15 13·7 |
| | Panaria I., N pt. | 38 38·7 | 15 4·5 |
| | Secca di Capo | 38 37·2 | 14 54·5 |
| | Salina I., Salvatore M., 3125f. | 38 33·2 | 14 50·7 |
| | Lipari I., summit, 1978f. | 38 29 | 14 56 |

| (36) | Places | Lat. N | Lon. E |
|---|---|---|---|
| ⊕ *Lipari Is.* | Vulcano I., 1601f., lt. F, Fl. | 38° 22′·1 | 14° 59′·0 |
| | Felicudi I., 2598f., Church | 38 34·1 | 14 34·2 |
| | Alicudi I., summit, 2172f. | 38 32·7 | 14 21·1 |
| | Ustica I., ⚓ 3m., Uomo-Morto pt., lt. F, Fl. 328f. | 38 42·5 | 13 11·7 |
| | **SICILY.** | | |
| *Sicily* ⊕ | Faro I., lt. F, Fl. 147f. | 38 15·8 | 15 39·7 |
| | Messina, ⊞, lt. F, Fl. 134f. | 38 11·2 | 15 35·2 |
| | Scaletta, fort | 38 1·7 | 15 27·7 |
| | Trizzi Tower | 37 34·4 | 15 11·2 |
| | Mt. Etna, 10,874f. | 37 45 | 15 0·2 |
| | Catania, Sciara Biscari, lt. F, Fl. 98f. | 37 29 | 15 6 |
| | C. Sta. Croce, lt. F 91f. | 37 14·5 | 15 16 |
| | Augusta Port, ⊞, lt. F, Fl. 88f. | 37 12·8 | 15 14 |
| | C. Panagia, pt. | 37 6·5 | 15 17·0 |
| | Syracuse, ⊞, w. r. lt. F 82f. | 37 3·0 | 15 18·5 |
| | C. Morro di Porco, lt. Fl. 108f. | 37 0·0 | 15 21 |
| | Avola | 36 55·2 | 15 8·0 |
| | Passaro I., NS 1m., lt. F, Fl. 137f. | 36 41·2 | 15 9·7 |
| | — S. extr., or Correnti I. | 36 38·5 | 15 5·2 |
| | C. Scalambri, lt. F 121f. | 36 47 | 14 29·7 |
| | Terra Nuova, Col. | 37 2·9 | 14 15·0 |
| | Licata, Castle, lt. F 32f. | 37 6·0 | 13 57·0 |
| | Rossello, lt. F, Fl. 324f. | 37 17·5 | 13 27·7 |
| | Girgenti, ⊞, Mole lt., 3 lts. F | 37 17 | 13 32·5 |
| | C. Bianco, 90f., (shl. ¼m. S), tower | 37 23·2 | 13 17 |
| | C. St. Marco, fort, tow. | 37 29·5 | 13 2 |
| | C. Granitola, lt. F 123f. | 37 33·7 | 12 40·2 |
| | Mazzara, Cathedral | 37 29·2 | 12 35·7 |
| | Marsala, lt. F, Fl. 65f. | 37 47·4 | 12 27 |
| | Trapani, ⊞, Columbara, lt. F, Fl. 134f. | 38 0·7 | 12 30·2 |
| | St. Julian, Castle | 38 22·7 | 12 36 |
| | Maritimo I., NS 3m., 2376f., N pt., Castle | 37 58·7 | 12 3·7 |
| | Levanso I., ⚓ 3m., N pt., T. tow. | 38 1·6 | 12 21·0 |
| | Favignana I., EW 5m., St. Cath. Castle, 1249f. | 37 55·7 | 12 19·2 |
| | Porcelli rks., ⚓ ¾m., T | 38 4·5 | 12 27·0 |
| | Formiche, lt. F 85f. | 37 59 | 12 26 |
| | C. St. Vito, lt. F, Fl. 142f. | 38 11·1 | 12 44·2 |
| | Castel a Mare, Petrolo Pt. | 38 2·5 | 12 54 |
| | C. di Gallo (1692f.), lt. F 148f. | 38 13·5 | 13 10·2 |
| | Palermo, ⊞, Observatory | 38 6·7 | 13 21·5 |
| | C. Zaffarana, lt. F 111f. | 38 6·5 | 13 32·5 |
| | Termini, fort, lt. F 30f. | 37 59·5 | 13 42·2 |
| | Cefalu, Cathedral | 38 2·2 | 14 1·7 |
| | Caronia, Castle | 37 59 | 14 27 |
| | C. Orlando, ⊥, Castle | 38 9·8 | 14 45·0 |
| | C. Calava | 38 12·5 | 14 54 |
| | Milazzo, lt. F 288f. | 38 16·1 | 15 14·0 |
| *Pantellaria, &c.* | Skerki Bank, 1 | 37 45·5 | 10 49·7 |
| | Keiths rf., 1 | 37 48·6 | 10 56·6 |
| | Pantellaria I., S. Leonardo, windmill | 36 50 | 11 57 |
| | ———— sum. 2730f. | 36 46·8 | 12 0·5 |
| | Grahams shl., 18f. | 37 9 | 12 43 |
| | Linosa I., ⚓ 1¾m., landg. cove | 35 51·8 | 12 52·0 |
| | Lampion I., ⚓ ¼m. | 35 32·8 | 12 20·0 |
| | Lampedusa I., EW 6m., T, ⊞, Castle | 35 29·2 | 12 35·2 |

## MARITIME POSITIONS

| | (27) Places | Lat. N | Lon. E |
|---|---|---|---|
| | **MALTA.** | | |
| *Malta* ⊕ | Valetta, ⊞, Palace | 35° 53′·8 | 14° 31′·2 |
| | SPENCER'S MONUMENT | 35 53·0 | 14 30·7 |
| | St. Elmo, lt. F 167f. | 35 54·1 | 14 31·5 |
| | SE extr., Pt. Dellamara, (rf. 1⅛m.), lt. R 151f. | 35 49·2 | 14 34 |
| | Gozo I., 9m., NW pt., or C. Demitri, lt. Rev. 400f. | 36 4·2 | 14 13·2 |
| | **ITALY.** | | |
| *Italy, South Coast* | C. delle Armi, tow., lt. F 312f. | 37 57·1 | 15 41·2 |
| | C. Spartivento, F. Fl. 210f. | 37 55·5 | 16 3 |
| | Bruzzano C. | 38 2 | 16 8·2 |
| | Marina de Monasteraci | 38 26 | 16 34·5 |
| | C. Rizzuto, pt. | 38 53·5 | 17 5·5 |
| | C. Colonne, lt. F 183f. | 39 1·5 | 17 12·2 |
| | Cotrone, lt. F 30f. | 39 5·6 | 17 8·5 |
| | Pt. Alice, tower | 39 24 | 17 8 |
| | Pt. del Trionto, tower | 39 37 | 16 46 |
| | Roseto | 39 59 | 16 35·7 |
| | Tarento, ⊞, Citadel | 40 28·2 | 17 14 |
| | C. St. Vito, lt. F, Fl. 150f. | 40 24·5 | 17 12·5 |
| | Port Cesareo, tower | 40 15·6 | 17 53·7 |
| | Gallipoli, St. Andrea I., ¾m., mid. (N pt., lt. F, Fl. 149f.) | 40 2·7 | 17 57·2 |
| | **ADRIATIC.** | | |
| *Adriatic, W. Coast* ⊕ | C. St Maria di Leuca, lt F, Fl. 345f. | 39 47·7 | 18 22·5 |
| | Gagliano | 39 51 | 18 20 |
| | C. Otranto, Telegr. (E pt. of Italy) | 40 8·6 | 18 29·7 |
| | Port Otranto, ⊞, lt. F 197f. | 40 6 | 18 31 |
| | Brindisi, ⊞7, Telegr., lt. F 106f. | 40 39·3 | 17 59·2 |
| | Torre della Testa | 40 41·4 | 17 52·5 |
| | Monopoli, Telegr., lt. F 50f. | 40 57·1 | 17 18·2 |
| | Bari, St. Cataldo, lt. F, Fl. 49f. | 41 8·3 | 16 51 |
| | Molfetta, tow., lt. F, Fl. 65f. | 41 13 | 16 36·0 |
| | Barletta, ⊞[6], (lt. F), 69f. | 41 20 | 16 18·7 |
| | Manfredonia, lt. F, Fl. 65f. | 41 37·7 | 15 55·5 |
| | Mt. Nero, 3336f. | 41 43 | 15 41 |
| | Vieste, Sta Croce, lt. F | 41 53·3 | 16 11·2 |
| | Termoli, tower | 42 0·2 | 15 0 |
| | Tremiti Is., 3m., Semaphore | 42 7·3 | 15 30·5 |
| | Pianosa I., *l*, EW 4c., E pt. | 42 13·5 | 15 45·2 |
| | Pelagosa Is., 2, 1m., lt. F, Fl. | 42 24 | 16 16 |
| | Pt. Penna, tower | 42 10·4 | 14 43·0 |
| | Ortona, Ch., lt. F 39f. | 42 19·7 | 14 24·5 |
| | Mt. Brancastello, 7697f. | 42 27 | 13 39 |
| | Montepagano, 1046f. | 42 40·5 | 13 59·5 |
| | Guilianova | 42 45 | 13 59 |
| | Colonella, sum. 1096f. | 42 52 | 13 54 |
| | Grottamare, Church | 42 59·8 | 13 52·2 |
| | Pedaso, Church | 43 6·4 | 13 53·0 |
| | Fermo, Cath., 1197f. | 43 9·5 | 13 43·5 |
| | Loretto, Ch., 565f. | 43 26·3 | 13 37 |
| | Mount Conero, Telegr. | 43 33·3 | 13 36·5 |
| | Ancona, lt. N mole, 34f. | 43 37·7 | 13 30·5 |
| | Sinigaglia, lt. F 45f. | 43 43·7 | 13 13·5 |
| | Fano, lt. F 58f. | 43 51·3 | 13 0·7 |

| | (28) Places | Lat. N | Lon. E |
|---|---|---|---|
| | Pesaro, lt. F 30f. | 43° 55′·3 | 12° 54′·7 |
| | Rimini, lt. F 67f. | 44 4·3 | 12 35 |
| | Ravenna, tower | 44 25 | 12 12·5 |
| | Goro, ⊞, W mo. of the Po. | 44 48 | 12 23 |
| | Chioggia, ⊞, Cathedral | 45 12·9 | 12 17·0 |
| | Port Malamocco, ⊞, N mole | 45 20 | 12 20·7 |
| | S. Nicolo, Port Lido, ⊞, fort, lt. 9f. | 45 26 | 12 23·5 |
| | Venice, St. Mark | 45 26 | 12 20·5 |
| | Venice, Instituto di Mar. Mer | 45 26·2 | 12 20·5 |
| | Piave Vecchia, lt. F 146f. | 45 28·6 | 12 33·4 |
| | R. Tagliamento, fort mouth | 45 38·2 | 13 6·2 |
| | Port Buso, lt. Rev. 11f. | 45 43 | 13 15 |
| | Grado, Ch. (lt. F) | 45 40·6 | 13 23·2 |
| | Monfalcone, Church | 45 48·3 | 13 32·2 |
| | Trieste, ⊞, lt. Fl Sta Teresa mole hd. 110f. | 45 38·8 | 13 46·2 |
| | Capo d'Istria, Church | 45 32·7 | 13 44·2 |
| | Pirano, St. G. Church | 45 31·6 | 13 34·2 |
| | Salvore Pt., Pt. Bassania, lt. F 112f | 45 29·5 | 13 29·5 |
| | Citta nuova, ⊞, Church | 45 18·8 | 13 33·7 |
| | Parenzo, Church | 45 13·6 | 13 35·7 |
| | Rovigno, ⊞, Pelago I., lt. 42f. | 45 2·2 | 13 36·7 |
| | POLA, ⊞, OBSERVATORY | 44 51·8 | 13 50·7 |
| | C. Promontore, Porer rk., lt. F 111f., (rk. SSE 1½m.) | 44 45·2 | 13 53·5 |
| *Adriatic, E. Coast* ⊕ | Albona, Church | 45 5·1 | 14 7·7 |
| | Fianona, Church | 45 8·2 | 14 11·0 |
| | Fiume, clock tower | 45 19·6 | 14 26·7 |
| | Porto Re, Di Ostro Pt., lt. F, Fl. 54f. | 45 16·7 | 14 34·2 |
| | Segna, mole, lt. F 27f. | 44 59·6 | 14 54·0 |
| | Carlopago, mole | 44 31·7 | 15 4·7 |
| | Nona, Cathedral | 44 14·6 | 15 11·2 |
| | Zara, lt. F 17 | 44 6·8 | 15 12·0 |
| | Zara Vecchia | 43 56·3 | 15 26·7 |
| | Galiola rk. | 44 43·5 | 14 11·0 |
| | Unie Bay, Islet, [2c.] | 44 38 | 14 14 |
| | Sansego I., 2m., 350f. sum. | 44 30·9 | 14 18·2 |
| | Grivizza I., [½m.] | 44 24 | 14 33 |
| | Sette Bocche Chan., N or Bonastra Pt. | 44 12·3 | 14 49·0 |
| | Mt. Vela Strazza, 1070f | 43 59 | 15 2 |
| | Zuri I., 7m., E pt., Massarina I. | 43 37·5 | 15 44 |
| | Sebenico, Castel Vecchia, lt. F 18f. | 43 44·2 | 15 53·7 |
| | Zirona piccola, I., sum. | 43 27 | 16 4 |
| | Trau, St. John's Church | 43 30·9 | 16 15·2 |
| | Spalato, Boticella pt., lt. F, Fl. 35f. | 43 30·4 | 16 26·7 |
| | Makarska, lt. F | 43 17·5 | 17 1·0 |
| | Solta I., 10m., SE pt. | 43 19 | 16 23 |
| | Brazza I., EW 7 l. St. Vito, sig. st. mid. | 43 16·7 | 16 37·5 |
| | Lessina I., EW 12 l., Pokonjidol I., lt. F 76f. | 43 9 | 16 27 |
| | Lissa I., EW 9m., Port St. Georgio, St. Francis Ch., 2 lts. F 72f., 14f. | 43 3·4 | 16 10·2 |
| | Busi I., 2½m., sig. st. | 42 58 | 16 2 |
| | St. Andrea in Pelago, 1½m., 1000f., | 43 1·7 | 15 45·7 |
| | Pomo rk., [2c.], ⊥ | 43 5·5 | 15 27·7 |
| | Proisdo I., EW 1m., (off W pt. of do.) | 42 59 | 16 37 |

## MARITIME POSITIONS

| | (29) Places | Lat. N | Lon. E |
|---|---|---|---|
| Adriatic, E. Coast ⊕ | Curzola I., EW 8 l., Fort St. Biaggio | 42°57′4 | 17° 8′0 |
| | Glavat I., lt. F, Fl. 121f. | 42 46 | 17 9 |
| | Cazza I., $\#^{1s}_{4}$ 2m., sig. st. | 42 46·0 | 16 31·0 |
| | Cazziola I., $\#^{1s}_{8}$ 1m. | 42 45 | 16 43 |
| | Lagosta I., EW 7m., St. George Chap., lt. F 342f. | 42 43·0 | 16 53·0 |
| | Lagostini rks., EW 3½m., E sum. | 42 45·8 | 17 9·0 |
| | Meleda I., $\frac{4}{8}$ 7 l., W pt. | 42 47 | 17 18 |
| | — Port Palazzo, ⊞. ruin | 42 46·8 | 17 21·7 |
| | Ragusa, ⊞, fort, W bast. | 42 38·9 | 18 7·0 |
| | Markana Is., grp., $\frac{4}{8}$ 2m., sum | 42 34·3 | 18 12·0 |
| | Molonta I., sum. | 42 29·9 | 18 23·5 |
| | Pt Ostro, lt. F, Fl. 263f. | 42 23·4 | 18 31·7 |
| | Kattaro, Sanità | 42 25·4 | 18 46·5 |
| | Vetergnach, 3960f. | 42 19 | 18 52 |
| | Budua, Greek Church | 42 16·5 | 18 50·5 |
| | Antivari, Volovica Pt., lt. F | 42 5·3 | 19 4·5 |
| | Meuders Pt., lt. F 33f. | 41 57 | 19 9·5 |
| | Dulcigno, ⊞. la Cala beach | 41 55 | 19 12·5 |
| | C. Rodoni, 400f., lt. Fl. | 41 35 | 19 27·2 |
| | C. Pali, sum. | 41 24·7 | 19 24·2 |
| | Durazzo, mole, lt. F 52f. | 41 18·2 | 19 27·2 |
| | C. Laghi, tower | 41 10·2 | 19 25·5 |
| Albania | Avlona, or Valona, ⊞, w, Custom house | 40 27·2 | 19 26·7 |
| | Sasseno I., $\frac{4}{8}$ 2m., sum. 1000f. | 40 29·2 | 19 14·2 |
| | C. Linguetta, ⊥, 2290f. | 40 26·7 | 19 17·7 |
| | Mt. Cica, 6300f. | 40 15 | 19 35 |
| | Port Palermo, ⊞, fort | 40 2·9 | 19 48·2 |
| | C. Kiephali | 39 54·3 | 19 55·5 |
| | Tignoso, lt. F 100f. | 39 47·2 | 19 58·5 |
| | Port Gomenitza, ⊞, Dogana | 39 29·7 | 20 17·1 |
| | Parga, w, Madonna I. | 39 16·4 | 20 25 |
| | Mt. Zarothema, 3000f. | 39 11·2 | 20 38 |
| | Prevesa, Fort Giorgio | 38 56·7 | 20 46·2 |
| | Vonizza | 38 55 | 20 53·7 |
| | **IONIAN ISLES.** | | |
| Ionian Is. ⊕ | Fano I., $\#^{1s}_{8}$ 3½m., 1339f., lt. F, Fl. 346f | 39 51 | 19 27 |
| | Merlera, NS 2m., sum. | 39 53·2 | 19 36 |
| | Samothraki I., $\frac{4}{8}$ 2½m., N pt. | 39 46·7 | 19 31·5 |
| | Corfu, Citadel, lt. F 240f. ... ⊕ | 39 37·0 | 19 56·7 |
| | — C. Drasti | 39 47·6 | 19 41·5 |
| | — Mt. St. Giorgio, 1288f | 39 36 | 19 48·0 |
| | — C. Bianco, pt. | 39 21·2 | 20 7·7 |
| | — Vido I., Fort Alexander | 39 38·2 | 19 56·5 |
| | Paxo I., $\frac{4}{8}$ 4½m., NW pt., Laka, lt. F 416f. | 39 14·4 | 20 8·5 |
| | — Port Gajo, ⊞ | 39 12 | 20 13 |
| | Antipaxo I., $\frac{6}{8}$ 2m., E pt | 39 8·7 | 20 14·0 |
| | Sta. Maura, lt. F mole, 54f. | 38 50·5 | 20 43 |
| | — Sesola rk., 114f. | 38 41·5 | 20 33·5 |
| | — Mt. Stavrota, 3700f. | 38 41·6 | 20 38·5 |
| | — S extr., C. Ducato, ⊥, 200f. | 38 33·5 | 20 33·7 |
| | Ithaca, N pt. | 38 30·0 | 20 40·0 |
| | — Vathy, Port, ⊞. Lazaretto | 38 22·1 | 20 43·5 |
| | — SE pt., or Iganni Pt. | 38 19 | 20 46·7 |
| | Cephalonia, N extr. | 38 28·5 | 20 34·0 |
| | — C. Aterra, pt. | 38 21·5 | 20 25 |
| | — Guardiana I., lt. F 112f. | 38 8·4 | 20 26·5 |
| | — Port Argostoli, C.S. Theodoros | 38 11·6 | 20 29 |

| | (30) Places | Lat. N | Lon. E |
|---|---|---|---|
| Ionian Is. | Cephalonia, St. George, Castle, 1050f. | 38° 8′5 | 20°34′0 |
| | — Sum., or Mt. Elato, 5218f. | 38 8·5 | 20 41·0 |
| | — S pt., or C. Monda | 38 3·6 | 20 48 |
| | Zante, N pt., or C. Skinari | 37 56·2 | 20 42·2 |
| | — Mt. Vachronis, 2724f. | 37 48·8 | 20 42·7 |
| | — S pt., C. Marathia | 37 39 | 20 50 |
| | — Ieraki Pt. | 37 42·5 | 20 59·2 |
| | — Mt. Scopo, 1621f. | 37 45 | 20 56·2 |
| | Krio Nero, lt. F 93f. | 37 48·2 | 20 54·5 |
| | **GREECE.** | | |
| Greece, W. Coast ⊕ | Dragomesti Bay, Astoko | 38 32 | 21 5 |
| | Oxia I., pk., 1411f. | 38 18·7 | 21 7 |
| | Messalonghi | 38 21·9 | 21 25·7 |
| | Pt. Bakari | 38 17 | 21 31 |
| | Roumelia, Castle | 38 19·5 | 21 46·2 |
| | Lepanto, Castle | 38 23·8 | 21 49·0 |
| | Corinth, Acropolis | 37 53·5 | 22 52 |
| | Morea Castle, centre | 38 18·5 | 21 47·0 |
| | Patras, w′, lt. F, Fl. 65f. | 38 15·1 | 21 43·5 |
| | C. Papas, ruined fort | 38 12·7 | 21 23·5 |
| | Montague rks., 2, $\frac{4}{8}$ 1m., 15f. | 37 55 | 21 0 |
| | Konoupoli Pt. | 38 6 | 21 23 |
| | C. Glarenza, ruin | 37 56·8 | 21 8·5 |
| | Kastro Tornese, 795f. | 37 53·7 | 21 8·7 |
| | C. Katakelo, *h* | 37 38 | 21 19·0 |
| | Stamphanes Is., $\frac{4}{8}$ 2½m., T, *l*, lt. F 127f. | 37 15·3 | 21 0·2 |
| | C. Kunello | 37 10 | 21 34 |
| | Proti I., NS 2m., sum. 605f. | 37 3·4 | 21 33·5 |
| | Sphaghia I., $\frac{4}{8}$ 2½m., S pt. | 36 54·5 | 21 40·5 |
| | Navarino, Pylos I., lt. F 116f. | 36 54 | 21 41 |
| | Mt. St. Nicolo, 1542f. | 36 53·0 | 21 42·0 |
| | Modon | 36 48·4 | 21 42·5 |
| | Sapienza I., NS 5m., sum. 740f. | 36 46·6 | 21 42·2 |
| | Cabrera I., $\frac{4}{8}$ 5m., S extr. | 36 41·7 | 21 47 |
| | C. Gallo | 36 42·9 | 21 52·7 |
| | Venetico I., NS 1½m., (Ants. SSE 2m.). sum 570f. | 36 41·7 | 21 53·7 |
| | Koron, w′ N 2m., r, Lividia Pt. | 36 47·5 | 21 58·5 |
| | Kalamata, highest ruin | 37 2·6 | 22 7·2 |
| | C. Kitries | 36 54·7 | 22 8·0 |
| | Mt. Makrino, 7900f. | 36 56·5 | 22 22·2 |
| | Limeni, ⊞ | 36 40·6 | 22 13 |
| | C. Grosso, ⊥, *h*, sum. | 36 28·6 | 22 22·2 |
| | C. Matapan, ⊥, *h*, lt. F, Fl. 133f. | 36 22·5 | 22 29·2 |
| | C. Stavri | 36 36·2 | 22 32·5 |
| | Marathonisi | 36 44·6 | 22 35·0 |
| | Eurotas R., mouth | 36 48·2 | 22 41 |
| | C. Xyli, (pk. 1040f. N 1′·5), pt | 36 39·0 | 22 49·5 |
| | Servi I., NS 3½m., S and E pt. | 36 27·0 | 22 59·5 |
| | C. St. Angelo, *h*, ⊥, pt. | 36 26·0 | 23 12·0 |
| Cerigo I. | Cerigo I., N. pt., C. Spathi, lt. F, Fl. 362f. | 36 23·0 | 22 57·2 |
| | — Fort St. Nikolo | 36 13·1 | 23 5·0 |
| | — S extr. | 36 7·7 | 22 59·7 |
| | Ovo I., NS 8c., 550f., T | 36 5·5 | 23 0·0 |
| | Nautilus rk., [½m.] | 35 56 | 23 13 |
| | Pori I., $\#^{1s}_{8}$ ¾m., 410f. | 35 58·5 | 23 15 |
| | Cerigotto I., $\#^{1s}_{8}$ 6m., sum. 1230f. | 35 50·1 | 23 18·0 |

## MARITIME POSITIONS

| | (31) Places | Lat. N | Lon. E |
|---|---|---|---|
| *Greece, East Coast* | Mt. Krithina, 2600f. | 36°28·2 | 23° 8·2 |
| | Karavi I., rk., T | 36 46·1 | 23 36·5 |
| | Falconera I., 1¼m., *h*, sum. | 36 50·9 | 23 53·7 |
| | Belo Poulo I., 1¾m., T, sum. | 36 54·9 | 23 27·7 |
| | Spezsia I., 4½m., sum. 812f. | 37 15·3 | 23 8·7 |
| | Trikeri I., NS 1m., N sum. | 37 16·2 | 23 17·0 |
| | Napoli di Romania | 37 33·6 | 22 48·0 |
| | Hydra, 11m., sum. 1939f. | 37 19·5 | 23 28·0 |
| | Stavronisi I., EW ½m. | 37 15 | 23 27 |
| | St. George d' Arbora I., 3m., sum. SE part, 1085f. | 37 28·0 | 23 56·0 |
| | Poros I., EW 5m., ⊞', W pt., lt. F 96f. | 37 32 | 23 26 |
| | Methana, Mt. Khelona. 9429f. | 37 36 | 23 22 |
| | Egina I., 8m., Mt. St. Elias, on S part, 1752f. | 37 41·9 | 23 30·0 |
| | Kalamaki, E. ent. canal | 37 55 | 23 0 |
| | Ledsina I., or Eleusis, tow. | 38 2·4 | 23 32·2 |
| | C. Themistocles, lt. F. 51f. | 37 5 | 23 28 |
| | Piræus, 2 lts. F | 37 56·2 | 23 38·0 |
| | Athens, Parthenon | 37 58·1 | 23 43·7 |
| | ——— Observatory | 37 58·3 | 23 44 |
| | C. Colonna. temple, 269f. | 37 38·8 | 24 1·7 |
| | Port Mandri, ⊞, pk. | 37 44·3 | 24 3·7 |
| | Macronisi I., 7m., S pt. | 37 38·5 | 24 6·7 |
| | Port Raphti, ⊞', St. Nicolao | 37 53·0 | 24 1·0 |
| | C. Marathon | 38 7·1 | 24 3·7 |
| | Petalies, or Split Is., sum. | 37 59·5 | 24 16·2 |
| | **ARCHIPELAGO.** | | |
| *Archipelago* ⊕ | Zea I., 10m., Mt. St. Elias | 37 37·3 | 24 21·7 |
| | — Port St Nicolao, ⊞, lt. F Fl. 108f. | 37 40 | 24 19 |
| | Thermia I., 10m., sum. 966f. | 37 22·5 | 24 26·2 |
| | Piperi I., EW ¼m., sum. | 37 18·2 | 24 32·0 |
| | Serpho Poulo Is., EW 1½m., mid. | 37 15 | 24 36 |
| | Serpho I., 7½m., sum. 1585f. | 37 10 | 24 30 |
| | Siphanto I., 9m., N pt. | 37 2·7 | 24 38·5 |
| | Anti Milo, NS 2m. sum. | 36 48 | 24 15 |
| | Ananes rks., ⅛m. | 36 33 | 24 9 |
| | Milo, EW 11m., Mt. St. Elias, on SW part, 2480f. | 36 40·5 | 24 23·2 |
| | — Port, ⊞, W pt., Pt. Vani | 36 45·3 | 24 22·7 |
| | Argentiera I., NS 5m. | 36 49·3 | 24 33·5 |
| | Polino I., 3½m., sum. | 36 46 | 24 39 |
| | Peignes rks. | 36 38 | 24 35 |
| | Policandro I., 2 l. sum. | 36 37·1 | 24 55·2 |
| | Sikyno I., 7m., sum | 36 40 | 25 6 |
| | Nio I., 8m, sum | 36 42·7 | 25 21·0 |
| | Amorgo Poulo I., NS 2m. | 36 36·9 | 25 42·7 |
| | Santorin I., NS 8m., Mt. St. Elias, on SE part | 36 22·0 | 25 28·7 |
| | Christiana I., (*Askania*), 1m | 36 15 | 25 13 |
| | Anaphi I., 7m., sum. | 36 23 | 25 47 |
| | Hermonisi I. | 36 32 | 26 10 |
| | Stampalia I., or Astropalaia, 4 l., SW sum. | 36 32·2 | 26 19·7 |
| | Levita I., EW 4m., E pt. | 37 0·0 | 26 32·0 |
| | Zinari I., 2m., W pt. | 36 58·7 | 26 17·7 |
| | Amorgo I., 18m., sum. near mid., 2175f. | 36 50·7 | 25 55·7 |
| | Karo I., EW 4m., mid. | 36 53 | 25 40 |
| | Skinosa I., 2½m., SE pt. | 36 51·0 | 25 33·0 |
| | Heraclia I., 4m., sum. | 36 49·7 | 25 27·5 |

| | (32) Places | Lat. N | Lon. E |
|---|---|---|---|
| *Archipelago* | Naxos I., 18m., Mt. Zia, SE-d of mid., 3290f. | 37° 1·8 | 25°31·2 |
| | — N pt., or C. Stauro | 37 12·5 | 25 33·0 |
| | Paros I., 12m., 2530f., C. Koraka, lt. F, Fl. 193f. | 37 9 | 25 14 |
| | Boidi, or Buey rk, T | 37 14·5 | 25 56·7 |
| | Antiparos, NS 7m. S pt. | 36 56·0 | 25 5·0 |
| | Strongylo I., 1½m., S pt. | 36 56·2 | 24 57·5 |
| | Stapodia, 1½m. | 37 25 | 25 35 |
| | Myconi I., 8m., E sum. 1150f. | 37 27·5 | 25 27·2 |
| | Rhenea, NS 4½m., S pt. | 37 22·0 | 25 14·0 |
| | La Nata, rk., (rk. W ¼m.) | 37 21·7 | 25 4·0 |
| | Syra I., NS 9m., 1415f. | 37 28·9 | 24 55·7 |
| | — Gaidaro, lt. R 224f. | 37 25·5 | 24 59·0 |
| | Jura I., 5m., W pt. | 37 36·2 | 24 39·5 |
| | Tinos I., 15m., 2340f. | 37 35·0 | 25 14·5 |
| | Andros I., 22m., Mt. Kovari, W side, mid., 3200f. | 37 50·1 | 24 50·5 |
| | — C. Fassa, lt. F, Fl. 708f. | 37 57·6 | 24 41·7 |
| | Kaloyeri rks., NS 2m. | 38 10 | 25 17 |
| | Negropont, Euripo. lt. F 39f. | 38 28·7 | 23 36·5 |
| | — C. Doro, islet off, 93f | 38 9·4 | 24 36·5 |
| | — C. Kumi | 38 39 | 24 9·7 |
| | — Mt. Delphi, 5730f. | 38 37·4 | 23 50·7 |
| | G. of Volo, C. Kavoulia, lt. F 85f. | 39 6 | 23 4 |
| | Volo, fort | 39 24·0 | 22 56·5 |
| | Skyro I., 5 l., rf. N end, Mt. Kokhilas, 2565f. | 38 49·7 | 24 36·5 |
| | Skyro Poulo, [1m.], 617f. | 38 50 | 24 22 |
| | Skantzura I., NS 1 l., mont. | 39 5 | 24 6 |
| | Adelphi Is., 1½m., 521f. | 39 5·8 | 23 59 |
| | Khelidromi, 4 l., N sum. 1590f. | 39 10 | 23 53 |
| | Skopelos I, 11m., sum. 2149f. | 39 8·8 | 23 40·2 |
| | Skiathos I., 6m., Mt. Stavros, 1448f. | 39 11·4 | 23 28·2 |
| | Pelago, NS 2 l., sum. 1050f. | 39 20·4 | 24 3 |
| | Psathoura I., lt. Fl. 129f. | 39 30 | 24 10·7 |
| | Mt. Pelion, 5310f. | 39 26·5 | 23 3 |
| | Ossa, Mt., 6407f. | 39 48·0 | 22 42·0 |
| | **TURKEY.** | | |
| *Turkey, South Coast* | Mt. Olympus, 9754f. | 40 4·7 | 22 22·0 |
| | Salonika, ⊞ | 40 37·8 | 22 57·2 |
| | C. Kassandra, *l*, lt. Fl. 72f. | 39 57·2 | 23 22·0 |
| | C. Pailluri, *l* | 39 55 | 23 44·7 |
| | C. Drapano, 880f. | 39 56·5 | 23 56·2 |
| | Mt. Athos, sum. 6349f. | 40 9·5 | 24 20·0 |
| | Pilaf Tepe, 6143f. | 40 53·5 | 24 5·2 |
| | Kavala B., lt. F 148f. | 40 55 | 24 25 |
| | Thaso I., NS 14m., sum. 3428f. | 40 41·7 | 24 42·7 |
| | C. Fenar, lt. F 72f. | 40 56·7 | 25 8·5 |
| | Marona, hill, 2174f. | 40 52·7 | 25 32·5 |
| | C. Makri, w', 1m. | 40 49·5 | 25 45·0 |
| | Dédéagatch, lt. Rev. 115f. | 40 50 | 25 55 |
| | Enos | 40 42·0 | 26 5·0 |
| | Xeros I., NS ½m. | 40 36·5 | 26 44·0 |
| *Lemnos Is.* | Samothraki, 12m., 5248f. | 40 27·0 | 25 35·5 |
| | — W pt., C. Akrotiri, *l* | 40 28·2 | 25 27·0 |
| | Zurafa rk. | 40 27·5 | 25 50·5 |
| | Strati I., 5½m., 973f | 39 31·0 | 25 1·7 |
| | Lemnos, 7 l., W pt, or C. Mourtzephlos, 1410f. | 39 58·7 | 25 2·0 |
| | — Moudros, ⊞ | 39 52·0 | 25 16·2 |

## MARITIME POSITIONS

| Region | (33) Places | Lat. N | Lon. E |
|---|---|---|---|
| Sea of Marmara | Lemnos, S pt., or C. Irene ... | 39°46'·6 | 25°21'·5 |
| Sea of Marmara | — N and E pt., C. Plaka ...... | 40 1·7 | 25 27·0 |
| Sea of Marmara | Imbros, ⚓ 5l. sum. 1959f. ... | 40 10·6 | 25 49·0 |
| Sea of Marmara | — W pt., or Pt. Anflaka ...... | 40 7·2 | 25 40·0 |
| Sea of Marmara | Dardanelles, Asia Castle, lt. F 50f. .................... | 40 9·0 | 26 24·5 |
| Sea of Marmara | Gallipoli, lt. Rev. 120f. ......... | 40 24·0 | 26 41 |
| Sea of Marmara | Koutalai I., Roun rk, lt. F 49f. .................... | 40 31·0 | 27 28·5 |
| Sea of Marmara | Marmara I., Fanar Adasi, lt. F. Fl. 134f. .............. | 40 38 | 27 45 |
| Sea of Marmara | Pasha harb., ⊞, Liman ......... | 40 29·5 | 27 36·2 |
| Sea of Marmara | Rodosto .......................... | 40 59·7 | 27 31·0 |
| Sea of Marmara | Erekli, lt. F 184f. ................ | 40 58·5 | 27 58·0 |
| Sea of Marmara | CONSTANTINOPLE, ST. SOPHIA | 41 0·3 | 28 59·0 |
| Sea of Marmara | Bosporus Seraglio pt., lt. F, Fl. 117f. .................... | 41 0 | 29 1 |
| Sea of Marmara | Roumili, lt. F 190f. ............ | 41 14 | 29 7·2 |
| Sea of Marmara | Fanar Bournou, lt. F 83f. ... | 40 57·7 | 29 2·2 |
| Sea of Marmara | Proti I., [1m.] Vill. E side .. | 40 54·0 | 29 3·5 |
| Sea of Marmara | Dil Burnu, lt. F 40f. ............ | 40 44·5 | 29 30·7 |
| Sea of Marmara | Ismid .............................. | 40 45·7 | 29 55 |
| Sea of Marmara | C. Bos Burnu, 1050f. ............ | 40 32 | 28 47 |
| Sea of Marmara | Gemlik or Kios .................. | 40 26 | 29 9·5 |
| Sea of Marmara | Kalolimno I., NS 4m. N sum. | 40 34 | 28 32 |
| | **BLACK SEA.** | | |
| Black Sea | Kilios, tow ........................ | 41 10·8 | 29 37 |
| Black Sea | C. Karábournú, N pt. lt. Fl. 302f. .................... | 41 21·7 | 28 41·2 |
| Black Sea | C. Kouri .......................... | 41 52·7 | 28 3·0 |
| Black Sea | Cisópol ............................ | 42 26·3 | 27 43·7 |
| Black Sea | Bourgas, Minaret ............... | 42 30·3 | 27 30·7 |
| Black Sea | Akhiólo, Mosque ............... | 42 34·0 | 27 40·5 |
| Black Sea | C. Emeneh, E pt., lt. Fl. 207f. | 42 42 | 27 55·7 |
| Black Sea | Varna, Mosque, mid ............ | 43 12·0 | 27 56·5 |
| Black Sea | C. Kaliagri, ruin ............... | 43 22·1 | 28 29·7 |
| Black Sea | C. Shabler lt.. F 120f. ......... | 43 32·7 | 28 37·7 |
| Black Sea | Kustenjeh, C., lt. F 68f. ...... | 44 10·5 | 28 41·0 |
| Black Sea | Portitski Mouth ................ | 44 40·5 | 29 1·7 |
| Black Sea | Danube R., Sulina mo. lt. F 70f. .................... | 45 9·3 | 29 40·5 |
| Black Sea | Serpent's I., w, lt. R 194f. ... | 45 15·5 | 30 14·2 |
| Black Sea | Tsaregradskoe mo. 2 lts. F 52f. .................... | 46 4·8 | 30 29·7 |
| Black Sea | Akerman, Church ............... | 46 11·9 | 30 20·2 |
| Black Sea | C. Fontane, lt. F 200f. ......... | 46 22·8 | 30 45·5 |
| Black Sea | Odessa, ⊞, Reidovi mole, lt. F, Fl. 63f. .................. | 46 30 | 30 46 |
| Black Sea | — OBSERVATORY ............... | 46 28·5 | 30 45·5 |
| Black Sea | Berezan I., ⚓ ½m., fort ...... | 46 35·6 | 31 23 |
| Black Sea | Kinbourn lt. v. 2 vert. ......... | 46 35·4 | 31 29·2 |
| Black Sea | Otchakov., Church ............ | 46 36·4 | 31 32·2 |
| Black Sea | Nicolayev, ⊞, Observatory ... | 46 58·2 | 31 58·0 |
| Black Sea | Kherson, Cathedral ............ | 46 37·7 | 32 38·0 |
| Black Sea | Tendra I., l, ⚓ 8m. N end, beac. | 46 21·7 | 31 32·0 |
| Black Sea | — lt. Rev. 96f. bell ............ | 46 18·9 | 31 30·2 |
| Black Sea | Armiansk, Church ............... | 46 7 | 33 43 |
| Black Sea | C. Jarkan, lt. F 117f .......... | 45 20·7 | 32 29·7 |
| Black Sea | Eupatoria pt. lt. F, Fl. 52f. ... | 45 9·7 | 33 15 |
| Black Sea | C. Khersonese, l, lt. Rev. 116f. .................... | 44 35 | 33 22·2 |
| Black Sea | Sevastopol, ⊞, Church ......... | 44 37·9 | 33 29·5 |
| Black Sea | C. Saritch, pt. .................... | 44 23 | 33 44 |
| Black Sea | C. Aitódor, lt. F 315f. ......... | 42 25·3 | 34 7·7 |

| Region | (34) Places | Lat. N | Lon. E |
|---|---|---|---|
| | Mt. Tchatirdag, SW sum ....... | 44°44'·0 | 34°17'·2 |
| | C. Meganom ..................... | 44 46·7 | 35 7 |
| | O. Karatlamà, sum ............... | 44 57·0 | 35 22 |
| | C. Theodosia ..................... | 45 0 | 35 26 |
| | C. Chaouda, S pt., lt. F Fl. 120f. .................... | 44 59·5 | 35 50 |
| | C. Takli, lt. ........................ | 45 5·9 | 36 27 |
| | Kertch, ⊞, Church ............... | 45 21·2 | 36 29·5 |
| Sea of Azov | Yenikaleh, lt. Fl 409f. ........ | 45 23·1 | 36 39·2 |
| Sea of Azov | C. Kazantip, sum. ............... | 45 28·0 | 35 54·0 |
| Sea of Azov | Arabat, E bast. ................... | 45 17·9 | 35 29·5 |
| Sea of Azov | Ghenitchesk, lt. F 81f. ......... | 46 11·0 | 34 52 |
| Sea of Azov | Berdiansk, lt. F 165f. ......... | 46 46 | 36 48·2 |
| Sea of Azov | C. Bielosarai, lt. F 73f. ....... | 46 52·5 | 37 20·7 |
| Sea of Azov | Mariupol, Church ............... | 47 5·3 | 37 35·5 |
| Sea of Azov | Taganrog, lt. F 161f. ............ | 47 12·2 | 38 57 |
| Sea of Azov | Azov, Cathedral ............... | 47 7·0 | 39 26·5 |
| Sea of Azov | Long nose, s ..................... | 46 48 | 38 35 |
| Sea of Azov | Gheisk, lt. F 34f. ................ | 46 43 | 38 17 |
| Black Sea | Taman ............................... | 45 13·0 | 36 44 |
| Black Sea | Anápa, lt. F 98f .................. | 44 54·1 | 37 18·5 |
| Black Sea | Ghelenjik, ⊞, fort ............... | 44 33·4 | 38 3·2 |
| Black Sea | High Summit, 4m. inland ...... | 43 17 | 40 16 |
| Black Sea | Soukoum, fort, lt. Rev. 121f... | 42 59·3 | 40 59·7 |
| Black Sea | C. Batoum, Mosque, lt. F 65f. | 41 39·4 | 41 37·0 |
| Black Sea | Rezo .................................. | 41 3·0 | 40 31·5 |
| Black Sea | Trebizonde, ⊞, lt. Fl. 105f. ... | 41 1·0 | 39 46·0 |
| Black Sea | C. Ieros, T, N pt., lt. Fl. 98f... | 41 7·7 | 39 26·0 |
| Black Sea | Triboli ............................... | 41 1·0 | 38 49 |
| Black Sea | Keresoun ........................... | 40 57·2 | 38 24 |
| Black Sea | C. Yazon, l, rks .................. | 41 8·5 | 37 41·5 |
| Black Sea | Eunich, S. Mosque ............... | 41 7·7 | 37 17·7 |
| Black Sea | Samsoun, N lt. F 56f. .......... | 41 19 | 36 21·2 |
| Black Sea | C. Kizil Ermak, W. mo. riv.... | 41 44 | 35 58 |
| Black Sea | Sinope, Castle, lt. F 344f. ...... | 42 1·2 | 35 12·5 |
| Black Sea | C. Indjeh, lt. F, Fl. 92f. ........ | 42 6 | 34 58 |
| Black Sea | C. Kerempeh, lt. Fl. 262f. ....... | 42 1 | 33 17·2 |
| Black Sea | Amastra, E extr., lt. Fl. 312f... | 41 45·3 | 32 24·5 |
| Black Sea | C. Babà, lt. F 657f. ............ | 41 18 | 31 26 |
| Black Sea | Kephken Adassi I., lt. F 98f... | 41 14 | 30 17·5 |
| | **ASIA MINOR.** | | |
| Asia Minor | Rabbit Is., l, ⚓ 2m.. W extr. | 39 55·5 | 26 3·7 |
| Asia Minor | Tenedos I., ⚓ 6m., rf. NW-d., sum. .................... | 39 50·2 | 26 5 |
| Asia Minor | C. Baba, fort ..................... | 39 28·2 | 26 4·5 |
| Asia Minor | Mt. Ida, 5750f. .................. | 39 42·0 | 26 50·5 |
| Asia Minor | Adramyti ......................... | 39 35·5 | 27 2·5 |
| Asia Minor | Mityleni, ⚓ 13 l., E pt., C. Agia Maria ........... | 39 0·7 | 26 37·7 |
| Asia Minor | — Mt. Olympus, 3079f. ......... | 39 4·2 | 26 22·0 |
| Asia Minor | — Caloni, ⊞, Isl. ............... | 39 4·7 | 26 5·5 |
| Asia Minor | — W. pt. C. Sigri, lt. Rev. 180f | 39 13 | 25 51 |
| Asia Minor | SMYRNA, MILL ON DARAGAZ PT. .................... | 38 26·5 | 27 9·7 |
| Asia Minor | Vourla Scala, fountain ......... | 38 21·7 | 26 47·5 |
| Asia Minor | C. Karabournou, pt. ............ | 38 39·9 | 26 22·7 |
| Asia Minor | Scio, NS 27m., N sum. 4157f. | 38 33·7 | 26 1·2 |
| Asia Minor | Venetico I., off S pt. of Scio, T | 38 8·0 | 26 2·0 |
| Asia Minor | Psara I., ⚓ 5m., S pt. ........... | 38 32 | 25 35 |
| Asia Minor | Antipsara, W pt. ................ | 38 32 | 25 31 |
| Asia Minor | C. Blanco ......................... | 38 16·6 | 26 14·7 |
| Asia Minor | C. Koraka, T ..................... | 38 6·5 | 26 36·7 |
| Asia Minor | Sighajik, ⊞ ....................... | 38 12·0 | 26 48·2 |

## MARITIME POSITIONS

| | (35) Places | Lat. N | Lon. E |
|---|---|---|---|
| *Asia Minor* | Scala Nuova, lt. F 98f. | 37° 51′·5 | 27° 16′·5 |
| | Samsum Dagh, 4130f. | 37 39·8 | 27 9·0 |
| | C. Monodendri, ruin | 37 21·3 | 27 13·0 |
| | Wreck rk. 21f. | 37 9·0 | 27 17·7 |
| | Budroom, ⊞, Castle | 37 2·0 | 27 27·5 |
| | Port Giova | 37 3·5 | 28 22 |
| | C. Krio, W pt. | 36 41·0 | 27 23·5 |
| | Iujah Pt. | 36 39·4 | 27 42·7 |
| | Symi I., grp. NS 9m. S islet, Trompetto | 36 30·7 | 27 54·2 |
| | C. Aloupo | 36 33·0 | 28 1·0 |
| | **ARCHIPELAGO.** | | |
| | Samos, Mt. Kerki, 4725f. | 37 43·8 | 26 38·5 |
| | — Vathi ⊞, port. lt. F 260f. | 37 47 | 26 58 |
| | — S pt., or C. Colonna | 37 38·3 | 26 52·7 |
| | Furni Is., NS 11m., S extr. rk. ⚓ | 37 28·4 | 26 31·2 |
| | Nikaria, ⚓ 22m. W pt., or C. Papas, lt. F, Fl. | 37 31·2 | 25 59·5 |
| | Mt. Melissa, 3390f. | 37 32·2 | 26 4·7 |
| | Gaidaro, EW 4m. sum. 720f. | 37 28·1 | 26 58·7 |
| | Arki, ⚓ 4m. N pt. | 37 24·9 | 26 44·5 |
| | Patmos, NS 7m. Prasso Islet | 37 16·0 | 26 34·7 |
| | — Scala, ⊞, pier | 37 19·5 | 26 34·0 |
| | Lipso, ⚓ 4½m. SW pt. | 37 18·2 | 26 44·2 |
| | Lero, ⚓ 8m., Mt. Klidi, 1060f. | 37 10·7 | 26 51·5 |
| | Kalimno, ⚓ 10m. Mt. Parasiva, 2250f. | 36 58·8 | 27 0·0 |
| | Saphonidi, ⚓ ½m. sum. | 36 53·0 | 26 56·7 |
| *Archipelago* ⊕ | Kos, ⚓ 24m. W pt. | 36 43·1 | 26 56·5 |
| | Madona I. sum., lt. F, Fl. | 36 30·5 | 26 57·5 |
| | Nisero, EW 4½m. sum. 2270f. | 36 35·5 | 27 11·0 |
| | — W Islet off, ⚓ 1m., N pt. | 36 35·6 | 27 3·5 |
| | Piskopi, ⚓ 8½m., sum. 2097f. | 36 26·1 | 27 21·0 |
| | Karki, EW 5m., SW pt. | 36 12·2 | 27 33·2 |
| | Rhodes, ⊞, ⊡. lt. Rev. 82f. | 36 26·9 | 28 16·2 |
| | — W pt., C. Monolitho | 36 8·7 | 27 43·2 |
| | — S pt. C. Prasso Nisi | 35 52·4 | 27 47·0 |
| | Khina Id., rk. | 35 51·2 | 27 56·0 |
| | Scarpanto I., NS 27m. S pt. | 35 23·5 | 27 10 |
| | Saria [2m.] mid., 1853f. | 35 51 | 27 14 |
| | Caxo I., EW 12m. SW pt. | 35 19 | 26 50 |
| | Stakida, 2 Is. [2m.] N one | 35 53 | 26 51 |
| | Unia Nisia | 35 50 | 26 29 |
| | Kamila Nisi | 35 51 | 26 14 |
| | Sofrana Is. | 36 4·5 | 26 25 |
| | Tria Nisia, Is. | 36 18 | 26 45 |
| | Sirina I., 1087f. | 36 20·8 | 26 41·2 |
| | Adelphæ Is., N one | 36 25 | 26 38·5 |
| | Ovo I., 170f. | 35 36 | 25 35·5 |
| | **Candia.** | | |
| *Candia* ⊕ | C. Krio | 35 13·4 | 23 34·7 |
| | Pondikonisi, 730f. | 35 34·7 | 23 28 |
| | Agria Grabusa, N point | 35 38·6 | 23 34 |
| | N extr., C. Spada, *h*, ⊥, sum. | 35 41 | 23 43·7 |
| | Khania, ⊞, lt. F 85f. | 35 30·8 | 24 1 |
| | C. Tripiti | 35 36·1 | 24 7·7 |
| | Suda, ⊞, lt. F 82f. | 35 28 | 24 9·3 |
| | Rhitymno, lt. F 49f. | 35 22 | 24 29·2 |

| | (36) Places | Lat. N | Lon. E |
|---|---|---|---|
| *Candia* | C. Stavros | 35° 25′·6 | 24° 59′ |
| | Megalo Kastron, ⊡, (lt. F 53f.) | 35 20·6 | 25 9 |
| | Standia I., summit, 870f. | 35 27 | 25 14·2 |
| | C. St. John, ⊡, SW 2¾m. | 35 20·5 | 25 47 |
| | Yanisades Is., N pt., Paximada | 35 23 | 26 11·5 |
| | C. Sidero, lt. Rev. 138f. | 35 19 | 26 19·7 |
| | C. Salomon, or Plaka | 35 9·2 | 26 19·5 |
| | C. Zakro | 35 5·2 | 26 17·2 |
| | Kupho Nisi, S pt. | 34 54·7 | 26 8·7 |
| | Gaidaro Nisi, W pt. | 34 52·3 | 25 41·3 |
| | C. Littinos | 34 54·7 | 24 45 |
| | Mt. Ida, 8060f. | 35 13·3 | 24 47·0 |
| | Paximadia Is., W end, 1160f. | 35 0 | 24 35 |
| | Sphakia | 35 12 | 24 8·7 |
| | Gavdo I., ⚓ 5m., lt. Rev. 1181f. | 34 50 | 24 4 |
| | Gavdo Pulo, ⚓ 1½m., 440f. | 34 55·2 | 24 0·5 |
| | **KARAMANIA.** | | |
| *Karamania* | Marmorice, ⊞, Castle | 36 51·1 | 28 19·0 |
| | — Cape, lt. F 131f. | 36 43·9 | 28 20·7 |
| | Karaghatch, ⊞, watering place | 36 51·5 | 28 30·7 |
| | Linosa I., 327f., sum | 36 46·5 | 28 29·0 |
| | C. Suvelah | 36 35·2 | 28 54·0 |
| | Makry, ⊞, theatre | 36 38·1 | 29 9·7 |
| | Highest sum., 5980f. | 36 31·8 | 29 14·2 |
| | C. Seven Capes, W pt. T | 36 21 | 29 12 |
| | Volos I., T | 36 13 | 29 25 |
| | Port Vathy, ⊞, sarcophagus | 36 11·5 | 29 39 |
| | Port Sevedo, ⊞, tank | 36 10·3 | 29 41 |
| | C. Roxo, Hipsili I., T | 36 6 | 29 40 |
| | Kakava I., ⚓ 4m. ⊞. W pt. | 36 9·6 | 29 52 |
| | Phineka Prom. *h*, T, S pt. | 36 14·5 | 30 9 |
| | Khelidonia Is. NS 2m., S islet | 36 9·5 | 30 26·2 |
| | Grambousa I., ⚓ 1m., w′ NE part | 36 13·5 | 30 30 |
| | Yanar, volc. | 36 24 | 30 30 |
| | Mt. Takhtalu, 7800f. | 36 31·7 | 30 28 |
| | C. Avova, ⊥, w W-d. | 36 35·4 | 30 38 |
| | Adalia, ⊡, lt. F 131f. | 36 52·2 | 30 47 |
| | Esky Adalia, theatre, $w_o$, $b_o$ | 36 45·6 | 31 26 |
| | C. Karabournu | 36 38·0 | 31 43 |
| | Alaya, ⊡$_o$, SE pt. | 36 31·5 | 32 1 |
| | C. Anamour, ⊥ | 36 0·8 | 32 49 |
| | Chelindreh, ⊞, w | 36 9 | 33 22 |
| | C. Cavaliere, ⊥, S pt. (⚓ N-d.) | 36 7·5 | 33 43·7 |
| | Provençal I., ⚓ 2m., $w_o$ Castle, sum. | 36 11·1 | 33 48 |
| | Pt. Lissan al Kahbeh, *l*, shl. ⚓ off, lt. F 49f. | 36 14·3 | 33 59 |
| | Lamas Riv., T, w′ | 36 33·8 | 34 17·7 |
| | C. Karadash, lt. F 131f. | 36 32·4 | 35 21 |
| | Ayas, tower on I. | 36 46·1 | 35 48 |
| | **SYRIA.** | | |
| | Alexandretta, 2 lts. F 49f. | 36 35·5 | 36 9·7 |
| | Ras el Khanzir | 36 19·2 | 33 46 |
| | Antioch | 36 12 | 36 8 |
| | Ras el Bazit | 35 52 | 35 47·5 |
| | Ras Ibn Hani, lt. Fl. 45f. | 35 35·4 | 35 42·5 |
| | Latakiyah, ⊡, w, lt. F 49f. | 35 30·7 | 35 45·5 |
| | Ruad I., lt. Fl. 92f. | 34 51·7 | 35 51 |
| | Tripoli, Ramkine I., lt. F 67f. | 34 30 | 35 45 |
| | Ras Beirut, lt. Fl. 125f. | 33 54·2 | 35 28 |

## MARITIME POSITIONS

| | (37) Places | Lat. N | Lon. E |
|---|---|---|---|
| Syria ● | Damascus, Madinet-el-Arûs | 33°30′6 | 36°18′5 |
| | Mt. Hermon, sum. 9053f. | 33 25·5 | 35 51 |
| | Saida, Jesireh, 2 lts. F' 62f. | 33 34·5 | 35 21·5 |
| | Sur, 2 lts. F 56f. | 33 16·7 | 35 11·2 |
| | Acre, lt. F' 46f. | 32 55·5 | 35 4 |
| | C. Carmel Cont. lt. F, Fl. 490f. | 32 49·8 | 34 58 |
| | Jaffa, lt. Rev 69f. | 32 2·7 | 34 44 |
| | Jerusalem, Kubbet es Sakhrah, or Dome of the rock | 31 46·5 | 35 14·7 |
| | Ascalon, ruins | 31 39·0 | 34 32·7 |
| | El Arish, fort | 31 6·5 | 33 48·0 |
| | **CYPRUS.** | | |
| Cyprus | C. Arnaut | 35 6·8 | 32 16·2 |
| | C. Cormachiti | 35 24·7 | 32 55·7 |
| | Kyrenia, lt. F 68f. | 35 20 | 33 18·7 |
| | N and E extr., C. St. Andrea | 35 42·2 | 34 36·5 |
| | Famagousta, lt. F 49f. | 35 7·7 | 33 57·2 |
| | C. Grego | 34 56·5 | 34 6·5 |
| | Larnaca, lt. F 42f. | 34 55·2 | 33 37·7 |
| | C. Chiti, *l*, tow. | 34 49·9 | 33 36·2 |
| | Limasol, lt. F 25f. | 34 40·2 | 33 1·7 |
| | C. Gatto, *l* | 34 33·7 | 33 2 |
| | C. Bianco, *h* | 34 38·2 | 32 42·2 |
| | C. Papho | 34 44·8 | 32 23·7 |
| | **EGYPT.** | | |
| Egypt | Port Saïd, lt. Fl. 175f. | 31 15·7 | 32 19·2 |
| | Nile, Rosetta mouth | 31 30·5 | 30 19·5 |
| | — Damietta mouth, Kawa Burun | 31 33 | 31 52 |
| | Damietta, Engl. Cons. | 31 24 | 31 48 |
| | — lt. Rev. 180f. | 31 31 | 31 51 |
| | Cairo, tow. of Janissaries | 30 2·1 | 31 15·5 |
| | Great Pyramid, sum. (487f.) now 460f. | 29 58·6 | 31 7·5 |
| | Aboukir, B., Nelson I. | 31 21·4 | 30 6 |
| | Alexandria, ⊞, lt. R 180f. | 31 11·7 | 29 51·7 |
| | Arab's tower | 30 59·7 | 29 34·7 |
| | Ras al Kanais, pt. | 31 15·4 | 27 52 |
| | Marsa Mutroo, ⊞, w, Pt. Labeit | 31 22·9 | 27 15·5 |
| | Ishailah rks., E one, 58f. | 31 31·3 | 26 38·7 |
| | Ras Haleimah | 31 37·5 | 26 0 |
| | **TRIPOLI.** | | |
| Tripoli | Ras al Milhr | 31 53·2 | 25 5·7 |
| | Tebruk, ⊞, Saracen gate | 32 5 | 23 59·2 |
| | Bomba, or Bhurdah I. | 32 22·6 | 23 13·7 |
| | Ras al Tyn, sum. | 32 37·7 | 23 7·8 |
| | Dernah, lt Rev. 92f. | 32 46·0 | 22 46 |
| | Pt. Zawani (Ras al Hilil) | 32 57 | 22 8 |
| | Marsa Sousa, ⊞, Arsenal | 32 54·9 | 21 56·5 |
| | Ras Sem | 32 57 | 21 42·2 |
| | Tolmeitah, pt. of the Kothon | 32 43·1 | 20 53·2 |
| | Benghazi, lt. Rev. 72f. | 32 6·8 | 20 2·7 |
| | Gharah I. | 30 47·5 | 19 54 |
| | Marsa Boureigah, ruin | 30 25 | 19 35·5 |
| | Bouskeifa I. | 30 17·5 | 19 9 |
| | Ras Ben Gahouah, ruin | 30 46·3 | 18 14 |
| | Marsa Zafran, Port Chebek | 31 12·6 | 16 36 |
| | C. Misratah, Ras Torug, lt. Fl. 138f. | 32 22·4 | 15 13·2 |
| | Marsa Ougrah, Ras al Tabiah | 32 33·5 | 14 26·2 |

| | (38) Places | Lat. N | Lon. E |
|---|---|---|---|
| | Lebida, Citadel | 32°38′7 | 14°16′5 |
| | Ras al Tajourah, E pt. | 32 53·5 | 13 23·2 |
| | Tripoli, ⊞, lt. R 115f. | 32 54·4 | 13 11·2 |
| | Port Zouaga | 32 48·5 | 12 27·7 |
| | Zoarah | 32 55 | 12 4 |
| | **TUNIS.** | | |
| Tunis ⊕ | Al Biban bank, Zera spit | 33 26·5 | 11 20 |
| | Jerba I., Houmt-souk, lt. F | 33 53·5 | 10 51 |
| | Kabes Dzara pier | 33 54 | 10 7 |
| | Surkenis B. Nathor Tr. | 34 14·2 | 10 3·5 |
| | Jebel Thelj, NE sum | 34 25 | 9 52 |
| | Sphax, lt. F 38f. | 34 44 | 10 46·2 |
| | Kerkenah Is., [illegible], 9l., *l*, Ras Sinub | 34 36·7 | 11 3·2 |
| | — NE extr., Gzira Kebir | 34 49 | 11 18·5 |
| | — Banks Eastern buoy lt. | 34 51·5 | 11 45 |
| | Kadijah, tower, 50f. | 35 14 | 11 10 |
| | Mehediah, Castle | 35 30·4 | 11 5 |
| | Kuriat Is., lt. F 98f. | 35 48·5 | 11 3 |
| | Monastir, fort Ghadir | 35 45·4 | 10 50·7 |
| | Soussa, lt. F | 35 49 | 10 39 |
| | Jebel Zaghwan, 4078f. | 36 21·5 | 10 7·2 |
| | Hammamet Castle | 36 23·3 | 10 37·2 |
| | Ras Mahmur | 36 27·5 | 10 49 |
| | Kalibia, lt. F 269f. | 36 49·7 | 11 8 |
| | Ras al Asuad (*blk.* Hd.) | 36 58 | 11 7 |
| | C. Bon. 1290f., lt. Int. 412f. | 37 5 | 11 2·7 |
| | Zembra, [illegible], 2½m. sum. 1324f. | 37 7·4 | 10 48·5 |
| | Jebel Irsas, 2536f. | 36 36 | 10 20·5 |
| | Tunis, Goleta, ◫, lt. F 39f. | 36 48·5 | 10 18·2 |
| | C. Carthage, lt. R 482f. | 36 52·4 | 10 21·5 |
| | Piana I., EW 1m., lt. F 65f. | 37 10·8 | 10 20·2 |
| | Cani, rks. [illegible] 2m. lt. F 129f. | 37 21·2 | 10 8·0 |
| | Benzert, fort, lt. F 46f. | 37 17 | 9 53 |
| | C. Il Guerra | 37 19·9 | 9 52·2 |
| | Fratelli, rks. [illegible], West Rock | 37 17·9 | 9 24·2 |
| | Galita I., [illegible] 3m. pk. Monte Guardia, 1240f. | 37 31·3 | 8 56·2 |
| | Sorelle, rks., Avenger reef | 37 23·7 | 8 37·5 |
| | **ALGIERS.** | | |
| Algiers ⊕ | Tabarca, N tow | 36 58·0 | 8 45·5 |
| | La Cala, ◫, lt. F 55f. | 36 54·0 | 8 27·5 |
| | Bona, North jetty Pt., lt. F 63f. | 36 54·5 | 7 47 |
| | C. de Garde, lt. F, Fl. 469f. | 36 58·0 | 7 48·5 |
| | Ferro I | 37 5 | 7 20 |
| | Ras Hadid, or C. de Fer, lt. Rev. 218f. | 37 5·1 | 7 11 |
| | Philippeville, 2 lts. F | 36 52·8 | 6 53·0 |
| | Srigina I., lt. F 180f. | 36 56·3 | 6 53 |
| | Collo, lt., F 33f. | 37 1 | 6 36·5 |
| | C. Bugaroni, (Peak 3579f.), lt. F 564f. on cape | 37 5 | 6 29 |
| | Marsa Zeitoun | 36 57 | 6 14 |
| | Jidjelli, 2 lts. F | 36 50·0 | 5 44·7 |
| | Mt. Babor, 6200f. | 36 32·5 | 5 27 |
| | Bougie, pier end, lt. F 23f. | 36 44·5 | 5 4·2 |
| | C. Carbon, lt. R 722f. | 36 46 | 5 6·3 |
| | Pisan, rks, [illegible] 1m., w., W pt. | 36 49·8 | 4 59·5 |
| | Mt. Azafoun, 4360f. | 36 50 | 4 25 |
| | C. Bengut, lt. F 208f. | 36 55 | 3 53·2 |
| | C. Tedlès | 36 55 | 4 9 |
| | Dellys, pier, lt. F 33f. | 36 55·5 | 3 55 |
| | C. Matifou, lt. Fl. 242f. | 36 48·9 | 3 14 |

## MARITIME POSITIONS

| (39) | Places | Lat. N | Lon. |
|---|---|---|---|
| | | | East |
| Algiers ⊕ | Algiers, Marine I., lt. R 115f.... | 36°47'·3 | 3° 3' |
| Algiers ⊕ | — OBSERVATORY ............. | 36 47·8 | 3 2·2 |
| Algiers ⊕ | C. Caxine, lt. Rev. 210f. ...... | 36 49 | 2 56·5 |
| Algiers ⊕ | Sherschel, ⊡, fort lt., F 121f. | 36 36·8 | 2 11 |
| Algiers ⊕ | C. Tenez, lt. R 292f. ............ | 36 31 | 1 18 |
| Algiers ⊕ | Palomos I., rk. ⌒, 85f. ........ | 36 26·3 | 0 55·7 |
| Algiers ⊕ | Mostaghanem, lt. F 115f. ...... | 35 56·3 | 0 4·5 |
| | | | West |
| Algiers ⊕ | Arzeu I., lt. F 66f. ................ | 35 52·5 | 0 17·7 |
| Algiers ⊕ | C. Ferrat, ⊥, *h*, lesser sum. ... | 35 54·3 | 0 23·5 |
| Algiers ⊕ | Pt. Abuja, 2050f., pt.............. | 35 53 | 0 29 |
| Algiers ⊕ | Oran Marsa el Kebir, lt. F 121f. .......................... | 35 44·3 | 0 41·7 |
| Algiers ⊕ | C. Falcon, *l*, 8, lt. Rev. 340f.... | 35 46·4 | 0 47·2 |
| Algiers ⊕ | Habibas Is., ✣ 3m. w, sum. lt. F 340f. .................. | 35 43 | 1 8 |
| | **MOROCCO.** | | |
| Morocco | Zafarine Is., EW 1¼ m. W ext. sum. 441f., lt. F ...... | 35 11·0 | 2 25·7 |
| Morocco | Melilla, ⊡ .......................... | 35 18·3 | 2 57·0 |
| Morocco | C. Tres Forcas, N pt. mid...... | 35 27 | 2 59 |
| Morocco | Alboran I., ✣ 1m., lt. F 115f. | 35 58 | 3 2 |
| Morocco | C. Quillates......................... | 35 16·5 | 3 45·5 |
| Morocco | Mostaza .............................. | 35 9·7 | 4 26·5 |
| Morocco | Tetuan, Custom-ho. ............ | 35 37 | 5 18 |
| Morocco | Centa, lt. R 590f................... | 35 53·6 | 5 17 |
| Morocco | Tangier, Battery, lt. F 58f...... | 35 47·2 | 5 48·2 |
| | **ATLANTIC OCEAN.** | | |
| | **Madeiras.** | | |
| Madeiras | Porto Santo. ✣ 7m., 1660f. | 33 5·0 | 16 19·5 |
| Madeiras | Styx, rks. NW of P. Santo, 12 | 33 11 | 16 24 |
| Madeiras | Desertas, ✤ 12m. sum. 1610f. | 32 31·3 | 10 30·7 |
| Madeiras | — S. or Agulha pt. ............ | 32 23 | 16 27 |
| Madeiras | Madeira, EW. 30m., E pt., lt. F, Fl. 343f................ | 32 43·4 | 16 39·5 |
| Madeiras | FUNCHAL, BRIT. CONS. ⊡...... | 32 38·3 | 16 54·5 |
| Madeiras | —PONTINHA, lt. F 112f.......... | 32 37·7 | 16 55 |
| Madeiras | Pico Ruivo, 6100f................ | 32 45·0 | 16 57·0 |
| Madeiras | West, or Pargo pt................ | 32 48 | 17 17 |
| Madeiras | Salvages, 2 grps., ✣ 15m. NE breaker................. | 30 8·6 | 15 49·7 |
| Madeiras | Great Salvage, ✤ 1¼m., W sum. | 30 7·5 | 15 51·2 |
| Madeiras | Great Piton, ✣ 3m., sum....... | 30 1·0 | 16 0·2 |
| | **Canaries.** | | |
| Canaries | Alegranza, ✣ 2½m., 939f., Pt. Delgado, lt. R 57f. ... | 29 24 | 13 29 |
| Canaries | Clara, ✣ 1m., N pt. ............ | 29 18·0 | 13 32·2 |
| Canaries | Graciosa, ✣ 5m. w, SW pt.... | 29 12·7 | 13 32·7 |
| Canaries | East rock, [3c.] ................. | 29 16·4 | 13 20·0 |
| Canaries | Lanzarote, ✣ 32m., NW pt.... | 29 2·7 | 13 48·0 |
| Canaries | — S pt. ............................ | 28 50·0 | 13 47·0 |
| Canaries | — Arecife, (Port Naos, ⊡, fort Gabriel, 2 lts. F 47 & 35f. ...................... | 28 57·0 | 13 32·5 |
| Canaries | Lobos I., ✣ 2m., N pt., lt. F 95f. ........................ | 28 45·5 | 13 48·5 |
| Canaries | Fuerteventura, ✣ 53m., NW pt. | 28 42 | 14 1 |
| Canaries | — Port Cabras ................. | 28 29 | 13 51·7 |
| Canaries | — S pt. or Pt. Jandia, *l*, lt. Rev. 108f. .................. | 28 3·0 | 14 32 |

| (40) | Places | Lat. N | Lon. W |
|---|---|---|---|
| Canaries | Grand Canary, NS 25m., NW pt........................ | 28° 9'·6 | 15°43'·2 |
| Canaries | — Palmas, mole head, lt. F 25f. | 28 7·0 | 15 25 |
| Canaries | — Maspalomas pt., lt. F 190f. | 27 43·8 | 15 34 |
| Canaries | — Isleta, ✣ 2m., lt. F, Fl. 817f. | 28 11·0 | 15 25·5 |
| Canaries | Tenerife I., N pt., Anaga rk.... | 28 36·6 | 16 8·5 |
| Canaries | — Sta. Cruz, Brit. Consul. w''' | 28 28·2 | 16 14·7 |
| Canaries | — S pt. or Pt. Rasca........... | 28 0·0 | 16 41·2 |
| Canaries | — Peak, 12,172f. .............. | 28 16·5 | 16 39·0 |
| Canaries | — W extr., *l* ..................... | 28 20·5 | 16 55 |
| Canaries | — Orotava, port................. | 28 25·2 | 16 32·0 |
| Canaries | Gomera, EW 14m., W pt...... | 28 6·5 | 17 20·5 |
| Canaries | — Sum. 1440f. ................... | 28 6·7 | 17 13·5 |
| Canaries | Lierro, or Ferro, ✣ 15m. N extr............................ | 27 50·5 | 17 55 |
| Canaries | — W extr., Orchilla pt. (or *Meridian of Ferro*) ...... | 27 42·5 | 18 10 |
| Canaries | Palma, Cumplida Pt., lt. R 207f. | 28 50 | 17 47 |
| Canaries | — S pt. or Fuencaliente......... | 28 26·7 | 17 49·7 |
| Canaries | — Sta. Cruz, fort San Miguel | 28 40·5 | 17 44·5 |
| | **Azores.** | | |
| Azores | Corvo, ✣ 4m., ⚓, N pt.......... | 39 43·5 | 31 7·2 |
| Azores | Flores, NS 9m., N extr......... | 39 31·6 | 31 13·0 |
| Azores | — Sta. Cruz, fort ............... | 39 27·0 | 31 8·0 |
| Azores | Fayal, ✤ 11m., W pt. ......... | 38 35·6 | 28 50·5 |
| Azores | — Horta, Sta. Cruz, castle, lt. F 28f. ....................... | 38 31·7 | 28 38·5 |
| Azores | Pico. ✤ 25m., Pk. 8400f. ? ... | 38 28·0 | 28 25·0 |
| Azores | — E pt. ............................ | 38 24·7 | 28 3·0 |
| Azores | St. George, ✤ 29m., S and E pt............................ | 38 32·5 | 27 46·7 |
| Azores | — N and W pt. outer rk. ...... | 38 45·2 | 28 20·2 |
| Azores | Graciosa, ✤ 7m., W. pt. ...... | 39 4·2 | 28 4·7 |
| Azores | — Praya, castle .................. | 39 3·2 | 27 58·5 |
| Azores | Tercera, EW 16m. Praya ...... | 38 43·7 | 27 4·2 |
| Azores | — Angra, Custom ho............ | 38 38·9 | 27 13·7 |
| Azores | — Sum. 3495f. .................. | 38 43·5 | 27 20·5 |
| Azores | St. Miguel, r, E or Arnel pt., F, Fl, 219f. ........... | 37 49 | 25 8·2 |
| Azores | — Delgada, lt. F 20f., Custom-ho. quay ........... | 37 44·2 | 25 40·7 |
| Azores | — West pt. or Pt. Ferraria, lt. bad ......................... | 37 51·7 | 25 52·2 |
| Azores | St. Mary I., ✤ 9m., town ...... | 36 56·6 | 25 9·5 |
| Azores | — mid., sum. 1660f. ........... | 36 58·5 | 25 6·2 |
| Azores | Formigas, NS ¾m., 60f.......... | 37 16·2 | 24 47·5 |
| Azores | Dollabarats shl. [1c.], 11f. 8 ... | 37 13·7 | 24 44·5 |
| | **Cape Verdes.** | | |
| Cape Verde Islands | St. Antonio, ✣ 22m. N pt., lt. F 23f. ...................... | 17 12·0 | 25 5·7 |
| Cape Verde Islands | — West pt........................ | 17 4·0 | 25 22·5 |
| Cape Verde Islands | — Sum. 7400f. ................. | 17 4 | 25 17 |
| Cape Verde Islands | — Tarafal B. wat. place ...... | 16 57·2 | 25 19·0 |
| Cape Verde Islands | — South pt. ................. ... | 16 54·7 | 25 18·5 |
| Cape Verde Islands | — NE, Bull pt., lt. F, Fl. 543f. | 17 7 | 24 59·0 |
| Cape Verde Islands | St. Vincent, EW 16m., S pt.... | 16 47·0 | 24 59·0 |
| Cape Verde Islands | — PORTO GRANDE, ⊡, Bird I., lt. F 306f................ | 16 54·7 | 25 0·7 |
| Cape Verde Islands | — FLAGSTAFF OF TELEGRAPH OFFICE ......... | 16 53·3 | 24 59·5 |
| Cape Verde Islands | St. Lucia, ✤ 7m., N pt.......... | 16 49·0 | 24 47·0 |
| Cape Verde Islands | — Village, ruins, SW side, w. | 16 45·0 | 24 45·5 |
| Cape Verde Islands | Branca, ✤ 3m., N pt............ | 16 41·0 | 24 41·5 |

## MARITIME POSITIONS

| | (41) Places | Lat. N | Lon. W |
|---|---|---|---|
| *Cape Verde Islands* | Raza, l, T, EW 2m., mid. | 16°38′ | 24°37′ |
| | St. Nicolas, ⚓ 25m., N pt | 16 42·0 | 24 20·5 |
| | — East pt. | 16 34·5 | 24 0 |
| | — South pt. | 16 28 | 24 18·5 |
| | — West pt. | 16 37·7 | 24 26·2 |
| | Sal, NS 17m., N pt. | 16 51·0 | 22 55·0 |
| | — NW hill | 16 48·0 | 22 5[illegible]·5 |
| | — Martinez Pk, 1340f. | 16 49 | 22 56 |
| | — Wreck, or SE pt. | 16 35·0 | 22 53·5 |
| | — South pt. | 16 34 | 22 57 |
| | Bonavista, EW 18m., N rf. and pt. | 16 14 | 22 57 |
| | — Hartwell rf., 8, NE pt | 16 11 | 22 41 |
| | — East extr. or Sandhead, outer rk. | 16 7 | 22 40 |
| | — South pt. (rks.) | 15 57·0 | 22 49·5 |
| | — English road, Small I., lt. F 91f. | 16 9 | 22 57 |
| | — New town, ch. | 16 7·6 | 22 55·5 |
| | Leton rks., [1m.], 8, | 15 48 | 23 10 |
| | Mayo, NS 12m., N rf., N and E pt. | 15 20 | 23 11 |
| | — North pt. | 15 19·0 | 23 12·0 |
| | — South pt. | 15 6·5 | 23 10·5 |
| | — English town, Fort San Jose, lt. F 62f. | 15 7 | 23 13·2 |
| | St. Jago, ⚓ 31m., E pt. | 15 1 | 23 26 |
| | — Port Praya, Temerosa pt., lt. F 85f. | 14 53·0 | 23 30·7 |
| | — Mt. St. Antonio, 7400f. ? | 15 2 | 23 39 |
| | — West pt., extr. | 15 17·3 | 23 48 |
| | — North, or Bighude pt. | 15 19·0 | 23 46·0 |
| | Fogo, EW 15m., N pt. | 15 1·5 | 24 21·5 |
| | — Fort Carlotta, lt. F 116f. | 14 52·0 | 24 30·5 |
| | — Peak, 9760f. | 14 56 | 24 20 |
| | Brava, NS 6m., W pt. | 14 49·7 | 24 45·2 |
| | — South pt. | 14 46 | 24 42·7 |
| | — Two Islets, EW 5m., W extr. | 14 57 | 24 43 |
| | **BERMUDAS.** | | |
| *Bermudas* | Mount hill, lt. F 208f. | 32 21·7 | 64 38·7 |
| | North rk. | 32 28·4 | 64 47·7 |
| | West extr. of reefs | 32 16 | 65 3 |
| | South extr. of reefs | 32 12 | 64 52 |
| | Dockyard, clock ⊕ | 32 19·4 | 64 51·5 |
| | Wreck hill | 32 16·7 | 64 54·7 |
| | Gibbs Hill, lt. Rev. 362f. | 32 15 | 64 51·5 |
| | Region of Submarine Volcanoes | 7 0N to 1 0S | 16 0 to 24 0 |
| | Penedo de San Pedro, or St. Paul's rks., [¼m.], mid. rk., 60f. | 0 55·5 | 29 22·5 |
| | **AFRICA, N.W. Coast.** | | |
| | C. Spartel, lt. F 312f. | 35 47·2 | 5 55·7 |
| | Mt. Habile, 3000f. | 35 28 | 5 43 |
| | Araish, w | 35 12·8 | 6 9 |
| | Jebel Sarsar, or pk. of Fas | 34 54 | 5 47 |
| | Mehedia, 456f. | 34 18 | 6 36 |
| | Sallee, | 34 2·7 | 6 46 |
| | C. Dar el Beida | 33 38 | 7 36 |
| | Azamor, 120f T | 33 18 | 8 15 |

| | (42) Places | Lat. N | Lon. W |
|---|---|---|---|
| *Africa, North-West Coast* | Mazagan, w, r | 33°15′ | 8°29′ |
| | North C. Blanco, 170f. | 33 8 | 8 38 |
| | C. Cantin, ⊥, 211f. (rks. off) | 32 32·5 | 9 21 |
| | Safi, Mosque, 209f., | 32 18 | 9 12 |
| | Jebel Hadid, SW sum. 2100f., tomb | 31 42 | 9 29 |
| | Mogador, or Souirah, , w r | 31 30·5 | 9 46·2 |
| | C. Tefelneh, 700f. pt. | 31 6 | 9 48 |
| | C. Ghir, ⊥, 1235f. pt. | 30 38 | 9 50 |
| | Mt. sum. E of C. Ghir, 4400f. | 30 39 | 9 33 |
| | Sta. Cruz, or Agadir, F | 30 26 | 9 32 |
| | R. Sous, bar | 30 22 | 9 30 |
| | Macas, or Messa R., Castle | 30 4 | 9 38 |
| | Cleaveland Shl. ? | 30 45 | 10 21 |
| | Fogo Pk., 2970f. | 29 11 | 10 6 |
| | C. Noun, ⊥, T, 170f. ○ | 28 46 | 11 3 |
| | R. Noun, or Soleiman ? | 28 42 | 11 5 |
| | Port Cansado, β, entr. | 28 2 | 12 14 |
| | C. Juby, l, [ ] | 27 58 | 12 52 |
| | False C. Bojador | 26 25 | 14 12 |
| | C. Bojador, l, W pt. | 26 7·0 | 14 29 |
| | Penha Grande, 300f. | 25 7 | 14 50 |
| | C. Seven Capes, Central C. | 24 41 | 15 0 |
| | Durnford Pt., entr. R. Ouro, | 23 36·0 | 15 58·0 |
| | Down of Cintra, or peaked sand hill, w | 23 5 | 16 10 |
| | C. Barbas, ⊥ | 22 19·5 | 16 45 |
| | C. Blanco, ⊥, 150f., (w N-d.) (8 SW-d. 5m.) | 20 46·5 | 17 4 |
| | Arguin bk. (lim. of 8, s), N extr. | 20 33 | 16 56 |
| | — West extr. | 20 6 | 17 7 |
| | — South extr. | 19 17 | 16 32 |
| | C. Mirik, l, 8 2 or 3 l. off | 19 24 | 16 32 |
| | Portendik, w, P. 2 near | 18 19 | 16 2 |
| | Mosquito Lagoon ⊖ | 16 35 | 16 30 |
| | Barbarie Pt. | 16 55 | 16 34 |
| *Senegambia* | Senegal, , St. Louis, (bar, 8), fort fl. st., and lt. F | 16 0·8 | 16 31·0 |
| | C. Verde, C. Almadie, lt. F 85f. | 14 44·5 | 17 32·7 |
| | — Paps, lt. R 371f. | 14 43 | 17 31 |
| | C. Manuel, lt. F 171f. | 14 38·6 | 17 27 |
| | Goree I., ⚓ 4c, , fl. st., fort | 14 39·9 | 17 24·5 |
| | Amboroo bk., W pt., | 14 16 | 17 3 |
| | Bird I., 2m., Pilots, fl. st. | 13 39·5 | 16 40·5 |
| | R. Gambia, , , Bath. fl. st. | 13 28·0 | 16 35·0 |
| | C. St. Mary, l | 13 30 | 16 41 |
| | Bald Cape (Is. 4m. W-d.) | 13 23 | 16 50 |
| | Casamanza R., lt. F 52f. | 12 35·5 | 16 44 |
| | C. Roxo, l, Sand hill, | 12 20 | 16 46 |
| | Falulo breakers, ⚓ 3m., T, W pt. | 12 10 | 16 44 |
| | Fort Cacheo, Portug. Settlem. | 12 17·7 | 16 13 |
| | Cayo Is., l, T, , S pt. | 11 50 | 16 22 |
| | Bissao, , w, r | 11 52 | 15 37 |
| | Bijouga Is. P., W extr. breaker 30m., out. | 11 30 | 16 58 |
| | — South breaker | 10 40 | 16 8 |
| | Pullam I. [1m.], l, , (rfs., SW 8m.) | 10 52 | 15 43 |
| | Alcatraz reefs, 7m., NE Id. | 10 37 | 15 21 |
| | Conflict rfs., S and E prong | 10 22 | 15 4 |
| | Rocky Head, | 10 6 | 15 6 |
| | Rio Nunez, w, P., Sandy I. | 10 36·6 | 14 42 |
| | C. Verga, pt. l | 10 12 | 14 28 |
| | Mt. Kakulimah, 2900f. | 9 45·8 | 13 28 |

## MARITIME POSITIONS

| | (43) Places | Lat. N | Lon. |
|---|---|---|---|
| | | | West |
| | Is. de Los. EW 6m, w', r, Crawford Id.. Engl. Estab. | 9°27'4 | 13°48'5 |
| | — W one, Tamara I., 8 l. T, ‡' E, W pt. | 9 28 | 13 52 |
| | Sallahtook Pt. | 9 4 | 13 20 |
| | Yellaboi I., EW 2m., ✦, W cliff | 8 57·0 | 13 15·5 |
| | C. Sierra Leone, lt. F, Fl. 75f. [h]. | 8 30·0 | 13 18·5 |
| | Freetown, N battery | 8 29·9 | 13 14·5 |
| | False C. Sierr. L. | 8 26 | 13 18 |
| | C. Shilling, l, ✦, sum over ... | 8 10 | 13 10 |
| *Sierra Leone* | Bananas Is., ⚓ 5m., ✦, Gov. ho. | 8 8·0 | 13 11·7 |
| | Plaintain Is., EW 5m., outer rk. | 7 54 | 13 3 |
| | Shls of St. Ann, NW patch: s, 5 | 7 58 | 13 34 |
| | Turtle Is., l, N Id., [½m.] | 7 40 | 13 4 |
| | Sherboro I., W pt., or C. St. Ann, ✦ | 7 34 | 12 58 |
| | R. Shebar, E entr., or Mana Pt. | 7 23 | 12 31 |
| | R. Gallinas, Kamasoun I. [1m.], W elbow | 7 0·1 | 11 38·7 |
| | C. Mount Riv., town | 6 45 | 11 23 |
| | C. Mount, w, pk., 1060f. | 6 43 | 11 21 |
| | C. Mesurado, 8 l. ✦, w, lt. F 240f. | 6 19 | 10 50 |
| | Monrovia. Govt. ho. | 6 19·1 | 10 49·0 |
| *Liberia* | Marshall. Agent's ho. | 6 8·1 | 10 22·7 |
| | Grand Bassa, Amer. Agent's ho. | 5 54·1 | 10 4·0 |
| | Tabocannee rk. | 5 48 | 10 1 |
| | Trade Town | 5 44 | 9 54 |
| | Mt. Tobacco, 830f. | 5 47 | 9 44 |
| | Cestos, factory | 5 26·4 | 9 34·7 |
| | R. Sanguin, r, b, Pt. Sanguin | 5 12·7 | 9 20·2 |
| *Grain Coast* | Bloobarra pt. | 4 59·2 | 9 2·0 |
| | Settra Kroo | 4 54 | 8 50 |
| | King William Town, Europ. factories | 4 49 | 8 43 |
| | Coley rk 1 | 4 23 | 7 54 |
| | **Gulf of Guinea.** | | |
| | C. Palmas, lt. F | 4 22·1 | 7 44·2 |
| | Tafou pt. | 4 24·8 | 7 21·5 |
| | Kadahboo bluff | 4 39 | 6 54 |
| *Ivory Coast* | Oval Mountain, 1315f | 4 57 | 6 48 |
| | King George Town | 4 58 | 6 3 |
| | C. Lahou | 5 11 | 4 31 |
| | Head of the Bottomless Pit, 100 | 5 15 | 3 57 |
| | Assini R., entr. bar, 11f. | 5 8·6 | 3 23 |
| | Apollonia (abandoned) | 4 59 | 2 35 |
| | Axim, Dutch fort | 4 52·3 | 2 14·7 |
| | C. Three Pts., $\delta_0$ 2m., lt. F 75f. | 4 44·7 | 2 5·7 |
| | Dix Cove, f, fort | 4 47·8 | 1 56·7 |
| | Elmina, Dutch fort | 5 4·8 | 1 22·2 |
| | C. Coast Castle. lt. F on Fort William, 192f. | 5 6 | 1 13·7 |
| | Accra, Fort James, ⊥₀, lt. F 50f. | 5 31·8 | 0 11·5 |
| *Gold Coast* | Camel's Hump, 1200f. | 5 37 | 0 31 |
| | | | East |
| | R. Volta, W pt., l, entr. | 5 46·0 | 0 41·2 |
| | C. St. Paul, l (no distinct cape), ✦ | 5 50 | 0 58 |
| | Jella Coffee | 5 52 | 1 0 |
| | Quitta Danish, r, SE bast. | 5 55·1 | 0 59·7 |
| | Little Popo, ✦, ⊥ NW shed... | 6 13·6 | 1 36·2 |
| | Grt. Popo (bar. ⚓) | 6 16 | 1 54 |
| | Whydah, fl. st. | 6 18·9 | 2 5·0 |

| | (44) Places | Lat. | Lon. |
|---|---|---|---|
| | | North | East |
| | Porto Novo (no port) | 6°23' | 2°35' |
| | Badagry, shore hut | 6 24·2 | 2 53·2 |
| *Bight of Benin* | Lagos, entr. [½m.] bar 8 f., lt. F 70f. | 6 24 | 3 27 |
| | Oddy Sand beach | 6 20 | 4 31·7 |
| | R. Benin, bar 12f. NW pt. | 5 46·0 | 5 4 |
| | R. Forcados, entr. S pt. | 5 22·0 | 5 19·2 |
| | R. Quorra, or Niger, E pt. | 4 17 | 6 4 |
| | C. Formosa, l, ✦ (no distinct cape) | 4 15 | 6 11 |
| | New Calebar R., entr. 18f., W pt. | 4 23 | 7 1 |
| | Bonny R., entr. 18f., E pt., T, r, rough corner | 4 23 | 7 8 |
| | Old Calebar, Tom Shot's Pt. | 4 36 | 8 19 |
| | Mt. Cameroons, 13760f. | 4 13 | 9 12 |
| | Cape Cameroons | 3 55 | 9 30 |
| | Rumby Mountains, sum. | 4 57 | 9 18 |
| | Qua Mount., 25 l. | 5 15 | 8 51 |
| *Bight of Biafra* | Ambas B., Mondoleh I. [⅓m.] h. ✦, w, S pt. | 3 58·7 | 9 12·5 |
| | Suellaba pt. (rf. 3m. off) | 3 51 | 9 35 |
| | The Mitre, 3940f., S sum. | 1 20 | 9 57 |
| | C. St. John, ✦ | 1 9·7 | 9 22 |
| | Corisco I, l, ✦ | 0 55·9 | 9 20 |
| | C. Esteiras | 0 38 | 9 21 |
| | Gaboon R., r w, Libreville, lt. F | 0 23 | 9 26 |
| | King George Town | 0 8 | 9 44 |
| | Fernando Po, ⚓ 40m. $\delta_0$ 3m. C. Bullen, or N pt. | 3 48 | 8 43 |
| | — Peak, 10710f. | 3 35 | 8 47 |
| | — S. pt., or C. Barrow | 3 13 | 8 43 |
| | — Clarence Cove, w', b, Adelaide islet [h], lt. F | 3 46·0 | 8 47·5 |
| | Princes I., NS 9m. N rk. off | 1 43 | 7 23 |
| | — St. Antonio B., fort Sta. Anna | 1 39·5 | 7 26·5 |
| | Brothers, 2 Is., NS 2½m.. S one | 1 21·1 | 7 17·5 |
| | St. Thomas I., ⚓ 25m. sum. 7020f. | 0 14·7 | 6 33 |
| *Islands in the Bight of Biafra* | — Sta. Anna de Chaves, fort St. Sebast., lt. F 35f. | 0 20·5 | 6 43 |
| | | South | |
| | — Ilha das Rollas [1m.] off S. pt. | 0 0·5 | 6 30 |
| | Annobona, ⚓ 4m., $\delta_0$ ... Turtle I., [1m.], ✦, w, r | 1 24·3 | 5 38·2 |
| | — S extr., rk. off | 1 28·6 | 5 36·7 |
| | **ISLANDS IN SOUTH ATLANTIC.** | | West |
| | Ascension, EW 7½m., Fort Thornton, lt. F, [h] | 7 55 | 14 25 |
| | — Green Mtn., 2820f. | 7 57 | 14 21 |
| | — Cross Hill, 850f. on with Gr. Mt., S 71° E | 7 55·7 | 14 25·0 |
| | St. Helena, ⚓ 9m., Diana's pk. 2700f. | 15 57 | 5 40·5 |
| | — OBSERVATORY, ✦ 1h G.M.T. | 15 55·4 | 5 42·5 |
| | Fernando Noronha, Is., ⚓ 6m., S and W. extr. pt. | 3 52 | 32 28 |
| | — peak, on SE side | 3 50·4 | 32 25·5 |
| | Rocas [4m.], rf. NW end | 3 51·5 | 33 49 |

## MARITIME POSITIONS

| (45) Places | Lat. S | Lon. |
|---|---|---|
| | | West |
| Trinidad I., ✱ 4m., 2020f. S. pt. | 20° 31′ | 29° 19′ |
| Martin Vas. 3 Is., NS 1½m. ... | 20 28 | 28 51 |
| Tristan d'Acunha, [6m.] Waterfall, N side ......... | 37 2·7 | 12 18·5 |
| Inaccessible Is., 16 L., ⌒, ⌊, w, W one .................. | 37 17 | 12 36 |
| Nightingale I. [2m.] ............ | 37 27 | 12 29 |
| Gough's I. [5m.], 4385f., N pt. ..................... ⊖ | 40 19 | 9 44 |
| **AFRICA, West Coast.** | | |
| | | East |
| Nazareth R., Fetish town, W entr. ............................ | 0 37 | 9 1 |
| C. Lopez, *l*, ⊤, ᶠ ................... | 0 36·0 | 8 43 |
| C. St. Catherine, [♆] ........ | 1 51 | 9 6 |
| Settee R., a high ♆ ............ | 2 23 | 9 26 |
| Mayumba B., ᶠ, Matooti Pt.... | 3 22·7 | 10 38 |
| Loango R., entr. ...................... | 4 39·5 | 11 45 |
| Black Pt., B., [♆], w‴. Sandy Pt., *l* ..................... ⊖ | 4 49 | 11 46 |
| Lendana Pt., lt. F 111f. ........ | 5 11 | 12 8 |
| Kabenda Pt., lt. F 50f. .......... | 5 32 | 12 11 |
| Congo R., P., Pt. Padron ...... | 6 8 | 12 13 |
| — S. entr., or Shark's Pt, ⊤, ȣ₀ 2c. ................................ | 6 4·6 | 12 17 |
| Foreland bluff, lt. F 78f. ...... | 7 15 | 12 53 |
| Ambriz, ‡,,, lt. F .................. | 7 52 | 13 8 |
| Dandé Pt. and riv. ............. | 8 28 | 13 19 |
| C. Lagostas, rks., lt. F, Fl. 210f. | 8 46·1 | 13 17·5 |
| St. Paul de Loando, ⊞, 🄱. fl. st. 🄱 .............................. | 8 48·3 | 13 13 |
| Palmairinhas Pt., lt. F, Fl. 57f. | 9 4 | 13 0 |
| C. Ledo, *h*, ♆, pt. ................ | 9 46 | 13 17 |
| C. St. Bras, ◫, ᶠ. .................... | 10 1 | 13 22 |
| Nova Redonda, r, w₀ ⌊, ...... | 11 12 | 13 54 |
| Quicombo B., β 1m. out, w., S pt. ........................... ⊖ | 11 20 | 13 48 |
| St. Philip de Benguela, ᶠ, w., St. Philip's Bonnet, lt. F 394f. ................................ | 12 33·9 | 13 18 |
| Logito R., w‴ r ...................... | 11 58·5 | 13 46 |
| Lobito, ⊞, ᶠ, ww₀, pt. .......... | 12 20 | 13 32 |
| Salinas Pt., *l*, ♆ at pt., lt. F, ⊖ | 12 53 | 12 59 |
| Elephant B., ⊞, Pᶠ ww₀, Monks, or Friars, rks. 12 or 14f. ................... ⊖ | 13 14 | 12 42·7 |
| C. St. Mary, ⊤, w₀ ......... ⊖ | 13 25 | 12 33 |
| Little Fish B., Ponta do Giraul, lt. F 64f. .............. | 15 9 | 12 12 |
| C. Negro, 200f., *l* pt., Diaz's Pillar ............................ | 15 40·7 | 11 58 |
| Port Alexander, ⊞. ᶠ ♆ ...... | 15 46 | 12 0 |
| Great Fish B., w, P′, Tiger Pt., ⊤, ȣ₀ 2c. ......................... | 16 30·2 | 11 46 |
| Nourse R. (temporary) ...... ○ | 17 25 | 11 54 |
| C. Frio .................................. | 18 23 | 12 2 |
| C. Cross (or Sierra) ............ | 21 50 | 13 57 |
| Mt. Colquhoun, 17 or 18 l. ... ⊖ | 22 32 | – – |
| Walvisch B., ⊞, ᶠ w₀, factory, lt. F 24f. ......... | 22 57 | 14 30 |
| Port Sandwich, or d'Ilheo, ◫. ᶠ ‡,,, ........................... | 23 30 | 14 25 |
| Hollam's Bird I. [2c.], rf. SW 5m., ⌒, ⌊, .................... | 24 37·4 | 14 32 |

*West Coast of Africa*

| (46) Places | Lat. S | Lon. E |
|---|---|---|
| Mercury I. [⅓m.] ............ ○ | 25° 46′ | 15° 0′ |
| Angra Pequena, ᶠ, w N 10m., SW or Pedestal Pt. ......... | 26 38·4 | 15 8 |
| Seal I. [1m.], w₀ .................... | 26 34 | 15 14 |
| Possession I., ✱ 3m., rfs. off, w₀, S pt. ............ ○ | 26 58 | 15 13 |
| Arched rk., 100f. ............ ⊖ | 27 20 | 15 19 |
| Orange R., ⌒, bar ................ | 28 38 | 16 28 |
| C. Voltas, ♆, ........................ | 28 44 | 16 32 |
| Koussie R. ...................... ○ | 29 40 | 17 10 |
| **CAPE COLONY.** | | |
| Olifant's R., or Elephant's R. ⌊₀ | 31 38 | 18 12 |
| C. Donkin .............................. | 31 54·2 | 18 19 |
| C. Deseada, ⊥, *h* ................ | 32 18 | 18 23 |
| Berg R., entr. (w′ 5m. up) ... | 32 45 | 18 13 |
| Britannia rk. ........................ | 32 38 | 17 41 |
| St. Helena B., Pt. St. Martin, *l* | 32 40 | 17 59 |
| Pt. Paternoster, or W pt. ...... | 32 42·2 | 17 54·2 |
| Sunken rock ? ...................... | 32 51 | 17 46 |
| Saldanha B., ᶠ, r, w, Ship rk., at N pt. ........................ | 33 1·7 | 17 54 |
| — Houtjes B., ⊞, Hout. pt. ... | 33 0·1 | 17 58·0 |
| — Schapen I., w′, W pt. ...... | 33 4·2 | 18 1·0 |
| Dassen I., ✱ 2m., *l*, ⌒, w₀, β 2m., cent. ................ | 33 26·2 | 18 6·7 |
| Bock Pt. ................................ | 33 33·8 | 18 19 |
| Robben I., ✱ 1½m., lt. F 154f. | 33 49·2 | 18 22 |
| Table B., Green Pt., lt. F 65 ft. 🄱 .......................... | 33 54·2 | 18 24·5 |
| Devil's Peak, 3270f. ............ | 33 57·2 | 18 26·7 |
| Cape Observatory, ✦ 1ʰ G.M.T. 11ʰ 46ᵐ 5ˢ ............ | 33 56·0 | 18 28·7 |
| Cape of Good Hope, lt. Rev. 816f. ............................ | 34 21·2 | 18 29·5 |
| Bellow's rk. ........................ | 34 23 | 18 29·7 |
| Simon's B., Dk. yd. ............ | 34 11·3 | 18 26·0 |
| C. Hangklip ........................ | 34 23·2 | 18 49·5 |
| Danger Pt., *l*, rks. 2m. bluff .. | 34 37·8 | 19 17·7 |
| Quoin Pt. ............................ | 34 46·8 | 19 38·5 |
| C. Agulhas, S extr. of Africa, lt. F 128f. ...................... | 34 49·7 | 20 0·7 |
| Pt. Struys, ȣ 3m. ................ | 34 41·4 | 20 14·2 |
| C. Infanta, S pt., Sebastian B. | 34 28·4 | 20 51 |
| C. Barracouta ........................ | 34 26·4 | 21 18·4 |
| C. Vacca ................................ | 34 19·7 | 21 55 |
| Flesh Pt. .............................. | 34 17·7 | 21 57·0 |
| C. St. Blaize, lt. Fᵛ 240f. ...... | 34 11·2 | 22 9·5 |
| Knysna R., ◫, entr. ⊥ ...... | 34 5 | 23 3·7 |
| Plettenburg B., w, r, ᶠ, S pt. or Seal C. ............................ | 34 6·5 | 23 25 |
| C. St. Francis, rf., β, ⊤, lt. Fl. 118f. | 34 11·6 | 24 50 |
| C. Recif, *l*, lt. Rev. 93f. (rf. 4m.) | 34 1·7 | 25 42·2 |
| Algoa B., Port Elizabeth, lt. F 225f. ............................ | 33 57·7 | 25 37·7 |
| Bird Is., ✱ 3m., E pt. lt. F 80f. | 33 50·5 | 26 17·2 |
| Pt. Padron ............................ | 33 46·5 | 26 28 |
| Kowie R., entr. Port Alfred, lt. F 40f. ............................ | 33 36 | 26 54·2 |
| Grt. Fish Pt. .......................... | 33 31·4 | 27 7 |
| ————R., entr. ........................ | 33 29·6 | 27 8·5 |
| Keiskama, R., entr. W pt. ...... | 33 16·7 | 27 29·5 |
| Cove rks., centre .................. | 33 5·1 | 27 49·2 |
| Buffalo R., East London, F 45f. | 33 1·7 | 27 55·0 |
| C Morgan .............................. | 32 42·1 | 28 24·7 |
| Hole in the Wall .................. | 32 3·2 | 29 1·0 |

*Cape Colony ⊕*

## MARITIME POSITIONS

| | (47) Places | Lat. S | Lon. E |
|---|---|---|---|
| *Kafferland* | Rame Head | 31° 48′·4 | 29° 14′·5 |
| | St. John's R., entr. | 31 34·5 | 29 28·7 |
| | C. Natal | 29 53·0 | 31 2·2 |
| | Port Natal, ⊞, bar 8, S pt. of bay, lt. Rev. 282f. | 29 53 | 31 4 |
| | Fisher's R. | 29 16·3 | 31 33 |
| | Durnford Pt. | 29 0 2 | 21 51·5 |
| | C. St. Lucia | 28 32·5 | 32 27·5 |
| | St. Lucia R., entr. | 28 26·0 | 32 26·5 |
| | C. Vidal | 28 9·6 | 32 38·0 |
| | Goldown's Blind river | 26 55 | 32 53 |
| | **AFRICA, East Coast.** | | |
| *East Coast of Africa* | Delagoa B., C. Collato, 260f. | 26 4·0 | 32 58 |
| | — C. Inyack, N pt. of St. Mary I., 265f. | 25 58·0 | 33 0 |
| | Port Melville, Elephant I., w SW side, Gibbon B<sup>n</sup> pt. | 25 58 | 32 54·2 |
| | English R, Reuben pt., lt. F 134f. | 25 58 8 | 32 36 |
| | Innampura R., entr. | 25 11·6 | 33 31·5 |
| | Pt. Zavora R. | 24 28·5 | 35 12·5 |
| | C. Corrientes, 11 l., small rk., 15f. | 24 5·5 | 35 30·5 |
| | Barrow Hill, Burra, lt. F 80f. | 23 45·5 | 35 32·2 |
| | Innamban B., ⊞, town | 23 49·5 | 35 3 5 |
| | C. Lady Grey, 95f. | 22 55 | 35 36·5 |
| | C. St. Sebastian, 10 l., pt. 225f. | 22 6 | 35 29 |
| | Bazarouta Is., N pt., or C. Bazarouta, 390f. | 21 31·0 | 35 28 0 |
| | Inverarity shl., Mi-adjuano | 20 42 | 35 10 |
| | Chiuwan I. [5m.], *l*, ⚓, Singune, lt. F 36f. | 20 38·2 | 34 53·5 |
| | Sofala R., bar. 12f. fort | 20 10·7 | 34 43 |
| | Pungue R., Beira, lt. red | 19 50·2 | 34 50·5 |
| | Zambesi R., Kongoni R. mouth, lt. 85f. | 18 53 | 36 11·7 |
| | Kiliman R., bar 8f., *l*, ⚓, Pt. Tagalane, lt. F 52f. | 18 1·4 | 36 57 |
| | Acorn rk | 17 37 | 38 13·5 |
| | Primeira Is., Casuarina, or Raza I., ⚓ W, w₀, b | 17 6 5 | 39 4 |
| | Mt. Cockburn | 16 29 | 38 56 |
| | Angoche Is., Wst., or Moma bk. [1m.] | 16 47 | 39 32 |
| | — Mafamede I., *l*, ⚓, rfs., cent. | 16 20·5 | 40 2 |
| | — R., Custom ho. | 16 13 | 39 56·5 |
| | St. Antonio, R., S pt, rf. [2m.] | 15 57 | 40 9 |
| | Huddart's shl. | 15 47 | 40 26 |
| | Moginkwah R, Funeo pt. | 15 32 | 40 29 |
| | Port Mocamba, N pt., entr., T, ⊞, pk., ab. 2000f. | 15 8 | 40 35 |
| | Mozambique, ⊞, Sebastian Fort fl. staff, lt. F. green 42f. | 15 0·7 | 40 44 7 |
| | Mt. Pao | 14 50 | 40 25 |
| | Mount Meza, 1095f. | 14 43 | 40 38 |
| | Titangonya I., ⚓ 2m., S pt | 14 51 0 | 40 50 0 |
| | C. Melamo | 14 25·0 | 40 50 |
| | Penda shl, E extr. | 14 15 0 | 40 50·0 |
| | Loguno Peak | 14 21 0 | 40 35 |
| | Sorisa Pt | 13 32 8 | 40 35·2 |
| | Mauohané Pt. | 12 58 | 40 36 |

| | (48) Places | Lat. S | Lon. E |
|---|---|---|---|
| *Mozambique* | Pomba Bay, ⊞, N pt., entr., T | 12° 55′·8 | 40° 31′·2 |
| | Arimba Head | 12 38·2 | 40 39·0 |
| | Ibo I., ⚓ 5m., Ibo Bluff, lt. F 51f. | 12 20·0 | 40 38·5 |
| | Mahato I., ⚓ 2m., N and E pt. | 11 58·2 | 40 36·2 |
| | I. dos Mattos, [½m.], rfs. 2m. out | 11 49 | 40 37 |
| | Fungu Namegno, E. pt. of reef | 11 28·5 | 40 40·7 |
| | Tambuzi I., EW 2m., rfs. 2m., w′ | 11 21·3 | 40 41 |
| | Mazimba, fort | 11 18·5 | 40 22·5 |
| | Numba I., ⚓ 3m., E pt. | 11 9·5 | 40 42·2 |
| | Rongwi I, E pt. | 10 51 | 40 41·5 |
| | C. Delgado, pt., lt. F 59f. | 10 41·3 | 40 39 |
| | C. Rovouma | 10 28·7 | 40 31·5 |
| | Matunda Pt. | 10 21 | 40 27 2 |
| | C. Paman, Hull rk. | 10 11·5 | 40 9 |
| | Mikindani Hr. Kinizi Vill. | 10 16·5 | 40 7·5 |
| | Mongulho R., b, ẇ, Madjovi Rks. | 10 6·7 | 39 59 |
| | **MADAGASCAR.** | | |
| *Madagascar* | S extr., C. St. Mary | 25 38·9 | 45 5·0 |
| | Star bk., SW part, 27 | 25 39 | 45 21 |
| | Star reefs, NS 3 l., T W, S one | 25 25 | 44 16 |
| | Leven I, [½m.], centre | 25 12 5 | 44 16·0 |
| | Barracouta I., [½m.] | 25 3·0 | 44 5·5 |
| | St. Augustine B., Tent rk. | 23 35·4 | 43 43·7 |
| | Noss Veh, or Sandy I. | 23 38·4 | 43 36 |
| | Murderer's Bay, N pt. | 22 12·5 | 43 16·0 |
| | Murder I., rf. 2m., SW | 22 5·3 | 43 13·5 |
| | C. St. Vincent | 21 52 5 | 43 18 5 |
| | Mourondava, w, r, *T* | 20 18·3 | 44 17·5 |
| | Barren Is., *l*, ⚓, S danger | 18 41 | 44 1 |
| | — Smyth's islet, on rf. ⚓ 2½m. | 18 18·1 | 43 44·7 |
| | Coffin I., *l*, (8 2 l.) | 17 29 0 | 43 45·2 |
| | NW extr., C. St. Andrew | 16 11·4 | 44 29 |
| | Chesterfield bk. [¼m.], *T* | 16 17 | 43 53 |
| | Boyanna B., W or Table C. | 15 59·0 | 45 16 |
| | Bembatooka B., ⊞, r, E or Majunga Pt. | 15 42·9 | 46 18 5 |
| | Makumba I. | 15 42·0 | 45 55·7 |
| | Majambo B., ⊞, entr. W pt. | 15 11·7 | 46 57 5 |
| | Nareenda B., ⊞, entr. W pt. | 14 40·3 | 47 24·5 |
| | Luza R., bar 2, ⊞, entr. | 14 36 9 | 47 41·0 |
| | Saucassee I, NS 4½m., N pt. | 14 30·7 | 47 33·2 |
| | McCluer Pt. | 14 15 0 | 47 47·2 |
| | Erandza I., NS 2m., N pt. | 13 53·5 | 47 45 |
| | Passandava B., Ninepin I., lt. F 184f. | 13 28 2 | 48 13·0 |
| | Passage I., [½m.] | 13 28·2 | 48 27·7 |
| | Dalrymple B., ⊞, r, ⚓, b, entr. | 13 30 | 48 0 |
| | Martahoolah Pk. | 14 6 | 48 18 |
| | Noss Beh I., NS 13m., N pt. | 13 12·2 | 48 16 7 |
| | Minow I, N. pt. | 12 49·5 | 48 37·0 |
| | C. St. Sebastian (Is. 5m. off), pt. | 12 27·7 | 48 43·7 |
| | Woody I., [¼m.] | 12 16·7 | 48 39·2 |
| | Port Liverpool, ⊞, entr. N pt. | 12 3·3 | 49 9·5 |
| | N extr., C. Amber | 11 57 5 | 49 17·0 |
| | Amber Mountain | 12 34·5 | 49 9 |
| | British Sound, ⊞, entr., Clarence Id. | 12 13·8 | 49 21·5 |
| | C. Lowry | 12 35·0 | 49 37·7 |
| | Porte Looké, ⊞, Bathurst Pt. | 12 44·2 | 49 45·0 |

## MARITIME POSITIONS

| (49) Places | Lat. S | Lon. E |
|---|---|---|
| *Madagascar, E. Coast ⊕* | | |
| Port Leven, ⊞. Lingo rk. | 12°46′·5 | 49°53′·2 |
| Noshe Barracouta, [1m.] | 12 48 | 49 55 |
| Andrava B., Berry Hd. | 12 56·8 | 49 54·5 |
| Manambatoo Vill., ⚓, | 13 14· | 49 56·5 |
| Vohemar Pt. | 13 23·5 | 50 1·2 |
| Mananhar, Table Hill | 14 39·7 | 50 13·7 |
| C. East, outer I. | 15 15·8 | 50 29·5 |
| Durnford Noss, pt. | 16 0·0 | 50 9·5 |
| Port Choiseul, town | 15 27·3 | 49 50·2 |
| C. Ballones, pt. | 16 14·0 | 49 52·0 |
| Tangtang, ⊞, fl. st. | 16 42·5 | 49 44·2 |
| St. Mary's I., 11 l., N. pt. | 16 40·5 | 50 2·7 |
| — I. Madame, or Quail I., on W side, Establ., lt. F 31f. | 17 0·0 | 49 52·0 |
| Fenerive, town | 17 23·0 | 49 26·2 |
| Foule Pt. Vill., r, | 17 40·4 | 49 33·2 |
| Pruno I., vis. 5l., | 18 4 | 49 30 |
| Tamatave Pt., | 18 10 | 49 27 |
| Fong Is., small, S one | 18 26· | 49 23·7 |
| Vatomandri | 19 17·8 | 49 2 |
| Mahanuru, town | 19 54·0 | 48 50·2 |
| Fanantara, town | 20 51·2 | 48 31·2 |
| Rangazava, town | 20 58·2 | 48 30·7 |
| Footak, town | 24 4·0 | 47 30 |
| Manambatoo (South), town | 24 17· | 47 23·0 |
| Loodatoo. town | 24 36·7 | 47 15·5 |
| St. Luce, N islet | 24 44·7 | 47 12·2 |
| Pt. Ytapere, extr. | 24 59·7 | 47 5·7 |
| Fort Dauphin, fl. st. | 25 1·3 | 47 0·2 |
| **Islands off Madagascar.** | | |
| *Islands in Mozambique and off Madagascar* | | |
| Europa I., [1 l.], ✱, 65f. | 22 22·5 | 40 24·2 |
| Bassas da India, [2 l.]. T, S pt. | 21 31 | 39 41 |
| St. Juan da Nova, [2½m.]. *l*, 8, ~ | 17 3·5 | 42 47 |
| Mayotta. NS 7 l., Pamanzi I., lt F. | 12 46 | 45 15 |
| Johanna, NS 8 l., pk., E part | 12 15 | 44 27·1 |
| — Town. w, r, P | 12 11·0 | 44 22 |
| Numachao Mohillah | 12 25 | 43 42 |
| Comoro, NS 12 l., T, ⚓ NW, SE pt. ○ | 11 54 | 43 33 |
| — North-east pt. ○ | 11 19·5 | 43 39 |
| Geyser sh., SW elbow | 12 25 | 46 25 |
| Borneo shl. | 12 14 | 46 12 |
| Glorioso I. and rfs. [4 l.], *l*, ✱, T, Isle du Lise, W pt. | 11 30·2 | 47 22 |
| Assumption I., 2 l., *l*, ✱, hummock on SE pt, 60f. | 9 46 | 46 30·5 |
| Aldabra Is., EW 8 l., ⊞ ? , W pt., 70f. | 9 22·5 | 46 12·2 |
| Cosmoledo Is., [3 l.], lag., no entr., [⚓] S;—SW, or Menai I., 40f. | 9 41 | 47 31 |
| Astove, small, *l*, centre | 10 6·5 | 47 45·7 |
| **African Coast continued.** | | |
| Lindy R., w, r, fort | 9 59·5 | 39 43·7 |
| Mchinga B. Vill. | 9 44·4 | 39 44 |
| Kiswere Hr, ⊞, Rushingi Vill | 9 25·6 | 39 37·5 |
| Pagoda, Pt. | 9 1·7 | 39 33·2 |
| Quiloa, ⊞, fort | 8 57·0 | 39 31·2 |

| (50) Places | Lat. | Lon. E |
|---|---|---|
| *East Coast of Africa ⊕* | South | |
| Quiloa, Ukyera reef, E extr | 8°53′·5 | 39°39′ |
| Songa I., 1½m., SE pt. | 8 32·5 | 39 31 |
| Mafia I., 9 l., W. or Kisimani pt. | 7 56·5 | 39 35·7 |
| Panna Pt. extr. | 7 2·0 | 39 34·2 |
| Latham's I., [2c.], *l*, sd., mid. | 6 54·2 | 39 56 |
| Zanzibar I., 16 l., , S pt. or Kizimkaz, w., lt. | 6 28·5 | 39 30·0 |
| — English Consulate | 6 9·7 | 39 11·2 |
| — N pt., or Nungwe Pt., lt. Rev. 105f. | 5 43 | 39 18 |
| Mazeewy I., and rfs., [1½m.] | 5 30·0 | 39 6·0 |
| Tungaty, Mt., 15 l., S pk | 5 22·3 | 38 52·0 |
| Pemba I., NS 13 l., *l*, , S or Saïd pt. | 5 29·3 | 39 39 |
| — North-East pt. | 4 54·2 | 39 51·5 |
| — Port Chak chak. ⊞, Mosal I., [1m.]. SW. pt. | 5 15·7 | 39 37·5 |
| Waseen Peaks, 15 l., mid one | 4 30 | 39 20 |
| Mombaza, *l*, , w, r, P,. fort. | 4 4·0 | 39 41·0 |
| Melinda (Leopard rf. 3m. off), Pillar | 3 12·8 | 40 18·2 |
| Ras Gomany. N pt. | 3 0·0 | 40 17·7 |
| Ozy Pt., (Riv. 5m.; rf. 4m.) | 2 37·5 | 40 38·5 |
| Lamo B., ⊞, W pt., or Ras Kattow | 2 18·7 | 40 56·7 |
| — Town | 2 15·7 | 40 56·2 |
| Patta B., ⊞, rk. | 2 14·0 | 41 1·2 |
| Patta, town | 2 9·2 | 41 7·5 |
| Kwyhoo I., Sst. of Juba, or Dundas Is., pk. 155f. | 2 0·0 | 41 18·2 |
| Simmambaya, Settlem. | 1 45·5 | 41 32·0 |
| Mt. Gibbons | 1 12·2 | 41 28 |
| Port Durnford, ⊞, Foot Pt., N. entr. | 1 13·2 | 41 54·2 |
| Tola I., huts | 1 0·0 | 42 3·5 |
| Port Kiama, Doubt rk., mid entr. | 0 40·2 | 42 20·0 |
| Kismayo I., 3m., N pt. | 0 36·8 | 42 22·0 |
| Juba R., bar, P,, entr. | 0 14·5 | 42 39·2 |
| | North | |
| Brava, town | 1 6·8 | 44 3 |
| Marka, town | 1 44·1 | 44 51 |
| Magadoxa, town, P, | 2 1·8 | 45 24·7 |
| Murot hill | 2 41·3 | 46 17·2 |
| Ras Asuad, *l*, ⊥, pt. | 4 34·2 | 48 6·0 |
| Ras Awath | 5 32·8 | 48 40·0 |
| Ras al Khyle | 7 43·5 | 49 45·7 |
| Ras Mabbere, ⊥′ N. w, pt. | 9 29·0 | 50 50·2 |
| E extr. of Africa, Ras Hafoon, 500f., ⚓ S, w, r, E pt. | 10 26·8 | 51 22·0 |
| Hor Hadeea, (boats) | 10 34 | 51 10 |
| Ras Banna (w 11m.) | 11 9 | 51 10 |
| C. Guardafui (NE extr. Afric.) | 11 50·0 | 51 16 |
| **Gulf of Aden.** | | |
| Abd'l Koory, 7l., *h*, w, W pt | 12 13·5 | 52 3 |
| Salt's white rks. or Kal Faroon [1m.], 282f., mid. | 12 26 | 52 8 |
| Brothers, 2, 4½l. E, or Durjy | 12 7 | 53 16 |
| Socotra, EW 70m., W extr. pt. | 12 33 | 53 15·7 |
| — NW extr., Ras Bedoo, 300f. | 12 39 | 53 21·7 |
| — Gollonsier, vill.. w, r, b. | 12 41·5 | 53 26·7 |
| — Tamareed. r, w, Mosque | 12 39·0 | 53 59 |
| — E pt., Ras R'dresser, *l*. | 12 34 | 54 27·7 |

## MARITIME POSITIONS

| (51) | Places | Lat. N | Lon. E |
|---|---|---|---|
| Socotra | Socotra, Wadde Fellingk, w, reservoir | 12° 28′ | 54° 13′7 |
| | — SW pt., Ras Kattaunie, sum. over, 1465f. | 12 22·5 | 53 29·7 |
| | Ras Ahileh, *l* | 12 0 | 50 45 |
| | Ras Feluk, ⊥, 800f. T | 11 57 | 50 38 |
| | Meyet, or Burnt I., *h*, ~, w, S side, ⚓, 430 f. | 11 14 | 47 16 |
| | Berbereh Sandy pt., lt. F 49f. | 10 25 | 44 59 |
| | Zeyla, r, P, | 11 21 | 43 29 |
| | Cape Obokh, lt. F 64f. | 11 57 | 43 17 |
| | Ras Bir (w′ W 4m.), lt. F. | 11 58 | 43 22 |
| | High Brothers, 5, $\frac{4}{12}$ 4m., rks., large one | 12 29 | 42 23 |
| | **RED SEA, Western Shore.** | | |
| Red Sea, W. Coast | Jebel Searjan. volc., sum. | 12 29 | 43 17 |
| | Dumeirah I, [½m.], *h*, pk. | 12 43 | 43 7·5 |
| | Asab, lt. F. | 13 0·5 | 42 44 |
| | Ras Bilul, sum. | 13 14 | 42 32·5 |
| | Mohabbakah Is., 3, $\frac{4}{12}$ 2m., SW. Flat, 40f. | 13 25 | 42 32·5 |
| | Rakhmat I., 282f. | 13 40·2 | 42 12 |
| | Jebel Abayil I., 150f. | 13 54 | 41 58 |
| | Barn rock, 10f. | 13 59·5 | 41 51·5 |
| | Eid town | 13 57 | 41 38 |
| | Kurdumiyat I., 180f., [2m.], *h*, volc. | 14 7 | 41 39 |
| | Hanfelah B., Daramsas I, 25f. W. reef | 14 44·5 | 40 51·5 |
| | Shumna I., lt. F 59f. | 15 32 | 39 59·5 |
| | Howakel I., $\frac{4}{12}$ 7 m., sum., 720f. | 15 9 | 40 14·5 |
| | Massowah I., [½m.], w, r, b, ⚓′, lt. F 47f. | 15 38 | 39 28 |
| | Dahalak bank, SE extr., Mojeidi, [1½m.], *h* | 15 31 | 40 50 |
| | — N extr., Harmil I., $\frac{4}{12}$ 5m., *l*, ♆, E pt. | 16 32 | 40 12 |
| | Dahalak Kebír, $\frac{4}{12}$ 10 l. | 15 37 | 40 0 |
| | Difnein I., 30f. | 16 36·5 | 39 18·7 |
| | Towers, hill | 17 38 | 38 43 |
| | Khor Nowaret, ⊞, r₀. Shatireh I. | 18 15·2 | 38 19·5 |
| | Ras Asis | 18 26·5 | 38 7·7 |
| | Low Sandy Is., $\frac{4}{12}$ 12 l., E extr., Eddom Sheikh I. | 18 37 | 38 50·5 |
| | Trinkitat Harbour | 18 41 | 37 44 |
| | Barrmusa Kebír I.. [3m.], ✱ | 19 13·5 | 38 10 |
| | Sawakin, ⊞, w, r | 19 7 | 37 20 |
| | Omm el Kurush bk., [1m.], *l*, sand | 20 51 | 37 26 |
| | Chimney Hill | 20 28·5 | 37 48 |
| | Mahommed Ghoul | 20 54 | 37 9 |
| | Ras Raweyyah, rks., 3m., E pt. | 21 3 | 37 19 |
| | Reef, $\frac{4}{12}$ 3m., S pt. | 22 0 | 37 0 |
| | South Peak, 6900f. | 21 53 | 36 29 |
| | Merza Halaib, ⊞, w, b, P′, entr. | 22 15 | 36 38 |
| | Small Is., 3, *l*, ✱ ✱, E one | 22 47 | 36 12 |
| | St. John's, or Seberget I., small, 700f., T | 23 36·3 | 36 9 |
| | Macour, or Emerald I., [1m.], 100f., T, ⚓₀ | 23 50 | 36 47 |

| (52) | Places | Lat N | Lon. E |
|---|---|---|---|
| | Ras Benass, T E, δ SE, pt., *l* | 23° 56′ | 35° 47′ |
| | Jebel Wady Lehuma, vis., 100m. | 24 12 | 35 0 |
| | Wady Jumaul I., $\frac{4}{12}$ 2½m., *l*, mid | 24 39 | 35 8 |
| | Dædalus shl. (*Abd'l Kheesan*), T, lt. F 61f. | 24 56 | 35 52 |
| | Kosair, town | 26 6 | 34 16·7 |
| | The Brothers, 2 Is., $\frac{4}{12}$ 1½m., T, N Islet, lt. F 71f. | 26 18·8 | 34 50·7 |
| | Jaffatin I., Sereea pk. | 27 12 | 33 58·7 |
| Gulf of Suez ⊕ | Shadwan I., $\frac{4}{12}$ 7m., 700f., T, SE pt., lt. Fl. 120f. | 27 27 | 34 2·5 |
| | Jubal I., [2½m.], T E, sum. | 27 38·7 | 33 48 |
| | Ashrafi Is., lt. F 125f. | 27 47·3 | 33 42·5 |
| | Ras Gharib, lt. F 165f. | 28 20·9 | 33 6·5 |
| | Ras Zafarana, lt. F 83f. | 29 6·5 | 32 39·7 |
| | Mt. Agrib. (Gharib), 5740f. | 28 6·7 | 32 54 |
| | SUEZ, PORT IBRAHIM, S MOLE HD. | 29 56·2 | 32 33·5 |
| | Toor, harb., ⊞, w‴ | 28 13·7 | 33 37 |
| | Mount Sinai, 7450f. | 28 32 | 33 58·5 |
| | Ras Mohammed, ⊥, 90f., peninsula | 27 45·2 | 34 13·5 |
| | Akabah, fort, w̄ | 29 28 | 35 1 |
| | Tirahn Is., $\frac{4}{12}$ 3m., pk., 700f. | 27 55·2 | 34 34 |
| | **Eastern Shore.** | | |
| Red Sea, E. Coast | Sillah Is., $\frac{4}{12}$ 6m., *l*, crl., S pt. | 27 37 | 35 16 |
| | Moilah, w, r, ⚓″ | 27 40 | 35 28 |
| | — High pk., 9000f. | 27 37 | 35 45 |
| | Jebel Antar, 2500 or 3000f. | 26 34 | 36 28 |
| | Riackah I., $\frac{4}{12}$ 2m., *l* | 26 10 | 36 21 |
| | Mushabeah I., $\frac{4}{12}$ 5m., *l*, T w, W extr. | 25 38 | 36 27 |
| | Shab Shaybah, or Palinurus rfs., [4m.], T, ⚓₀, δ; mid. | 24 6 | 37 7 |
| | C. Bareedy, mid. pt, T | 24 16 | 37 33 |
| | Sherm Yembo, ⊞ | 24 9 | 37 54 |
| | Yembo, the port of Medina, w′ r, entr. | 24 4·5 | 38 1 |
| | Jebel Soubah, 4500f. | 23 18 | 39 3 |
| | Shab Subbah, or 7 shls., $\frac{4}{12}$ 3 l., δ, W lim. | 23 40 | 37 58 |
| | Thetis, rf., [½m.], T, δ | 23 38 | 38 1 |
| | Sherm Rhabuc, ⊞, r, w, P, | 22 43 | 39 4 |
| | Abu Madafi | 22 2 | 38 42 |
| | Jiddah, ⊞, δ WSW 7m., high mosque, E-d. of town | 21 28·3 | 39 13·0 |
| | Kadd Homeis, 5f. [2½m.], β, W pt. | 20 15 | 39 26 |
| | Lith | 20 9 | 40 12 |
| | Kunfidad | 19 7·7 | 41 3·2 |
| | Shab Mubarak, rk, [1m.] | 19 0 | 40 9 |
| | Khor Nohud | 18 15·8 | 41 27·5 |
| | Shab el Jumah, [1m.] | 17 36 | 40 50·5 |
| | Seïl Makawar, [1m.], (δ, NW 3 l.) | 16 58 | 41 20 |
| | Gizan Fort | 16 53 | 42 29 |
| | Jebel Teer, volc., [1½m.], 800f., ⚓₀ | 15 32·5 | 41 50 |
| | Kotumah I., $\frac{4}{12}$ 3m. | 15 41 | 42 16 |
| | Loheyyah Fort | 15 42 | 42 39 |
| | Kamaran I., NS 3 l., w, b, S sum. | 15 17 | 42 34 |
| | Zebayir Is., $\frac{4}{12}$ 5 l., N extr., Quoin rk., 100f. | 15 12 | 42 3 |

MARITIME POSITIONS

| (53) | Places | Lat. N | Lon. E |
|---|---|---|---|
| Red Sea | Zebayir I., large one, [3m.], S. sum. 734f. | 15° 2' | 42°10'? |
| | Hodeidah | 14 47 | 42 56 |
| | Ras Zebeed, w''' 1m. N. | 14 7 | 43 4·5 |
| | Avocet rock, 8 | 14 22 | 42 41·7 |
| | Jebel Zukur I., 2047f., 4/17 10m., h, High islet, 216f. | 14 5·2 | 42 45·2 |
| | — Tongue I., 166f. | 13 53·4 | 42 42·2 |
| | Harnish Is., 1335f., NS 6 l., Haycock I. | 13 47·2 | 42 47 |
| | — SW rocks, 22f. | 13 38·2 | 42 35·5 |
| | Mocha, Pier end | 13 19 | 43 14·0 |
| | Bab el Mandeb, pk. | 12 41 | 43 27 |
| | Perim I., [4½m.], ⊞, lt. R 249f. on summit | 12 39 | 43 26 |
| | **ARABIA.** | | |
| Arabia, S. Coast | Ras Arah, S pt. of Arabia, l, 8 | 12 35 | 43 56 |
| | Mt. St. Antony, 2772f. | 12 43 | 44 10 |
| | ADEN, RAS MÁRBUT | 12 47·2 | 44 58·5 |
| | C. Aden, summit, 1776f. | 12 46 | 45 0·7 |
| | Ras Marshigh, lt. F 244f. | 12 45 | 45 3 |
| | Sugrá, w', r, Castle | 13 21·5 | 45 40 |
| | Howtha, w', r, f | 13 25 | 46 45 |
| | A barn-like pk., 5284f. | 14 4 | 47 32 |
| | Ras Khelb, l, sandy, no point | 14 2 | 48 40 |
| | Makalleh | 14 31 | 49 7 |
| | Jebel Dhebah, a table land | 14 41 | 49 26 |
| | Shahah, Sultan's resid., r, w, | 14 43·7 | 49 35 |
| | C. Bogashu | 14 49 | 50 4 |
| | Palinurus shl. 2½fm. 4/17 2m., T T S pt. | 14 53 | 50 39 |
| | C. Fartak, 26 l., ⊥ | 15 39 | 52 16 |
| | Thurbat Ali | 16 38 | 53 3 |
| | Ras el Ahmar | 16 55 | 53 52 |
| | C. Merbat, l, rky., f, w, | 16 58 | 54 42 |
| | Jebel Kinkeri, 1600f. | 17 3 | 55 2 |
| | Ras Nús, 20 l., S pt., l | 17 14 | 55 18 |
| | Kuria Muria Is., EW 45m., W one, Haski, 1½m., pk. | 17 27·2 | 55 35·7 |
| | — Soda, 4/17 3m., pk., 1310f., w | 17 29·6 | 55 51·? |
| | — Helánea, EW 7m., NE bluff, 1645f., w, | 17 32·7 | 56 2·? |
| | — Kiblíyah, EW 2m., pk., 550f., $w_0$. rk. W 3m. | 17 29·2 | 56 19 |
| | Ras Sherbedát, ⊥, w 4m., W | 17 53 | 56 20 |
| | C. Isolette, vis. 16 l., pt. | 18 58·5 | 57 46·0 |
| | Mazeira I., 13 l., 600f., S pt. | 20 7·6 | 58 33 |
| | — N pt., or Ras Jeï | 20 43·5 | 58 52 |
| | Ras Jibsh | 21 27·5 | 59 21·5 |
| | Ras el Khubbeh | 22 14·4 | 59 49 |
| | Ras al Hed, Sandy Pt., l | 22 33 | 59 48 |
| | **PERSIAN GULF.** | | |
| Gulf of Oman | Ras Abu Daud | 23 19·2 | 58 55·5 |
| | Maskat, r, w, f, Fisher's rk. ⊕ | 23 37·7 | 58 36·0 |
| | — Saddlehill, 1340f. | 23 35·1 | 58 35 |
| | Jeziret Jun, 107f. | 22 50·5 | 57 58·5 |
| | Clive Shoal, 8f. | 22 51 | 57 57·2 |
| | Jebel Rostag, a bluff of the Jebel Akhthar | 23 14·2 | 56 16 |
| | Birkeh | 23 42·7 | 57 54·? |
| | Suwik, fort and town | 23 51·5 | 57 26 |
| | Sohar, town and fort | 24 21·5 | 56 46 |

| (54) | Places | Lat. N | Lon. E |
|---|---|---|---|
| | Schenas, town | 24°45' | 56°29' |
| | Dibbah, town | 25 38 | 56 17 |
| | Shám Peak, 6750f. | 25 58·7 | 56 14·5 |
| | C. Mussendom Peak, 875f. | 26 21·9 | 56 32 |
| | Great Quoin, 540f. | 26 30 | 56 31 |
| | Ras Sheikh Masud... | 26 15·4 | 56 13·? |
| | Shám, fort, r, w', P' | 26 1·4 | 56 5·5 |
| | Ras el Kheymeh, r | 25 48 | 55 57 |
| | Shargah, w, ⚓, | 25 22 | 55 24 |
| | Abúthabí fort | 24 29 | 54 21·7 |
| | Sír Bení Yás, N pt. | 24 21·5 | 52 38 |
| | Rug Zukkum shl. [3] | 24 48·5 | 53 46 |
| | Ras Luffan | 25 54 | 51 33 |
| | Sír Abú Neyr, NS 2¼m., N pt. 240f. | 25 15 | 54 13·5 |
| | Zirkuh I., 540f., S pt. | 24 52 | 53 5·? |
| | Girneyn I., 190f. | 24 56 | 52 52 |
| | Dás I., [1½m.], S pt., 145f. | 25 9 | 52 53 |
| | Arzeneh, 200f. | 24 46 | 52 34 |
| | Dalmeh, 244f. | 24 33 | 52 19 |
| | Deyni, 9f. | 24 57 | 52 24 |
| | Shiráao I., 40f. | 25 2 | 52 14 |
| | Halul, 180f. | 25 40 | 52 26 |
| Persian Gulf, S. Coast | Ras Rekken | 26 11 | 51 13 |
| | Shah Allum shl. [2½] | 26 25·5 | 52 31 |
| | Bahrain I., Manamah, town, r, ⚓ | 26 14 | 50 35 |
| | Maharag I., N pt. | 26 18 | 50 38 |
| | Rennie shl. [2¾] | 27 3·5 | 50 42 |
| | Al Krán, 5f. | 27 43 | 49 50 |
| | Herguz, 3f. | 27 56 | 49 42 |
| | Araby, 3f., sandy | 27 47 | 50 11 |
| | Farsè, 10f., sandy | 27 59 | 50 10 |
| | Ras al Ghar | 27 33 | 49 16 |
| | Ras Musháb, h | 28 11 | 48 39 |
| | Garú I. | 28 49 | 48 47 |
| | Kúbbr I. | 29 4 | 48 31 |
| | Ras al Arth | 29 20 | 48 8 |
| | Kuweit, N end town, ⊞ | 29 23 | 48 0 |
| | Feylecheh I., 4/17 7m. | 29 23 | 48 21 |
| | Basrah Custom House | 30 32 | 47 51·5 |
| | Ras Tanúb, l. | 30 8 | 49 ·6 |
| | Ras at Tamb | 29 58 | 50 10 |
| Persian Gulf, N. Coast | Khargú I., NS 4m., l, w, N pt. | 29 20 | 50 22 |
| | Kharg I., 4/17 5m., w', fort. NE ⊕ | 29 15·4 | 50 20·7 |
| | Abu-Shahr, ⊞, w, r. Residency ⊕ | 20 59·1 | 50 50 |
| | Asses' Ears, 5m. inland, 2500f. | 28 29 | 51 12 |
| | Hummocks of Dreng, S one, 3270f. | 28 4 | 51 37 |
| | Ras Mutaf, S pt. | 27 41 | 51 45 |
| | Konguin | 27 49·5 | 52 4 |
| | Barn Hill, 4660f. | 27 48 | 52 14 |
| | Ras Nabend, l. | 27 23 | 52 35 |
| | Sheykh Sháyb, 120f., L, 4/17 14m., w, P, E pt. | 26 48 | 53 24 |
| | Hinderabi I., EW 4m, l, 100f. | 26 41 | 53 40 |
| | Sumberrun Shl., [6] | 26 33 | 53 44 |
| | Gays, 120f., 4/17 8m., l, ⚓, T, r, w, P, E pt. | 26 31 | 54 3·5 |
| | Frúr I., 465f., NS 4m., N pt. | 26 19 | 54 30·5 |
| | Ras Bostaneh, l, pt. | 26 30 | 54 37 |
| | Frúr Shl. [½m.], 2 | 26 26 | 54 32·5 |
| | Nábyú Frúr I, [1m.], 120f. | 26 7 | 54 26·5 |
| | Seri I., 50f. [3m.], S pt. | 25 53 | 54 33 |
| | Bumusa I. [3m.], 360f., peak | 25 53 | 55 3 |

## MARITIME POSITIONS

| (55) | Places | Lat. N | Lon. E |
|---|---|---|---|
| *Persian Gulf, N. Coast* | Jest. Nabu Tumb [1m.] | 26° 14'7 | 55° 9' |
| | Jest. Tumb [3m.], 165f., w | 26 15·7 | 55 18·7 |
| | Basídúh Chapel | 26 39·2 | 55 16·2 |
| | Henjar I., ⚓ 5m., S pt. | 26 36 | 55 52 |
| | Kesm, fort | 26 57·5 | 56 17 |
| | Larek I., ⚓ 5½m., ϑ₀ ½m., N pt. l | 26 53·1 | 56 21·7 |
| | Hormuz I., EW 4m., fort, N pt. | 27 5·8 | 56 27·5 |
| | Bander Abbas, Sheikh's house ⊞, ✝ | 27 10·5 | 56 17 |
| | Kúbí Mubárck, rk. | 25 42·2 | 57 28 |
| *Makran Coast* | C. Jashak, l, sandy pt., Tomb | 25 38·3 | 57 45·7 |
| | Ras Tagin, l | 25 33 | 58 5·5 |
| | Ras Maidani l, (shl. 3m.) | 25 23·7 | 59 6·5 |
| | Ras Gurdim. ⊥, (rk., SE 3m.) | 25 19 | 60 7·2 |
| | Ras Mutakaddim | 25 16·5 | 60 27·7 |
| | Chahbar, ⚓', ł, ▼', Telegraph | 25 16·7 | 60 37·2 |
| | Ras Fasta | 25 3 | 61 25·2 |
| | Gwatar, vill. | 25 8·9 | 61 30·2 |
| | Ras Jiyuni | 25 0·5 | 61 42·2 |
| | Guadar Telegraph | 25 7·3 | 62 19·2 |
| | Ras Shahid | 25 12 | 62 58·7 |
| | Pasni Telegraph | 25 15·9 | 63 28 |
| | Astaluh I., EW 3m., (rk., 2m. S) | 25 6·2 | 63 49 |
| | Ormarah, Telegraph | 25 11·9 | 64 36·5 |
| | Ras Malan | 25 18 | 65 12·2 |
| | Sunmiyani, ł, ѱ, Jam's ho. | 25 25·3 | 66 35 |
| | Ras Muwari, or C. Monze, shl., 3m. | 24 50 | 66 39·5 |
| | **INDIAN OCEAN.** | | |
| | **Islands.** | | |
| | Laccadivas, l, ✝, ⚓₀ | | |
| *Laccadive Is.* | Bassas de Pedro bk., 22 l., T, N pt., ⚓ | 13 37 | 72 32 |
| | — rf., NS 6m., T, S dry sand (Cherbaniani) | 12 16 | 71 52 |
| | Byramgore, rf., NS 13m., S part | 11 48 | 71 50 |
| | Betra-par, rf., NS 7m., Id., [1m.], N extr., l | 11 35 | 72 11 |
| | Peremul-par, rf., ⚓ 7m., T, Id. NE | 11 9 | 72 0 |
| | Ancutta, [3½m.], P, ✝, mid | 10 51 | 72 10 |
| | Tingaro | 10 55 | 72 18 |
| | Pittie, [2c.], sand, ~ | 10 45 | 72 32 |
| | Ameni, [1½m.] | 11 6 | 72 41 |
| | Cardamum, and rfs., NS 6m. | 11 13 | 72 44 |
| | Chittae, [2m.] | 11 40 | 72 42 |
| | Kittan, [3m.], S pt. | 11 29 | 72 58 |
| | E extr., Elicalpeni bk., NS 5m., ϑ, mid | 11 13 | 73 56 |
| | Underoo, EW 3½m., rks., N-d. l, ✝, w, E end | 10 47 | 73 42 |
| | Kalpeni, 2 Is., ⚓ 7m., ✝, S pt. | 10 3 | 73 35 |
| | Cabrutee, [2½m.], rf. W-d, T, ✝, w | 10 31 | 72 36 |
| | Scuheli Par, Id., N, [2c.] | 10 5 | 72 15 |
| | — S extr. of rf., T | 9 56 | 72 9 |
| | Minikoy, ⚓ 6½m., ✝, P', lt. R 150f. | 8 15 | 73 1 |

| (56) | Places | Lat. | Lon. E |
|---|---|---|---|
| | **Maldives.** | North | |
| | Maldiva Is., 19 *Atolls*, or groups, l, T, ▮▮, ✝, P' | | |
| *Maldive Is.* | N extr., Heawandoo Pholo Atoll, 4 l., ⊞, w', N pt., Turacoon I. | 7° 6' | 72° 53' |
| | Heawandoo I., [1m.], ✝, on SW side, w | 6 57·5 | 72 54 |
| | Tilla, and Milla, dou Atolls, E extr. | 5 51 | 73 27 |
| | — N Id., Keelah, [2m.], ✝ | 6 59 | 73 12 |
| | — S extr. | 5 39 | 73 15 |
| | Malcolm Atoll, ⚓ 5 l., rf. Mah-koondoo I., [1m.], w' at NE extr. | 6 24·5 | 72 40 |
| | Powell's Is., 2, 2m., N one | 5 59 | 72 54 |
| | Paddipholo Atoll, 7 l., E pt. | 5 25 | 73 38 |
| | Cardiva I., ⚓ 1½m., ✝, w' | 4 58 | 73 26 |
| | Horsburgh Atoll, ⚓ 10m., entr. S, ⚓', E extr. Id., w | 4 54 | 72 58 |
| | A lagoon rf., EW 6m., N pt. | 4 46·5 | 73 23 |
| | Malé Atoll, NS 33m., E extr. | 4 27 | 73 42 |
| | — King's I., fl st., N side | 4 10 | 73 29 |
| | South Malé Atoll, ⚓ 7 l., S extr. | 3 48 | 73 25 |
| | To-doo I., [1m.], w' | 4 26 | 72 58 |
| | Ari Atoll, NS 16 l., ⚓' N, I. at S pt. w' | 3 30 | 72 50 |
| | Pha-lee-doo Atoll, EW 10 l., E extr. | 3 27 | 73 44 |
| | Moloque Atoll, ⚓ 8 l., S extr. | 2 45·5 | 73 23 |
| | — Do. Id., on N side entr. ⊞, w, b, ł | 2 57 | 73 33 |
| | Nillandoo Atolls, 2, ▮, NS 13 l., Id. at S entr., ✝, w', on W side entr. ⊡ | 2 40 | 72 54 |
| | Collomandoo Atoll, EW 10 l., Karn-doo-doo I., w', ⊞ | 2 20 | 72 55 |
| | Adou Matte Atoll, ⚓ 9 l., N and E pt. Id. | 2 7 | 73 35 |
| | — S extr., Id., (entr. ⊞. ⚓ 3m., ϑ₀) | 1 46·5 | 73 22 |
| | Suadiva Atoll, NS 15 l., W side, entr. to ⊞, 15 | 0 28 | 72 56 |
| | | South | |
| | Phoowa Moloku I., w', N pt. | 0 16·5 | 73 23 |
| | S extr., Addoo Atoll, EW 3 l. w, b, ł, Gung I., ⊞, E pt. | 0 41·5 | 73 6 |
| | **Almirante & Seychelles.** | | |
| | W extr., I. Boudeuse, small, ✝ ⊖ | 6 11 | 52 56 |
| | Marie Louise I., small, ✝, (rf. off, ϑ) | 6 10·4 | 53 9·2 |
| | S extr., I. De Neuf, small, ♣ | 6 14·5 | 53 14 |
| | I. Etoile, [1½m.], l, ♣ | 5 48 | 53 9 |
| | Poivre Is., two, [1m.], rfs., NE pt. | 5 45·2 | 53 19·5 |
| | Isle de Roches, (bks. 4 l.), North beach | 5 41 | 53 41·2 |
| | St. Joseph Is., E pt. ○ | 5 27 | 53 37 |
| | D'Arros I., NE pt. | 5 24·4 | 53 18·5 |

## MARITIME POSITIONS

| | (57) Places | Lat. S | Lon. E |
|---|---|---|---|
| *Almirante Is.* | Eagle, or Remire I., [½m.], *l*, ✱, rfs. 2m., w₀, NE pt. | 5° 6'4 | 53°19' |
| | African Is., small, *l*, ‡' W, w₀, North I. | 4 52·5 | 53 23·7 |
| | I. Platte, [½m.], rfs. 3m. | 5 52 | 55 22 |
| | La Perle rf., Centre | 6 1 | 55 17·5 |
| *Seychelle Archipelago* | Mahé I., ⚓ 13 l., ✝, Port Victoria, Hodoul jetty | 4 37·2 | 55 27·5 |
| | — lt. F 37f. on S reef | 4 37 | 55 31 |
| | Silhouette I., [3m.], *h*, ✝, N pt. | 4 27·0 | 55 16·7 |
| | Recif I., [1½ " .], 150f., ⌒, mid. | 4 34·8 | 55 50 |
| | E extr., Frigate I., [1½m.], 550f., P, rf. SW, mid. | 4 35·2 | 56 1·2 |
| | Pra-lin I., 12 l., ‡ N, W pt. | 4 17·4 | 55 44·2 |
| | Curieuse I., EW 2m., w, ✝, mid. | 4 16 | 55 47·7 |
| | Denis I., NS 3m., *l*, ✝, lt. F 60f. | 3 48·2 | 55 40 |
| | N extr., Bird I., [2m.], *l*, ✱, ⌒, ✱, mid. | 3 42·7 | 55 12·5 |
| | French Shoal, [5 or 6m.], ɪ, mid. ○ | 3 58 | 54 42 |
| | Roquepiz, *l*, sandy, rfs. | 6 24 | 60 4 |
| | Alphonse, *l*, ✝, SE pt. | 7 0·5 | 52 45·2 |
| | Coetivy I., *l*, sandy, ⚓ 8m., ✝, ‡ NW, w', r, N pt. | 7 6 | 56 17 |
| | Agalegas, I. and reefs, ⚓ 5 l., ✝, NW pt. | 10 21·5 | 56 32 |
| | Sava de Malha bk., 5 fms. [illegible] | 9 12 | 60 21 |
| | John de Nova, or Farquhar Is., ⚓ 8 l., ✱, ✝, Grande Porte | 10 7 | 51 10·2 |
| | McLeod, or Marq. of Huntly bk., [2 l.], ⊤ | 9 55 | 50 15 |
| | St. Pierre, [1½m.], *l*, ✱, NW pt. | 9 19 | 50 43·5 |
| | Providence I., [2m.], w, r, *l*, Village | 9 14 | 51 2·5 |
| | Umsinto blk. coral 11 fms. | 9 39·5 | 51 18 |
| | Tromelin, [1m.], *l*, or Sable I., ɪ, N pt. | 15 51·6 | 54 27·7 |
| | Cargados Carajos reefs, ⚓ 9 l., *l*, T E, r, S extr., Coco I., ✝₀ | 16 48·9 | 59 31·5 |
| | — Baleine shl., rf., [½m.] | 16 40·7 | 59 32·2 |
| | — Establishment | 16 26·5 | 59 37·5 |
| | Albatross I., [½m.], ₀ | 16 15·0 | 59 36·5 |
| | **Chagos Archipelago.** | | |
| *Chagos Group* | Speakers' bk., ⚓ 8 l., T, ɪ, NE pt. | 4 45 | 72 24 |
| | Blenheim rf., ⚓ 6m., T, N pt. | 5 9 | 72 25 |
| | Salomon Is., ⚓ 5½m., ⊞, N Id., E of entr., or I. de Passe | 5 18 | 72 12·7 |
| | — SW, or Boddam I. | 5 21·5 | 72 9·7 |
| | Peros Banhos, 27 Is., ⚓ 6 l., *l*, ⊞, I. de Passe, E side, entr., mid. | 5 14·0 | 71 46·0 |
| | — Diamond I., [1½m.], establ. | 5 15 | 71 42·7 |
| | — S extr., Foquet I., *l*, ✱ | 5 27 | 71 46 |
| | Benares shl., ⚓ 1½m., T, mid. ɪ | 5 15 | 71 37 |
| | Victory bk., ⚓ 4m., E pt, ɪ | 5 33 | 72 13 |
| | Great Chagos bk., ⚓ 32 l., T, E extr., ɪ | 6 5 | 72 43 |
| | — Nelson's I., [1m.], *l*, ✱ | 5 40 | 72 16 |

| | (58) Places | Lat. S | Lon. E |
|---|---|---|---|
| | Great Chagos bk., N extr., ɪ | 5°39' | 72° 1' |
| | — NW extr., Eagle Is., ⚓ 5m., *l*, ✝, N pt. | 6 10·5 | 71 18 |
| | — W entr., Danger I. [1½m.] | 6 23 | 71 13 |
| | Egmont, or Six Is., ⚓ 6m., T, SE Id., ✝ | 6 40 | 71 22 |
| | Pitt's bk., ⚓ 10 l., T, N pt., ⊤ | 6 49 | 71 10 |
| | — West extr., ⊤ | 7 2 | 71 4 |
| | A Reef, NS 2 l. | 7 11 | 72 36 |
| | Ganges' bk., ⚓ 4m., W extr., ɪ | 7 22 | 71 2 |
| | Diego Garcia NS 13m., *l*, ⊞, ✝, r, ✱, Mid I., E entr. | 7 13·5 | 72 23·7 |
| | — South pt. | 7 26·0 | 72 23·2 |
| | **Islands in Southern Indian Ocean.** | | |
| | MAURITIUS, PORT LOUIS, Martello Twr., Ft. George | 20 8·6 | 57 29·0 |
| | — Round I., [1m.], 1049f. | 19 50·5 | 57 47·5 |
| | — Peter Botte, 2600f. | 20 11·3 | 57 33·5 |
| | — Grand Port, Fouquet Id., lt. F 108f. | 20 23·5 | 57 46·7 |
| | Bourbon I., ⚓ 14 l. St. Denis, 2 lts., F, vert., 85f. | 20 51·5 | 55 27·5 |
| | — Pt. of Bel Air, lt., F 148f. | 20 53·2 | 55 36·5 |
| | — South extreme | 21 22·5 | 55 39 |
| | Rodrigue, EW 15m., v's. 14 l., rfs., 5 l. to SW-d., Point Venus | 19 40·4 | 63 26·2 |
| | Keeling Is., ✝, *l*, N Id., [1½m.] | 11 50 | 96 51 |
| | — S grp., Borneo Coral Is., ⊞, NS 8m., S pt. | 12 12·6 | 96 54 |
| | — Direction I., [¾m.], SW pt | 12 5·4 | 96 33·0 |
| | Christmas I., EW 3 l., vis. 12 l., ✝, ⊥ NW, Flying-fish cove | 10 25·3 | 105 43 |
| *Islands in Indian Ocean* | Enderby's land, pt. uncertain | 67 30 | 44 0 |
| | Bouvet's I. ○ | 54 20 | 5 24 |
| | Thompson's I. ○ | 53 56 | 5 30 |
| | Prince Edward's I., 2 [5 l.], and [3 l.], *h*, ✝₀, West I. | 46 34 | 37 56 |
| | Marion I., East cape | 46 52 | 37 53·5 |
| | Crozet's Is., Hog I., *h*, ⊥, ‡₀, (a rf. SE 9 m.) | 46 10 | 50 28 |
| | Kerguelen's land, ⚓ 32 l., Christmas Harb., ⊞, b S side, N pt., or C. François | 48 40 | 69 4 |
| | — Bligh's Cap, *h*, ✝₀, 230f. | 48 27 | 68 48·5 |
| | — C. St. Louis ○ | 49 15·5 | 68 38 |
| | — C. Challenger | 49 43·5 | 70 5 |
| | — E extr., C. Sandwich | 49 11 | 70 33·5 |
| | Heard or McDonald Is., ⚓ 50m. Meyer rk., NW extr. | 53 1·5 | 72 31 |
| | St. Paul's, ⚓ 3m., 860f., ‡ E, r, Ninepin rk. on E side, (w' ½m.) | 38 42·7 | 77 34·7 |
| | Amsterdam [4m.], ✱, sum. 2760f. | 37 50·7 | 77 31·5 |

MARITIME POSITIONS

| (59) Places | Lat. N | Lon. E |
|---|---|---|
| **HINDUSTAN WEST COAST.** *(Hindustan, W. Coast ⊕)* | | |
| Karáchi, ⊞, fort, lt. Rev. 154f. | 24°47′3 | 66°58′1 |
| Indus R., mouths always changing, Kukewári mo. | 23 57 | 67 25 |
| Mandvee, town | 22 50 | 69 18·2 |
| Bate, fort | 22 28·5 | 69 9 |
| Pt. Jigat, or Dwarka, temple | 22 14 | 68 57 |
| Conical Hill | 20 57 | 71 18 |
| Diu Hd., pt., lt. Fl. 106f. | 20 40 7 | 70 51 |
| — Island, Watch Tower | 20 42 7 | 70 59 |
| Jarabad, ⊞. lt. F 75f. | 20 51·6 | 71 22·0 |
| Shalbet I., [¾m.], rfs. 1m., mid. | 20 54 | 71 31 |
| Goapnauth Pt., lt. F 68f. | 21 12·3 | 72 6·5 |
| Perim I., rfs. NS 5m., lt. F 129f. | 21 35 3 | 72 20 |
| Gogo, town, w, t, lt. F 55f. | 21 40·0 | 72 16 5 |
| Cambay, fl. st. | 22 17·0 | 72 35·5 |
| Surat Castle | 21 12·0 | 72 47 |
| Vaux's tomb, Tapti, lt. F 130f. | 21 5·7 | 72 37·5 |
| Damaon, r, lt. F | 20 24 | 72 49 |
| St. John's Highland | 20 2 | 72 43 |
| Versavah fort | 19 7 | 72 46 |
| Bassean R. | 19 18 | 72 49 |
| Terrapore Pt. | 19 52 | 72 40 |
| Bombay, ⊞, ⊟, Observʸ, ⸸ | 18 53 8 | 72 49 0 |
| — Lighthouse, lt. Fl. 136f. | 18 53·7 | 72 48·0 |
| — Kundari, lt. F 148f. | 18 42 | 72 48 |
| Coulaba I. | 18 37 | 72 51 |
| Chaoul, ⊞, ɪ | 18 34 | 72 54 |
| Rajpuri Harb. Pt., lt. F 179f. | 18 17 | 72 56 |
| Bancoot R., 10f. bar | 17 57 | 73 1 |
| Severndroog I., l | 17 47 | 73 5 |
| Angenweel Harb., ⊞, fort, S entr | 17 33·4 | 73 14 |
| Zyghur Pt., ⸸, ⊞ | 17 16 | 73 10 |
| Ratnagiri fort, lt. F 308f. | 16 59 | 73 16 |
| Geriah Pt., h, fl. st., ⊞ | 16 31 | 73 22 |
| Angria bk., NS 7 l., T, 13 S pt. | 16 18 | 71 43 |
| Vingorla rks., [5m.], 20f., T, beac., lt. F 100f. | 15 53 | 73 27 |
| Agoada Pt., w‴, (Goa), ⊞, r, lt. Rev. 280f. *(Malabar Coast ⊕)* | 15 29·5 | 73 46 |
| Mormagoa, r, fl. st. | 15 24½ | 73 46·7 |
| St. George Is., [2m.], h, outer | 15 21 | 73 45 |
| C. Ramas, h, ⊥, W extr. | 15 4·2 | 73 54·7 |
| Oyster rks., [½m.], lt. F 210f. | 14 49 | 74 2 |
| Carwar Hd. | 14 47 | 74 10 |
| Anjediva I., [½m.] | 14 45 | 74 5 |
| Merjee R., w′, b, bar 2, N bluff | 14 30 | 74 21 |
| Fortified I., w, [1m.] | 14 18·5 | 74 23·2 |
| Pigeon I., vis. 8 l., T | 14 1 | 74 18 |
| Barsalore Pk., 4452f. | 13 50 | 74 51 |
| St. Mary's rks., 5m. out, large one | 13 20 | 74 40 |
| Premiera, or Molky rks. | 13 11 | 74 38 |
| Mangalore hill. lt. F 240f. | 12 52 | 74 50 |
| Barn hill | 12 40 | 75 1 |
| Mt. Dilly, 8 or 9 l. | 12 2 | 75 11 |
| Cananore, pt., T, w′, lt. F 64f. | 11 51·2 | 75 21 7 |
| Tillicherry, r, w′, lt. F 88f. | 11 44·9 | 75 28 2 |
| Sacrifice rk., 20f., T | 11 30 | 75 30 |
| Calicut, lt. F 103f. | 11 15·2 | 75 45·7 |
| Chitwa, Ch. | 10 33 | 76 1 |

| (60) Places | Lat. N | Lon. E |
|---|---|---|
| Cranganore R., fort, bar 8f. | 10°12′ | 76°12′ |
| Cochin, w, r, bar 11f., (lt. F 100f.) | 9 58 | 76 14 |
| Quiloan, fl. st. | 8 53·5 | 76 33·2 |
| Anjenga, L, w, fl. st. | 8 39·9 | 76 45·0 |
| Trevandrum Pagoda | 8 29·0 | 76 56 |
| C. Comorin, pt. | 8 4·0 | 77 32·5 |
| — Peak | 8 23·2 | 77 30 5 |
| Minikoi I., lt. Rev. 150f. | 8 15 | 73 1 |
| Manapar Pt., T T | 8 22 | 78 3 |
| Trichindore pagoda | 8 30 | 78 7 |
| Punnecoil, w, r, b | 8 40 | 78 6 |
| Paumbeu Pt., fort | 9 17 0 | 79 14 |
| **CEYLON.** *(Ceylon)* | | |
| Calpentyn, fort | 8 15 | 79 45 |
| Negombo | 7 12 | 79 48 |
| Colombo, r, w, lt. Fl 135f. | 6 56·3 | 79 50·5 |
| Kalitura | 6 35 | 79 57·5 |
| Pt. de Galle, ⊟, ⊞, r, w, fl. st., lt. F 100f. | 6 1·8 | 80 12·5 |
| Adam's peak, 7000f. | 6 52 | 80 29 |
| Matura, b. w, fort | 5 57 | 80 33 |
| Dondra Hd., lt. 150f., l, ⸸ | 5 55 | 80 35·5 |
| Great Bassas, rks., [1m.], T, 8, lt. Rev. 110f. | 6 11 | 81 29 |
| Elephant rock, inland | 6 21 | 81 28 |
| Little Bassas, rks., lt. Fl. 110f. | 6 24·5 | 81 44 |
| Komarie | 7 2 | 81 52 |
| Batticaloa, (bar 8f.), b, w, lt. F 47f. | 7 45·5 | 81 41·2 |
| Vendeloos B., N or Elephant Pt. | 8 0 | 81 33 |
| Chelitivo I., 30f. | 8 7 | 81 28 |
| Foul Pt., lt. F, Fl 104f. | 8 32 | 81 19 |
| Trincomalee, ⊞, lt. F 103f., Fort Frederick | 8 35 5 | 81 15 |
| Pigeon I., [½m.], rk., ✱, 99f. | 8 43·7 | 81 12 5 |
| Muletivu House, (shl. 4m.) | 9 16 | 80 49 |
| Mark House | 9 32·5 | 80 30 |
| Pedro Pt., ⸸, (shl. 5m.) | 9 51 | 80 14·5 |
| **BAY OF BENGAL.** | | |
| Pt. Calimere. l, ⸸ | 10 18 | 79 52 |
| Negapatam, w, r. bar, lt. F 80f. | 10 45·6 | 79 50·5 |
| Five white pagodas | 10 49 | 79 50 |
| Tranquebar | 11 1·5 | 79 50·5 |
| Colero n Shl. | 11 27 | 79 47 |
| Porto Novo, w‴ | 11 30 | 79 43 |
| Cuddalore, town and riv., w, r | 11 43·5 | 79 45·7 |
| Pondicherry, lt. F 89f. | 11 55·7 | 79 50 |
| Alemparva | 12 15 | 80 0 |
| Mahábalipur pagodas, lt. Fl. 116f. | 12 37 | 80 11 |
| Covelang | 12 48 | 80 15 |
| Madras, ⊟, Observatory, ⸸ *(Coromandel Coast)* | 13 4·1 | 80 14 7 |
| — Ft. St. George, lt. Fl. 128f. | 13 4 7 | 80 17 |
| Pulicat, lt. F 68f. | 13 25·2 | 80 19·0 |
| Armeghon, lt. Rev. 107f. | 13 53 | 80 12 |
| Mootapilly shl., [1m.], ɪ, T, 8m. out | 15 25 | 80 18 |
| Pt. Divi, lt F 48f. | 15 59 | 81 9 |
| Masulipatam, lt. F 69f. | 16 9·1 | 81 8·5 |
| Narsapour, pt., l, ✱ | 16 20 | 81 42 |
| Pt. Gordewar, lt. F 83f. | 16 49 | 82 19 |
| Coringa, town | 16 49 | 82 12 |

## MARITIME POSITIONS

| Region | (61) Places | Lat. N | Lon. E |
|---|---|---|---|
| Bengal | Vizagapatam, fl. st. | 17°41′·6 | 83°17′ |
| | Santapilly, lt. F 173f. | 18 5 | 83 38 |
| | Chicacole | 18 17·0 | 83 53·2 |
| | Gopalpur, lt. F 85f. | 19 13 | 84 52 |
| | Ganjam, fl. st. | 19 22·5 | 85 3 |
| | Jugurnaut pagodas, large | 19 50 | 85 56 |
| | Black Pagoda | 19 52 | 86 8 |
| | False Pt., *l*, †, lt. occ. 120f. | 20 19·4 | 86 44 |
| | Mypurra I., [¾m.], S pt. | 20 41·3 | 87 7·0 |
| | Pt. Palmiras, *l*, †, (sh. 2 or 3 l. off) | 20 41 | 87 9 |
| | Balasor R., †₀, Chandipur, lt. F 106f. | 21 26·0 | 87 2 |
| | Kedgeree, lt. F 62f. | 21 50·3 | 87 55·7 |
| | Saugor I., Middleton Pt., lt. F, Fl. 74f. | 21 39 | 88 2 |
| | Calcutta, ⊞. Fort William | 22 33·5 | 88 19·7 |
| | Diamond Harb., Semaphore | 22 11·2 | 88 10 |
| | Luckipoor | 22 55 | 90 55 |
| | Chittagong, town, jetty | 22 19·5 | 91 49·5 |
| | — River, bar ȥ, fl. st. at mouth | 22 14·1 | 91 50 |
| | Kutabdia I., ⁴⁄₂ 4 l., *l*, †, lt. F on W side 126f. | 21 52·6 | 91 50 |
| | Shoal Patch, [1m.] ȥ | 21 48 | 91 43 |
| Arracan | Elephant Pt., vis. 5 l., rks. off | 21 10 | 92 3 |
| | Table Land, 8300f. ? | 21 9 | 92 23 |
| | St. Martin reef, [½m.] | 20 38 | 92 12 |
| | — I., NS 5m., S pt. rks. | 20 34 | 92 20·7 |
| | Oyster Id., ȥ, rfs., lt. F 75f. | 20 12 | 92 33 |
| | Mosque Pt., or Fakeer's Pt. | 20 6·7 | 92 53·7 |
| | Akyab harb., ⊞, fl. st. | 20 8·4 | 92 54·0 |
| | Great Savage, lt. F, Fl. 89f. | 20 5·2 | 92 53·7 |
| | Borongo I., ⁴⁄₂ 6 l., hum. S pt. | 19 49 | 93 2 |
| | Kenian kown toung pk., 12 l. | 19 48 | 93 28 |
| | Terribles, NS 6m., W lim. | 19 22 | 93 16 |
| | Kyook Phoo, ⊞, fl. st. | 19 26·4 | 93 32·5 |
| | Beacon I., [½m.] | 18 54·5 | 93 26 |
| | Cheduba I., ⁴⁄₂ 6 l., W pt. volc. | 18 52 | 93 28 |
| | — Town, r, w | 18 51 | 93 42·5 |
| | — South pk., 1700f. | 18 41 | 93 41 |
| | Tree I., [1m.], 250f. †, mid. | 18 26·5 | 93 55 |
| | Sandoway, town | 18 26 | 94 18 |
| | Foul I., ⁴⁄₂ 2m., sum. | 18 3 | 94 6 |
| | Vestal shl., ȥ, [½m.] | 18 2 | 94 14 |
| Pegu | Rocky Pt. | 17 36·5 | 94 34 |
| | Gwa, Mosque | 17 33·5 | 94 35·5 |
| | St. John's, or Ch. rks., [½m.] | 17 27·0 | 94 20 |
| | Calventura rks., ⁴⁄₂ 2 l., NW grp. | 16 55 | 94 14 |
| | Milestone rk. | 16 40 | 94 18 |
| | Coronge I., ⁴⁄₂ 2m., S pt. | 16 31 | 94 14·5 |
| | Shoal, awash, [½m.] | 16 29 | 94 12 |
| | Round Cape | 16 16 | 94 12·5 |
| | C. Negrais | 16 1·5 | 94 10·5 |
| | Diamond I., [1m.], *l*, †, mo. of Pegu R., (rks. off) | 15 51·5 | 94 15·5 |
| Gulf of Martaban | Poriam Pt., ⊥, † | 15 49·5 | 94 23·5 |
| | Aguada rf., ⁴⁄₂ 2m., lt. R. | 15 42 | 94 11 |
| | Elephant Pt., †, pagoda | 16 28·7 | 96 19·2 |
| | Rangoon R., bar ȥ, City, Dagon Pagoda | 16 47·8 | 96 8·5 |
| | — Eastern Grove, lt. F 93f. | 16 30 | 96 23 |
| | Riv. Settang, E pt. entr., *l*, † | 16 28 | 97 20 |
| | Martaban | 16 32 | 97 35 |
| | Maulmain, pagoda | 16 30 | 97 37 |
| | Quickine, pagoda, (rf. 1½m.) | 16 3·1 | 97 32 |
| | Amherst, pagoda | 16 4·7 | 97 33 |

| Region | (62) Places | Lat. N | Lon. E |
|---|---|---|---|
| Mergui Archipelago | Double I., [½m.], lt. F 164f. | 15°52′·5 | 97°34′·5 |
| | Callagouk I., NS 6m., w NE, N sum | 15 34·5 | 97 38 |
| | Padoga Pt., Bluff Pt. | 15 12 | 97 47 |
| | Moscos Is., N grp., N Id. | 14 27 | 97 45 |
| | — South grp., S extr. | 13 47 | 97 53 |
| | The Cone, vis. 16 l. | 14 1 | 98 24 |
| | Reef I., Tavoy N., lt. F 309f. | 13 36 | 98 13 |
| | Cap I., [½m.] | 13 32 | 98 6 |
| | Tavoy Pt., pagoda, ⊥, †, w, b. | 13 31·3 | 98 14·2 |
| | Tavoy town | 14 3 | 98 11 |
| | Tavoy I., ⁴⁄₂ 6 l., pk. (w. S part), Port Owen, ⊞, E-d, w, b, Clyde Pt. | 13 5 | 98 20 |
| | Mergui, SE corner of Court Ho. | 12 26·2 | 98 36 |
| | Kabosa, I., 1300f., ⁴⁄₂ 3½m., sum. | 12 47·6 | 97 51·5 |
| | W. Canister, [2c.], *h*, ⊥ | 12 42·0 | 97 43 |
| | Tenasserim I., NS 3½m., sum. | 12 34 | 97 50·7 |
| | Sir Ch. Metcalfe I., ⁴⁄₂ 3m., sum | 12 17 | 97 47 |
| | Great Western Torres, [5m.], W sum., 1413f. | 11 47·5 | 97 27·5 |
| | Black rk., vis. 8m. | 11 23 | 97 39 |
| | Forrest Straits, High I., 1392f. | 11 1·5 | 98 18·5 |
| | Twins, NS 10m., S one, [1m.] | 10 28 | 97 41 |
| | Horsburgh I., [¾m.], vis. 7 l. | 10 12 | 97 52·5 |
| | St. Matthew's I., sum. vis. 18 l. | 9 58·0 | 98 12 |
| | — Hastings Harb., ⊞, ww₀, harb. pk. | 10 5·1 | 98 11·5 |
| | Pt. Victoria, W pt. of Pak Chan R. | 9 58·5 | 97 33 |
| | Western rocky I., & rks. [¼m.] | 9 51·5 | 97 52 |
| | Chance I., ⁴⁄₂ 5m., peak, vis. 12 l. | 9 24 | 97 51 |
| | Middle I., [1½m.], vis. 8 or 9 l. | 9 4 | 97 48 |
| | Sayer Is., NS 4 l., T, pk., 334f. | 8 41 | 97 40·5 |
| | Junkseilon, or Salang I., NS 8 l., (a high mt. vis. 12 l.), S pt., Lem. Voalan | 7 46·4 | 98 18·2 |
| | — Puket, town, ⊞, r, † | 7 51 | 98 20·2 |
| | Pulo Rajah, or Taya, 1064f. | 7 36 | 98 22 |
| | Brothers, 2, NS 3m., S pt. | 7 28 | 98 18·5 |
| | Sangald, or Guilder rks., rf., *l*, T | 7 10 | 98 49·5 |
| | Telibon I., ⊞, r, SW part | 7 13 | 99 24 |
| | Butong Is., 2, E or Dome, 2815f. | 6 32 | 99 19 |
| | Pulo Ladda, [5m.], Bass Harb., ⊞. peak, 1000f. | 6 12 | 99 44 |
| | Queda, town, ⊞ | 6 6 | 100 18 |
| Andaman Isles | Preparis I., ⁴⁄₂ 8m., T E, †, reef off E side S pt. | 14 50·5 | 93 39 |
| | Great Coco I., NS 6m., †, †, b, w? lt. on Table I., F 195 f. | 14 12·5 | 93 22·2 |
| | Little Coco I., NS 2½m., †, † S pt. | 13 58 | 93 13 |
| | Great Andaman, Port Cornwallis, Brush Id., ⊞ | 13 17·5 | 93 2 |
| | — Saddle Hill, 2400f. N pk. | 13 12 | 93 0 |
| | Sir Hugh I., S extr. | 11 47 | 93 4·7 |
| | — Port Blair, Chatham I. | 11 41·2 | 92 43·0 |
| | — Ross I., lt. F 159f. | 11 41 | 92 45 |
| | Sisters, 2, [1m.], E one | 11 11·2 | 92 45 |
| | Brothers, 2, ⁴⁄₂ 3m., N one | 11 4 | 92 39·2 |

## MARITIME POSITIONS

| | (63) Places | Lat. N | Lon. E |
|---|---|---|---|
| | Little Andaman, NS 7 l., ✝, S bay, (P, w N pt.)... | 10°33'5 | 92°28'5 |
| | S. Sentinel, [1m.], 6 L, ✝ .. | 11 2·5 | 92 12·5 |
| | Flat Rock, [30 yds.], 8f. (on Invisible Bk.)............... | 11 8 | 93 30·2 |
| | Volcano or Barren I., 1158f.... | 12 15 | 93 50 |
| | Narcondam, T, 2330f. ......... | 13 25·8 | 94 16 |
| Nicobar Isles | Kar Nicobar I., Sawi B. ...... | 9 14·2 | 92 45·7 |
| Nicobar Isles | Batti Malv, or Quoin, [1⅓m.], ✱, w, 150f...... | 8 49·7 | 92 51 |
| Nicobar Isles | Chaura, [1⅓m.], ✝, 343f....... | 8 27 | 93 2·2 |
| Nicobar Isles | Teressa, ✝ 4 l., ✝, 897f, S pt........................... | 8 12 | 93 11 |
| Nicobar Isles | Tilangchong, EW 4 l., ✝, Maharani Pk., 1058f....... | 8 29·7 | 93 37 |
| Nicobar Isles | Kamorta I., 238f., Naukauri Hr., Naval Pt.............. | 8 2 | 93 32 |
| Nicobar Isles | Kachal I., 835f. pk. ........... | 7 57 | 93 23 |
| Nicobar Isles | Meroe, small, l .................. | 7 30·7 | 93 31·7 |
| Nicobar Isles | Little Nicobar, ✝ 4 L, ✝, Mt. Deoban, 1428f. ...... | 7 20 | 93 40·7 |
| Nicobar Isles | Grt. Nicobar, 2105f., Kondul I., 400f.................... | 7 13 | 93 42 |
| Nicobar Isles | — Pygmalion Pt. ............... | 6 45 | 93 49·5 |
| | **STRAIT OF MALACCA.** | | |
| | Pulo Pera, vis. 7 l., ✱, T ... | 5 42 | 98 56·7 |
| | Penang I., NS 4 l., sum. 2713f. | 5 25 | 100 14 |
| | — George Town, ⊞, ⓑ, fort Cornwallis, lt. Rev. 107f. ...................... ⊕ | 5 24·5 | 100 20·2 |
| | Saddle L, [⅓m.].................. | 5 13 | 100 10 |
| | Pulo Dinding, ✝ 2m., h, ✝, w E, Port Pancore, lt. F... | 4 13·3 | 100 34·2 |
| | Salangor fort, lt. F................ | 3 20 | 101 12 |
| | Sumbelan, or 9 Is., ✝ 7m., vis. 7 l., ✝, white rk....... | 4 2 | 100 30 |
| Strait of Malacca. | Jara I., [⅓m.], T, ✝ ......... | 4 0 | 100 9 |
| Strait of Malacca. | Parcelar hill .................... | 2 52 | 101 25 |
| Strait of Malacca. | Round, or S. Arroa, h, ✝, (rks. off)...................... | 2 49 | 100 35 |
| Strait of Malacca. | C. Rachado, ⊥, ✝, lt. F 446f. | 2 24 | 101 51 |
| Strait of Malacca. | Malacca, St. Paul hill, lt. F 180f. ........................ | 2 12 | 102 15 |
| Strait of Malacca. | Water Is., h, ✝, large or S, w | 2 4 | 102 19 |
| Strait of Malacca. | Mt. Moar, h, ✝ .................. | 1 59 | 102 40 |
| | Mt. Formosa, (bk. WSW 2 l.) | 1 49 | 102 54 |
| | Po. Pisang, ✝, lt. Fl. 325f. ... | 1 27 | 103 15 |
| | SINGAPORE, ⓑ, FULLERTON BATTERY........................ | 1 17·2 | 103 51·2 |
| | Pt. Romania, (Is., 3m. out) ... | 1 22 | 104 16 |
| | Barbukit hill, 645f. ............ | 1 24 | 104 11 |
| | Pedra Branca, T, NW, 8 S. Horsburgh, lt. Fl. 101f. | 1 20 | 104 24·6 |
| | Bintang hill, 1200f. ............ | 1 5 | 104 26 |
| | — Black rk. ....................... | 1 14·5 | 104 34 |
| | **WEST COAST SUMATRA.** | | |
| | Po. Rondo, (*Tepurong*), 426f. rks. S d ..................... | 6 3·5 | 95 7·7 |

| | (64) Places | Lat. | Lon. E. |
|---|---|---|---|
| | | North | |
| | Pulo Wai ✝ 3 l., vis. 12 l., T S, S pt. ................ | 5° 46'5 | 95°21' |
| | Buru I., or Malora lt. F 62f. | 5 40·7 | 95 24·7 |
| | Po. Nancy, (bay S, w, b, ⚓), N pt. .......................... | 5 40 | 95 10 |
| | Pulo Brasse, h. N, lt. Rev. 525f. | 5 45 | 95 4·2 |
| S. W. Coast of Sumatra | Golden or Queen's Mountain, 8280f. ............... | 5 22 | 95 45 |
| S. W. Coast of Sumatra | Achen Hd., or King's Pt., h, ⊥ | 5 31·5 | 95 13·2 |
| S. W. Coast of Sumatra | Rajah Passage ................... | 4 50·7 | 95 24 |
| S. W. Coast of Sumatra | Rigas Bay ......................... | 4 38·3 | 95 34·2 |
| S. W. Coast of Sumatra | Bubu Bay ......................... | 4 12 | 96 1 |
| S. W. Coast of Sumatra | Anslabu, w, r, b .............. | 4 8·2 | 96 7 |
| S. W. Coast of Sumatra | C. Felix, l, T .................... | 3 44 | 96 36 |
| S. W. Coast of Sumatra | Susu, Po. Kio ................... | 3 43·3 | 96 45·7 |
| S. W. Coast of Sumatra | Goonung Loo e, 12,140f. ...... | 3 44 | 97 7·2 |
| S. W. Coast of Sumatra | Tampat Tuan Pt. ............. | 3 15 | 97 10 |
| | Teumon Road...................... | 2 46 | 97 37 |
| | Sinkel. pt. ....................... ⊖ | 2 16·8 | 97 44·7 |
| | Cocos Is., 2, l, ✝ ............... ○ | 3 0 | 95 18 |
| | Pulo Simalla, ✝ 17 l., N pt. ○ | 2 57 | 95 47 |
| | — South pt. ........................ ○ | 2 19 | 96 22 |
| | Flat Is., 2, (small), S pt. ... ○ | 2 3 | 96 35 |
| | Banjak Is., Middle Is., Po Sorong Alu................... | 1 58 | 97 21 |
| | Pulo Lakotta, l, ✝ ............. | 1 51·5 | 97 59 |
| | Pulo Babi ........................ ○ | 1 41 | 97 27·2 |
| | Pulo Nias, ✝ 22 l., W pt., Tanjong Letung ......... ○ | 1 24 | 97 1 |
| | — South pt., ⊞, r, w, Telok Dalam ............ ○ | 0 33 | 97 50 |
| | Nako Is., Asu..................... | 0 54 | 97 11 |
| | Tapanuli B., I., ⊞, Siboga ... | 1 44·4 | 98 45·7 |
| | Pulo Dua.......................... | 1 28·5 | 98 9 |
| | Tabujong Road ................ | 0 51 | 98 55·5 |
| | Natal B., 88, Natal ......... ⊖ | 0 33·5 | 99 6 |
| | Ayer Bangies, Po. Panka... ⊖ | 0 8 | 99 16·5 |
| | Po. Pinie, Batu Belobang, ✝ 3 l. ......................... ○ | 0 9 | 98 30 |
| | Mt. Ophir, 9472 f. ............. ○ | 0 5 | 99 58 |
| | Tanah Massa I., N pt. ...... ○ | 0 2 | 98 22 |
| | | South | |
| | Po. Bojo, lt. Fl. 361f. ......... ○ | 0 39 | 98 32 |
| | Siberoet, N pt. Sigeb ...... | 0 55 | 98 55 |
| | — West I. ........................ ○ | 1 55 | 99 12 |
| | Sipora I., Hurlock Bay ........ | 2 2 | 99 33 |
| | — S pt., C. Marlborough ... ○ | 2 24 | 99 49 |
| | N. Pagi I., N pt. ............... | 2 32 | 100 0 |
| | — SW pt., or Pt. Batu ...... ○ | 2 49 | 99 57 |
| | S. Pagi I., S pt. Sibaru I....... | 3 20 | 100 25 |
| | Trieste I., Po. Mega, [1⅓m.], l, ✝ .................. | 4 0 | 101 1 |
| | Engano I, ✝ 7 L, P, W pt., Komang .............. | 5 21 | 102 5 |
| | — South pt., Kenemei ......... | 5 31 | 102 9·5 |
| | Priaman, fl. st. .................. | 0 38 | 100 6 |
| | Padang I, lt. Rev. 180f. ... ⊖ | 0 57 | 100 7 |
| Sumatra | Pulo Baringin ................... | 1 55 5 | 100 39 |
| Sumatra | Indrapura Pt., l, ✝ ........... | 2 10 | 100 50 |
| Sumatra | Moko Moko ....................... | 2 34 | 101 8 |
| Sumatra | Benculen, lt. F ................ | 3 47 | 102 16 |
| | — Po. Tikus, lt. F 44f ........ | 3 50 | 102 11 |
| | Mana Pt........................... ⊖ | 4 31 | 102 54·5 |
| | Kawur or Sambat ............ ⊖ | 4 50 | 103 24 |
| | Pulo Pisang, [1⅓m.], lt. ...... | 5 7 | 103 49·5 |

## MARITIME POSITIONS

| | (65) Places | Lat. S | Lon. E |
|---|---|---|---|
| | Kroe Road, w, r ........O | 5°11' | 103°56' |
| | Bengkunat B, rky. S pt. .. | 5 35 | 104 14 |
| | Little Fortune I., [1m.], l, ⚓ .......... | 5 57 | 104 24 |
| | **STRAIT OF SUNDA** | | |
| Strait of Sunda | Flat Pt., lt. Fl. 213f. ........O | 5 55 | 104 33·5 |
| Strait of Sunda | Labuan I, ⚓ 7m., W end ... | 5 47·5 | 104 47 |
| Strait of Sunda | Keyser's Pk., 7412f. .......... | 5 26 | 104 40 |
| Strait of Sunda | Kalambayang Harb., ▣, w, r, Klapa I. .............. | 5 46·2 | 105 2·2 |
| Strait of Sunda | Pulo Lagundi, ▣, mid. N side .................. | 5 50 | 105 17·2 |
| Strait of Sunda | Telok Betung, lt. F 48f. ...... | 5 28 | 105 15·7 |
| Strait of Sunda | Rajah Basa, w, r, pk., 4235f. | 5 47·5 | 105 39 |
| Strait of Sunda | Hog Pt .......................... | 5 55 | 105 43 |
| Strait of Sunda | Java Head ....................... | 6 47 | 105 11 |
| Strait of Sunda | Mew B., w''', SE of Mew I., P, .................. | 6 45 | 105 15 |
| Strait of Sunda | Prince's I., ⚓ 4 l., N and E pt., 1450f. ............ | 6 31 | 105 15 |
| Strait of Sunda | Krakatoa, pk., 2657f. ...... | 6 9 | 105 27 |
| Strait of Sunda | Sea rks., Gap rk ............... | 5 59 | 105 23 |
| Strait of Sunda | Sebooko, ⚓ 3m., 1398f., N pt. | 5 51·5 | 105 32 |
| Strait of Sunda | Thwart the Way, or Sangian I., ⚓ 2½m., l, (rks. 2m. NW), pk. 505f. .......... | 5 58 | 105 49·7 |
| Strait of Sunda | Anjer, ⚓, w, r., (lt. SW-d), fl. st | 6 3·2 | 105 55 |
| Strait of Sunda | St. Nicolas Pt. ................ | 5 52·5 | 106 2 |
| Strait of Sunda | North Id., small, vis. 7 l. ...... | 5 42 | 105 50 |
| Strait of Sunda | Thousand Is., Northernmost Dua I. ............ | 5 24·5 | 106 28 |
| Strait of Sunda | — Peblakan, or W. Id. ......... | 5 28·5 | 106 23 |
| Strait of Sunda | Arnemuiden rk., [½m.], 10f., ~ | 5 13 | 106 44·2 |
| Strait of Sunda | North Watcher, small, ⚓, (Omega shl., E' b S' ½m., 8 T), lt. R. 159f. ........ | 5 12·5 | 106 27 |
| Strait of Sunda | Two Brothers, ⚓, fl., N one... | 5 9·5 | 106 6 |
| Strait of Sunda | Lynn shl., [1c.], d, T ......... | 5 12 | 106 12 |
| Strait of Sunda | Brouwers shls, 2 rfs., [½m.]... | 5 4·7 | 106 16 |
| Strait of Sunda | Shahbunder shl., E lim. ...... | 5 7 | 105 59 |
| | **STRAIT OF SUNDA TO SINGAPORE.** | | |
| Banka Strait | Tree I., N pt. ................... | 3 46 | 105 54 |
| Banka Strait | Lucipara I., [1m.], ⚓, w', (rf. SSE, 2m.) ............ | 3 13 | 106 13 |
| Banka Strait | First Point, l, level, ⚓ ......... | 3 0 | 106 3 |
| Banka Strait | Banca, S extr., Dapur I. 120f. | 3 8 | 106 31 |
| Banka Strait | — Parmesang hill, 1608f. ...... | 2 35 | 105 56 |
| Banka Strait | — Nangka Is., 3, great one, w, b, N pt. 285f. .......... | 2 23 | 105 45·5 |
| Banka Strait | — Monopin Hill, 1456f. ...... | 2 1 | 105 11 |
| Banka Strait | — Kalian Pt., lt. F 170f. ...... | 2 5 | 105 8 |
| Banka Strait | — Frederic Hendric rks. ...... | 1 58 | 104 58 |
| Banka Strait | — North or Mengkudu Pt., islet | 1 29·3 | 105 53·5 |
| Banka Strait | — Goonung, or Mt. Marass, E sum., 2300f. ......... | 1 52 | 105 52 |
| Banka Strait | — E extr., Berikat Pt., 660f.... | 2 34 | 106 51 |
| Banka Strait | — Entrance Pt., (SE extr. of Lepa), Murong ......... | 3 2 | 106 54 |
| | Fairlie rk., [¼c.], rf., T ...... | 3 27 | 107 1 |
| | Sand I., [1 l.], ß all round ... | 3 30 | 107 10 |

| | (66) Places | Lat. | Lon. E |
|---|---|---|---|
| | | South | |
| Strait of Gaspar | Shoal-water I., lt. F 200f. ...... | 3°19'2 | 107°13'2 |
| Strait of Gaspar | Vansittart shls., NS 3 l., S pt. ............ | 3 10 | 107 6 |
| Strait of Gaspar | Saddle I., Klambau, 266f. ...... | 3 2 | 107 11 |
| Strait of Gaspar | Table I., Goesik, 116f. ........ | 2 59·8 | 107 17 |
| Strait of Gaspar | Pulo Leat, ⚓ 6m., Alceste (wrecked there), lt. F 39f. | 2 49 | 107 1·2 |
| Strait of Gaspar | Long I., EW 10m., W pt ...... | 2 52 | 107 21 |
| Strait of Gaspar | Billiton, Po. Selio, to SW [4m.], S pt. 242f. ......... | 3 15·5 | 107 32 |
| Strait of Gaspar | — S point, Kalumpang, (shl. 1m. out) ............... | 3 16·4 | 107 59·5 |
| Strait of Gaspar | — Shoals on E side E. Protet ........................ | 3 3 | 108 31 |
| Strait of Gaspar | — Burung Mandi Pt. ......... | 2 45·3 | 108 16·7 |
| Strait of Gaspar | — North-west I., Longwas, lt. I 200f. ............. | 2 32·3 | 107 38 |
| Strait of Gaspar | Carnbee shl., rks | 3 34·2 | 107 41 |
| Strait of Gaspar | Canning's rk., [½c.], s, T, 8... | 2 23 | 107 15·5 |
| Strait of Gaspar | Gaspar I., [1½m.], 812f. ........ | 2 25 | 107 5 |
| Strait of Gaspar | Tree I, [1m], 40f., 2 or 3 ⚓ | 2 28 | 106 59 |
| Strait of Gaspar | Warren Hastings rf. ......... | 2 22 | 106 56·5 |
| Strait of Gaspar | Belvidere rk, 10f. ............ | 2 12 | 107 2·5 |
| Strait of Gaspar | Stttard rf., s, 8 ................. | 2 12 | 106 46 |
| Strait of Gaspar | Magdalen shl., [1c.], s, T, crl. | 2 2 | 107 0·5 |
| Strait of Gaspar | Newland shl., s, 8, T r ......... | 1 52 | 107 1·5 |
| Strait of Gaspar | Palmer shl. ..................O | 1 58 | 106 24 |
| Strait of Gaspar | Severn shl., [3m.], 18f. ......O | 1 37·6 | 106 31·5 |
| Strait of Gaspar | Deva rfs ........................ | 1 10·2 | 106 46·2 |
| Strait of Gaspar | Vega shl., [½c.], sf., T 8 ...O | 1 7·5 | 106 37·5 |
| Carimata Strait | Shoe I., Kebatu, 346f ......... | 3 47·7 | 108 4 |
| Carimata Strait | Discovery, West bk., [1m.], ld. | 3 39 | 108 45·5 |
| Carimata Strait | — East bk., [½m.], ld., 2 ⚓... | 3 35 | 109 11 |
| Carimata Strait | Osterley shls., [6 l.], N one... | 3 17·7 | 108 38·2 |
| Carimata Strait | Cirencester bk., [½m.] ......... | 3 16·2 | 108 59·2 |
| Carimata Strait | Montaran Is, EW 12 l., NE extr. or Catherina rf. ....... | 2 30·7 | 108 55·2 |
| Carimata Strait | W. grp., Nangka I., pk. 549f... | 2 30 | 108 33 |
| Carimata Strait | Ontario rf., [½m.], T, 8 (a coral rf. W 3m., s) ...... | 1 59·5 | 108 39·5 |
| Carimata Strait | Serutu, EW 2 l., 1575f., w, W end ................ | 1 43 | 108 41·2 |
| Carimata Strait | Carimata, [3½ l.], w, b, pk. 3378f. ............... | 1 36 | 108 54·5 |
| Carimata Strait | Penebangan, ⚓ 2 l., h, w', pk. 1722f. ............... | 1 24 | 109 15 |
| Carimata Strait | Greig Shoals, N. Greig ......... | 0 52·5 | 108 32·5 |
| Carimata Strait | Greig shls., Gwalia ......... | 1 5·7 | 108 34·5 |
| Is. N. W. of Banka | Pulo Toty ...................... | 0 54·5 | 105 46 |
| Is. N. W. of Banka | Pulo Docan ..................... | 0 58 | 105 39 |
| Is. N. W. of Banka | Po. Tudju, or Seven Is., ⚓ 8m., ⚓, NW one ...... | 1 8 | 105 14 |
| Is. N. W. of Banka | Pulo Varella, (Is. [3m.]), 450f. | 0 48 | 104 24 |
| Is. N. W. of Banka | Pulo Taya, [3m.], 630f. ........ | 0 43·6 | 104 54·2 |
| Is. N. W. of Banka | Po. Sinkep, S pt. C. Bulu...... | 0 38 | 104 22 |
| Is. N. W. of Banka | Alang Kalem, [2m.], T ...... | 0 24 | 104 57 |
| Is. N. W. of Banka | Linga I., ⚓ sum. 3921f. ...... | 0 11 | 104 32·5 |
| Is. N. W. of Banka | East Domino, [1m.] .......... | 0 6 | 104 58 |
| | | North | |
| Is. N. W. of Banka | Pollux rk., s ................... | 0 12·5 | 104 44·5 |
| Is. N. W. of Banka | Terobi, 112f. ................ | 0 42·4 | 104 47 |
| Is. N. W. of Banka | Frederick rk., [3c.], s, ßß ... | 0 38·5 | 105 10·7 |
| Is. N. W. of Banka | Pulo Panjang, EW 4m., 390f., E pt. .............. | 1 1 | 104 51·2 |

## MARITIME POSITIONS

| Region | (67) Places | Lat. | Lon. E |
|---|---|---|---|
| | | South | |
| Sumatra, N.E. Coast | Batacarang Pt. .................. | 2° 0′ | 104°51′ |
| | Jabong Pt. .......................... | 0 56 | 104 23 |
| | C. Baroe ............................ | 0 1 | 103 48·5 |
| | | North | |
| | Rhio Str., Garras I., W side entr., lt. F 121f. ............ | 0 46 | 104 21 |
| | — Pulo Sau, lt. F 108f.......... | 1 4 | 104 10 |
| | Gt. Carimon, S pk., 1474f. ... | 1 5 | 103 19 |
| | Little Carimon, 3m., T NE, N pk., 1062f....... | 1 8 | 103 22 |
| | Bucalisse I., *l*, NE pt. ......... | 1 34 | 102 23 |
| | Pulo Roupat, N pt., T ......... | 2 6 | 101 39 |
| | Reccan R., Lalang Besar I. .... | 2 10 | 100 34 |
| | N. and S. Brothers, 5m., N one .................. | 3 24 | 98 46 |
| | Battoo Barra R.................... | 3 13 | 99 34 |
| | Pulo Varellah, 8 L, b, P,... | 3 47 | 99 30 |
| | Delhi R. ............................ | 3 46 | 98 41 |
| | Prauhilah Pt, (rf. 3m.).......... | 4 53 | 97 52 |
| | Diamond Pt., *l*, ............ ⊕ | 5 16 | 97 30 |
| | Pedir Pt., or Batoo Pedir ... ⊕ | 5 29·5 | 95 55·2 |
| | Pt. Pedro ....................... ⊕ | 5 39 | 95 27·2 |
| | **CHINA SEA.** | | |
| | Pulo Tingy, ww₀, sum. 2046f. | 2 18 | 104 8 5 |
| | Pulo Aor, 2½m., 1805f. ... | 2 28 | 104 31 |
| | Pulo Pemangil, 1507f. ......... | 2 36 | 104 19 |
| | Pulo Tioman NS 10m., 3444f., N pt., r₀, b, w, P, ......... | 2 55 | 104 10 |
| Entrance of China Sea | St. Barbe, [3m.], *h*, w, 752f.... | 0 8·1 | 107 13·5 |
| | Direction I., sum. 639f.......... | 0 14·3 | 108 2 |
| | Pulo Dattoo, *h*, SE pt. ......... | 0 8·2 | 108 36·2 |
| | Green Id., centre ................ | 0 44 7 | 107 19 |
| | St. Esprit Is., 4 L, 817f. ... | 0 37·5 | 107 1 |
| | Wellstead rk., s .................. | 0 32 4 | 107 53 |
| | Ellen shl., rks., [½c.], 9f. ...... | 0 41·2 | 107 31·2 |
| | St. Julian, summit 537f. ...... | 0 55·7 | 106 43 5 |
| | Tambelan Is., 6 L, Great, summit 1300f ...... | 1 1·0 | 107 32·2 |
| | — Gap rk ........................ | 1 12·5 | 107 34·5 |
| | Europe shl., rf., [1m.]. s ...... | 1 11·3 | 107 25·5 |
| | Camel I., summit 574f.......... | 1 11·7 | 106 53 |
| | Saddle I., summit 307f. ...... | 1 19·3 | 107 2·2 |
| | Barren I., summit 80f. ......... | 1 31·7 | 106 25·5 |
| | Victory I., summit 285f., 8 L | 1 34·7 | 106 18·5 |
| | Acasta rk., 2f., T .............. | 1 39 | 106 19 |
| Anambas | White rk., *h* 110f. ............... | 2 18 | 105 35 |
| | Repon, 695f. ...................... | 2 21·6 | 105 53 |
| | Pulo Domar, 270f, ₀, T ...... | 2 44·5 | 105 23 |
| | Djimaja, 5 l., S pt. ... ...... | 2 48 | 105 43 |
| | Tokong Belauer, Pillar rk. ... | 3 27 | 106 16 |
| | Pulo Selei, 480f. ............... | 3 12 | 106 30 |
| Natunas | St. Pierre Is., 2 ................... | 1 51·7 | 108 39 |
| | S. Haycock I........................ | 2 17 | 108 54 |
| | Sirhassan Id., Koti Hd., 765f. | 2 33 | 108 59·5 |
| | Kepalou ............................ | 2 39·5 | 109 10 |
| | West I., 865f., N end ......... | 2 43·5 | 108 35 |
| | Soubi I., N end, 200f. ......... | 3 3 | 108 51 |
| | Jackson rfs., E extr. ........... | 2 56 | 107 56 |
| | Low I., [1 l.], N end ........... | 3 1 | 107 48 |
| | N. Haycock I., *h*, rf., S-d ...... | 3 16 | 107 34 |
| | Elphinstone rk., [1m.], 70f. ... | 3 23 | 107 51 |
| | S extr., Sededap I., *h*............ | 3 33 | 108 3 |

| Region | (68) Places | Lat. N | Lon. E |
|---|---|---|---|
| Natunas | Great Natuna, NS 40m., N pt. | 4°16′ | 108°11′ |
| | —Mt. Ranay, on E side, 1890f. | 4 1 | 108 19 |
| | Miculle rf. ... .................... | 4 4 | 108 25 |
| | Selouan I., [1 l.], S sum. ...... | 4 8 | 107 49 |
| | Low pyramidal rks., 25f. ...... | 4 3 | 107 21 |
| | Success breakers, [2m.] ...... | 4 23 | 107 53 |
| | Semione, or Saddle I. ......... | 4 31 | 107 42 |
| | N. Natunas, , N islet ......... | 4 51 | 108 2 |
| Gulf of Siam | Blair Harbour, ............... | 2 38 | 103 47 |
| | Pulo Varela, rk., , rf. 2m.... | 3 19 | 103 38 |
| | Howard shl., 1 ................... | 4 17 | 103 38 |
| | Pulo Brala, 10 l., rks., N 5 l. | 4 49 | 103 39 |
| | Pulo Capas ....................... | 5 13 | 103 14 |
| | Tringano R., w, r, bar ......... | 5 21 | 103 6 |
| | Great Redang I., pk. ......... | 5 46 | 103 1 |
| | Pulo Lantinga .................... | 5 50 | 102 52 |
| | Printian Is., outer one ......... | 5 55 | 102 44 |
| | Pulo Lozin, small, 7f. ......... | 7 21 | 102 0 |
| | Kalantan R., bar, w′ ............ | 6 12 | 102 19 |
| | E. Patani Pt. ..................... | 6 58 | 101 17 |
| | Koh Krah, grp., large one ... | 8 25 | 100 44 |
| | Carnom Pt......................... | 8 56 | 99 49 |
| | Samui I., [2 l.?], 2000f. sum. | 9 33 | 100 1 |
| | How Luang, Mt., 7m. inland, 4326f. ............... | 11 38 | 99 33 |
| | Koh Tarkut (Po. Cin ?) (peaks, 1815f., 5m.) ... | 12 12 | 99 59 |
| | Bangkok R., lt. F 44f............ | 13 29 | 100 35 |
| | Bangkok, Brit. Factory......... | 13 44·6 | 100 28·2 |
| | Siam, now Ayuthia, mid. ...... | 14 22 | 100 36 |
| | Koh-si-chang I., NS 4m., w′, N pt. ...................... | 13 11 | 100 47 |
| | Koh Leum I., [¾m.], 445f. ... | 12 57·5 | 100 38 |
| | C. Liant ............................ | 12 35 | 100 57 |
| | Chalan I., [1c.], 40f., T, ₀ ... | 12 28 | 100 57 |
| | Cawsbaff Mt. ..................... | 12 31 | 103 4 |
| | Junk Rock Pt...................... | 12 8 | 102 47 |
| | Kusrovie rk. ...................... | 11 7 | 102 45 |
| | Samit Pt............................ | 10 52 | 103 7 |
| | Bumba town ...................... | 10 35 | 104 10 |
| | Teeksia R., mouth ............... | 10 6 | 104 54 |
| | Cambodia Pt. ..................... | 8 35 | 104 42 |
| | Po. Way, 2 Is., 1m., 250f... | 9 55 | 102 52 |
| | Pulo Panjang Is., EW 3m., 550f., w, b, r., great one... | 9 18 | 103 27 |
| | Pulo Oby, 2¼m., w, 1046f.... | 8 25 | 104 48 |
| Cochin China | Saigon, City ...................... | 10 46 7 | 106 42 |
| | C. St. James, 3m., lt F 482f. | 10 19·8 | 107 5 |
| | Britto shl., [1¼m.], 1, *T* ......... | 10 29 | 107 49·5 |
| | Pt. Kega, ₀, (Mt. Taicou, *h*) ............................ | 10 42 | 108 0 |
| | Ceicer de Terra, *l*, ₀, 3m. | 11 14 | 108 48 |
| | C. Padaran, *h*, ⊥, T, lt. Fl. ... | 11 23 | 109 1 |
| | False C. Varela, (Camranh Harb., ), *h* ............... | 11 44 | 109 13 |
| | Pyramid I., *h* ..................... | 12 17 | 109 20 |
| | Nhatrang B., , w, b, riv., bar, 7f., Tree I., pk. 1640f. | 12 13 | 109 16 |
| | Three Kings, rks., T, Hone-Cohe harb., , w, 15f. ... | 12 34 | 109 27 |
| | C. Varela, or Pagoda C., *h*, T, pt. ...................... | 12 55 | 109 26 |
| | Perforated rk., rks. ............ | 12 58 | 109 25·5 |
| | Conical Mountn., 1870f. ...... | 13 11 | 109 10 |
| | Phuyen Harb., , Nest I. ... | 13 23 | 109 15 |

## MARITIME POSITIONS

| (69) | Places | Lat. N | Lon. E |
|---|---|---|---|
| Cochin | Coumong Harb., Gainla Hd. | 13°31′ | 109°16′ |
| | Pulo Cambir, 3m., 6 l. | 13 37 | 109 19 |
| | Quinhone Harb., C. Sanho, h, ⊥ | 13 45 | 109 16 |
| Islands in the China Sea | Charlotte Bk., [3m.], s, T | 7 7·3 | 107 37 |
| | Brothers, 3m., E one, h | 8 37 | 106 9 |
| | Pulo Condore Is., [3 l.], w, r, 1954f., lt. F 696f. | 8 40 | 106 41 |
| | Royal Bishop, 32m., rs | 9 40 | 108 14 |
| | Lit. Catwick, summit 56f. | 9 59·5 | 109 4 |
| | Great Catwick, ✱, 196f. | 10 2·9 | 108 55 |
| | Yusun shl., s | 10 16 | 109 2·2 |
| | Pulo Sapatu, ✱, 346f. | 9 58·4 | 109 6 |
| | Holland bk., g, T, centre | 10 39 | 108 43 |
| | Pulo Ceicer de Mer, 3½m., r., highest peak 360f. | 10 32 | 108 56 |
| | Vanguard shl., E and W 7 l. s | 7 28 | 109 43 |
| | Grainger shl., s | 7 47·8 | 110 29·5 |
| | Prince of Wales bk., s, S part | 8 3 | 110 30 |
| | Prince Consort bk., rs, from | 7 46 | 109 55 |
| | Prince Consort bk., rs, to | 7 58 | 110 6 |
| | Rifleman bk., rf., SW end | 7 31·5 | 111 32 |
| | Rifleman bk., rf., NE „ | 7 57·5 | 111 45 |
| | Amboyna Cay, centre | 7 51·8 | 112 55·5 |
| | Owen shl., [2m.], crl., s | 8 8 | 112 0 |
| | Spratly or Storm I., 8f. | 8 38 | 111 55·2 |
| | Ladd rf. | 8 40·3 | 111 39 |
| | London rfs., W reef—cay ⊕ | 8 51·9 | 112 15·5 |
| | — central rf., d. ⊕ | 8 55 | 112 21 |
| | — East rf., E extr. ⊕ | 8 49·5 | 112 38·2 |
| | — Cuarteron rf., d. ⊕ | 8 51 | 112 50 |
| | Fiery Cross rf., 15m., I. or NW Investigator, SW bank, beacon ⊕ | 9 35 | 112 54·5 |
| Islands and Shoals N.W. of Borneo | Luconia breakers, South | 5 3 | 112 42 |
| | — shls., Seahorse breakers | 5 31 | 112 33 |
| | — Friendship shl., [3 l.], s, N pt. | 5 58 | 112 31 |
| | Louisa shl., [3m.] rks., T mid. | 6 20 | 113 18 |
| | Royal Charlotte shl., [1½m.], rks. ○ | 6 57 | 113 35 |
| | Swallow shl., [4m.], rks. at E pt. | 7 23 | 113 50 |
| | South Viper shl.? ○ | 7 30 | 115 0 |
| | North Viper shl.? ○ | 8 0 | 115 25 |
| | Ardasier shl., s | 7 37 | 114 10 |
| | — Gloucester shl. ○ | 7 50 | 114 14 |
| | SW Shoa ○ | 8 0 | 114 50 |
| | Investigator, rf., EW 5 l., W pt. ○ | 8 5 | 114 35 |
| | Cay Marino? ○ | 8 30 | 114 20 |
| | S. Cornwallis shl.? ○ | 8 52 | 114 12 |
| | Pearson shl., rks., NS 2m. ○ | 8 56 | 113 44 |
| | Ganges ○ | 9 25 | 114 10 |
| | Sin Cona I. ○ | 9 42 | 114 22 |
| | Discovery, Great rf., NS 7m., d., N end ⊕ | 10 7·5 | 113 53 |
| | — Small rf., d. ⊕ | 10 1 | 114 2 |
| | Western or Flora Temple ⊕ | 10 15 | 113 37·5 |
| | Tizard Bank, Itu Aba I. ⊕ | 10 22·5 | 114 21·5 |
| | — Nam Yit I. ⊕ | 10 12 | 114 22 |
| | — Eldad rf. | 10 23 | 114 42 |
| | — Gaven rf. | 10 13 | 114 13 |

| (70) | Places | Lat. N | Lon. E |
|---|---|---|---|
| Islands and Shoals N.W. of Borneo | Pennsylvania ○ | 9°59′ | 115°11′ |
| | — Another do. ○ | 9 5 | 115 17 |
| | Half Moon shl., 3m., S pt. | 8 52 | 116 15·5 |
| | Royal Captain shl., rks. | 9 1 | 116 39 |
| | NE Investigator ○ | 9 12 | 116 30 |
| | Pennsylvania ○ | 9 32 | 116 28 |
| | Bombay shl., rf., W pt., T | 9 26 | 116 56 |
| | Sabina shl. ○ | 9 42 | 116 38 |
| | Pennsylvania, shls., [4 l.], mid. ○ | 9 49 | 116 47 |
| | Pennsylvania ○ | 10 0 | 115 12 |
| | Ganges ○ | 10 18 | 115 5 |
| | Loai-ta I. and rfs., S. L. ⊕ | 10 40·5 | 114 25·5 |
| | — Cay, W end ⊕ | 10 44 | 114 21 |
| | Soubie rf., d., centre ⊕ | 10 55 | 114 7 |
| | Thitu I. and rfs., W end ⊕ | 11 2 | 114 11·5 |
| | Trident shl., N end, d. ⊕ | 11 31 | 114 39·5 |
| | North Danger, a, 2 islands, 10 to 15f. | 11 28 | 114 21 |
| | Brown, s ○ | 10 30 | 116 39 |
| | Brown, shl. ○ | 10 35 | 116 58 |
| | Brown, shl., [3 l.], s, a flat, mid. ○ | 10 43 | 117 20 |
| | North Pennsylvania ○ | 10 52 | 116 55 |
| | Carnatic shl., s ○ | 10 6 | 117 26 |
| | Auckland, s, T ○ | 10 20 | 117 20 |
| | Fairy Queen, s ○ | 10 34 | 117 39 |
| | Seahorse or Routh bk., 9m. | 10 50 | 117 47 |
| | Templar bk., NS 4m., rs ○ | 11 7 | 117 21 |
| | *Cochin China continued from* (68). | | |
| Cochin China | Buffalo I., or rk., T, 98f. | 14 9 | 109 16 |
| | Turtle I., small, l | 14 22 | 109 10 |
| | Tamquam R., bar | 14 35·5 | 109 2 |
| | C. Batangan | 15 16 | 108 54 |
| | Pulo Canton, vis. 9 l., rf. SE, w | 15 23 | 109 6 |
| | Qui-Quik, w, C. Bantam | 15 25 | 108 47 |
| | Collao Cham, False, Honong, h | 15 49 | 109 39 |
| | Collao Cham I., 5m., h, W, summit 1230f. | 15 57 | 108 30 |
| | C. Turon | 16 7 | 108 19 |
| | Turon Bay, w, r, Turon I | 16 5 | 108 12 |
| | C. Choumay, West C. | 16 20 | 107 54 |
| | R. Hue Fo, bar s, fort, W entr. | 16 33 | 107 38 |
| | Tiger I., [1m.], 230f. | 17 9 | 107 19 |
| | S. Watcher, 272f. | 17 55 | 106 39 |
| G. of Tuquin | Hon Tseu, Goat I., 475f. | 18 6 | 106 26 |
| | Hon Mat, Eastern I., 144f. | 18 49 | 105 58 |
| | Vinh, fort at entr. Ngan Ka R. | 18 47 | 105 43 |
| | Lacht Kuen Harbour | 19 4·5 | 105 41 |
| | Hon Mè I. | 19 20·5 | 105 57·5 |
| | Thunh-hoa town | 19 48 | 105 45 |
| | Song Ka River, Ninh Lacht Custom Ho. | 20 8·5 | 106 14 |
| | — Fort Ba Lacht | 20 19 | 106 27 |
| | Nightingale I., Batchlong vi. | 20 7 | 107 41 |
| | Hon Dau, lt. F 148f. | 20 40 | 106 47 |
| | Norway Is., S rk. | 20 37 | 107 8 |
| | Laitao I., S pt. | 20 43·5 | 107 25 |
| | Kua Doi or Bamoun | 20 58·5 | 107 30·5 |

## MARITIME POSITIONS

| | (71) Places | Lat. N | Lon. E |
|---|---|---|---|
| G. of Tonquin | Gautau Is., E cape | 21° 2′ | 107° 50′ |
| | Loshushan I., 804f. | 21 14 | 107 55·5 |
| | C Paklong | 21 29·5 | 108 11 |
| | Long Moun R., Onloi Pt. | 21 36 | 108 43·5 |
| | Pakhoi Kwantau Pt., 374f. | 21 27 | 109 2 |
| | Guie Chaw I., pk. 279f. | 21 1 | 109 6·5 |
| | Lui Chew, C. Cami | 20 13 | 109 55 |
| Hainan I. | Hainan I., 53 l., Hong-pi Kok | 20 0 | 109 49 |
| | Double hill pt., Pingmar | 19 55 | 109 17 |
| | Chappu B., Hiongpo fort | 19 43 | 109 12 |
| | Bluff Pt., 120f. | 19 21 | 108 41 |
| | South-west pt., Inkohai | 18 32 | 108 41 |
| | Button I., 256f. | 18 20 | 108 57·5 |
| | Great Cape, 1740f. | 18 18 | 109 12 |
| | Yu-lin-kan B., ⊞, entr. to inner harb. | 18 13 | 109 33 |
| | C. Bastion, 863f. | 18 9 | 109 36 |
| | Liong-soy Pt. | 18 22·5 | 110 3 |
| | Tien fung rk., rks., ‖ W, T | 18 26 | 110 8 |
| | Tinhosa Is., NS 2½m., 1609f., T E, N sum., ($w_o$) | 18 42 | 110 28·2 |
| | False Tinhosa, 150f. | 18 50·5 | 110 34 |
| | High Mountain, 3 pks., 2040f. | 19 2 | 110 23 |
| | Mt. Toncon, 1229f. | 19 40 | 111 1 |
| | Mofou Pt. | 20 1 | 110 55 |
| | NE pt., or Hainan Head | 20 10 | 110 41 |
| | Hoihau, W fort | 20 3·2 | 110 19·5 |
| | Taya Is., 648f., ‖ W, N one | 19 58·8 | 111 16 |
| Paracel Is. | Triton I., 4/8 4m., N part 20f. | 15 47 | 111 14 |
| | Bombay shl., 4 l., rks., T, mid. | 16 3 | 112 32 |
| | Discovery rf., 5 l., T, E extr. | 16 14 | 111 54 |
| | Crescent Chain, 6 Is., *l*, EW, Observation Bk. | 16 36 | 111 44 |
| | North shl., 2 l., T, E pt | 17 3 | 111 36 |
| | E extr., Dido | 16 49 | 112 54 |
| | Lincoln I., [1 m.], rfs. 1 m., *l*, ♦, w | 16 40 | 112 44 |
| | Amphitrite Is., 2 grps., 4/8 3 l., ‖, Tree I. | 16 58 | 112 17 |
| | Macclesfield shl., coral, EW 23 l., 5 to 50, supposed growing, W extr. | 15 41 | 113 43 |
| | Scarborough shl., S rk. 10f. | 15 5 | 117 49 |
| | St. Esprit shl., 7 | 19 33 | 113 2 |
| | Helen shl., | 19 12 | 113 54 |
| | Pratas shl., [7 l.], rks., 3, ld. at W part, 40f. | 20 42 | 116 42·5 |

**CHINA, SOUTH AND EAST COAST.**

| | Places | Lat. N | Lon. E |
|---|---|---|---|
| | Hainan B., conical mound, 80f. | 20 14·5 | 110 16·5 |
| | Black rks. | 20 29·5 | 110 32·5 |
| | Nau Chau I., 274f. | 20 54 | 110 36 |
| | Hai-ling-shan I., 4 l., Mamechan I. | 21 34 | 111 47 |
| | Mandarin's Cap, *wh.*, ♦ₒ, 200f. | 21 28 | 112 22 |
| | Passage I., E entr, Namoa, ⊞ | 21 35 | 112 34 |
| | Wizard rks., outer grp., 30f. | 21 47 | 113 1 |
| | Tylon I., *h*, *wh.*, patch E, T, S pt. | 21 52 | 113 15 |
| | Grand Ladrone, [2m.], ⊥, 9 l. | 21 57 | 113 43 |

| | (72) Places | Lat. N | Lon. E |
|---|---|---|---|
| China, S. Coast | Haipong I., 3m., S part, Asses' Ears | 21° 54′ | 114° 0′ |
| | Great Lema, 6m., w, E pt. | 22 5 | 114 19 |
| | Lantao pk., 3050f. | 22 16 | 113 58 |
| | Macao, Guia fort, lt. Rev. 339f. | 22 11·4 | 113 38 |
| | Canton, English factory | 23 6·9 | 113 15·0 |
| | Hong Kong, 9m, Victoria, N side, Cath. ⊞ | 22 16·9 | 114 9·5 |
| | C. Collinson, lt. F 200f. | 22 15·7 | 114 15 |
| | Mirs Bay, ⊞, rk. mid. entr. | 22 27·5 | 114 25·5 |
| | A high summit, 2810f. | 22 31 | 114 32 |
| | Single I., [3c.], T | 22 24 | 114 40 |
| | Mendoza I., [1m.], T, 480f. | 22 31 | 114 50 |
| | Fokai Pt., sum. N 1m., 670 f. | 22 34 | 114 54 |
| | Pedro Blanco, *h*, T | 22 18·5 | 115 7 |
| | Whale rk., small, T | 22 30·5 | 115 0 |
| | Che lang piah Pt., T | 22 39 | 115 34 |
| | Si-ki rk., 80f., T | 22 42 | 115 46 |
| | Cup-chi Pt., 210f., rks. S 2m. | 22 48 | 116 4·5 |
| | Breaker Pt., *l*, rky., lt. Occ. 152f. | 22 56 | 116 28 |
| | Tonglae fort | 22 59·5 | 116 31·5 |
| | C. of Good Hope, lt. Int. 171f. | 23 14·5 | 116 48·5 |
| | Swatau lt. F, Fl. 200f. | 23 19·9 | 116 45·5 |
| | Namoa I., EW 12m., 1934f. | 23 26 | 117 4·5 |
| China, S.E. Coast | Lamock Is., 8m., Boat rk. | 23 11·4 | 117 14 |
| | Table Hill, 1767f. | 23 39 | 117 9 |
| | Chelsieu rks., [1m.], 20f. | 23 29 | 117 15 |
| | Brothers, 2, 4/8 2m., S one | 23 32·5 | 117 42 |
| | Tonsang Harb., ⊞, entr., pagoda | 23 44 | 117 33 |
| | South-east I., [1m.] | 23 47 | 117 43 |
| | S Merope shl., 5m., 3, S pt., T | 24 6 | 118 6 |
| | Chapel I., ⊥, lt. F, Fl. 227f. | 24 10·3 | 118 13·5 |
| | Chauchat rks., *l*, E extr. | 24 21 | 118 9 |
| | Amoy, ⊞, Kulangseu Semph. | 24 26·8 | 118 4·0 |
| | Quemoy I., 10m., S pt. | 24 24 | 118 19 |
| | Dodd I., [1c.], lt. Occ. 147f. | 24 26·1 | 118 29·2 |
| | West Peak, a Mk., 1714f. | 24 40 | 118 20 |
| | Hoo-e-tow Pt., 80f. | 24 31 | 118 33 |
| | Chimmo, (South), Pagoda I. | 24 38 | 118 40 |
| | Mt. Keu-sau, pagoda, 760f. | 24 43 | 118 38 |
| | Chung-chi Pt., 400f., (rks. off) | 24 46 | 118 46 |
| | Chin chu, ⊞, Passage I. | 24 50 | 118 49 |
| | Pyramid Pt., (rks. off) | 24 52 | 118 57·2 |
| | Meichow I., 5m., S pt. | 25 1 | 119 6 |
| | — Sorrel rk., [½m.], 60f. | 25 2 | 119 9 |
| | Ockseu Is., 2m., lt. Rev. 286f. | 24 58·8 | 119 26 |
| | Ping-hai | 25 11 | 119 16 |
| | Loutzee rk., [1m.], (rks. off) | 25 7 | 119 22 |
| | Lam-yit I., 5/8 8m., peak | 25 12 | 119 33 |
| | Yit Is., E extr., Reef I. | 25 18 | 119 45 |
| | Chimney I., EW 2m., N pt. | 25 23 | 119 43 |
| | South reef, [½m.] | 25 23 | 119 50 |
| | Turnabout I., [¾m.], lt. F 257f. | 25 26 | 119 57 |
| | Hae-tan I., NS 17m., pk. on NE side, 1420f. | 25 36 | 119 49 |
| | Kwing I., [2m.], (off NE part of Hae-tan), E pt. | 25 36 | 119 55 |
| | White Dogs, grp., 5/8 4m., Middle Dog, lt. F, Fl. 257f. | 25 58 | 120 1 |
| | Sea Dog rk., small, T E | 26 5 | 119 59 |
| | River Min., Temple Pt. | 26 8·4 | 119 37·7 |
| | Ting-hae | 26 18 | 119 48 |

## MARITIME POSITIONS

| (73) | Places | Lat. N | Lon. E |
|---|---|---|---|
| CHINA, E. Coast | Matsou I., 3m., S pt. | 26° 9′ | 119° 56′ |
| | Chang-chi I., 3½m., 1330f. | 26 14 | 120 0 |
| | Larne rk. | 26 16 | 120 12 |
| | Alligator rk., small, 40f. | 26 9 | 120 24·5 |
| | Tung-ying Is., 3m., T S, sum. 853f. | 26 23 | 120 29·7 |
| | Double Peak I., 3½m., w, pk. 1190f. | 26 36 | 120 9·7 |
| | Pih-seang Is, [5m.], N Id. | 26 42 | 120 20·5 |
| | A dangerous rk.. ββo | 26 52·2 | 120 33·2 |
| | Fuh-yaou I, 4m., w' NE, W-d. sum. 1700f. | 26 56 | 120 21 |
| | Tae Is., [2 l.], E one, sum. 618f. | 26 59 | 120 42 |
| | Seven Stars, rks., [2m.] | 27 4 | 120 49 |
| | Cleft rk. | 27 6 | 120 47 |
| | Nam-quan, Bate I. | 27 9·2 | 120 24·2 |
| | Pih-quan Pk., 5m. inland | 27 18·5 | 120 27 |
| | Castellated rk. | 27 20 | 120 57 |
| | Nam-ki I., grp., 7m., w, 740f., | 27 26·5 | 121 2·5 |
| | Pih-ki-shan Is., EW 4m., Coin I. | 27 37·4 | 121 11·2 |
| | Quoin | 27 50 | 121 13 |
| | Wan-chu-fu, city | 28 1 | 120 36 |
| | Pe-shan Is., [2m.], E one | 28 5·5 | 121 30 |
| | S. Foreland, I., [½m.] | 28 16 | 121 42 |
| | Chik-hok I., [½m.]. ⊥, 760f. | 28 22·4 | 121 42 |
| | N. Foreland I., [½m.] | 28 33 | 121 37 |
| | Taichow Is., 9m., S pt., or Fingers | 28 23 | 121 53 |
| | — Shang-ta, grt. one, N pt. | 28 30 | 121 52 |
| | — North Id., [and rfs., ½m.] | 28 32 | 121 54 |
| | Square I. | 28 35 | 121 47 |
| | Tung-chuh, or Bella Vista, 2m., sum. 700f. | 28 42·2 | 121 54 |
| | Hai-mun, S of entr. of R. Taichow, citadel | 28 40 | 121 26 |
| | Fall I., [1m.] | 28 50 | 121 50 |
| | Hirshan Is., 5m., f, S or Saddle I., 320f., w. | 28 51 | 122 13 |
| | Eight feet rk., (N of do.) | 28 56 | 122 17 |
| | Triple I., [2c. ?] | 28 59 | 121 53 |
| | C. Conway | 29 3 | 121 55 |
| | Montague I., 4m., 740f., E pt. | 29 10 | 122 4 |
| | Sheipoo | 29 13 | 121 55 |
| | Kweeshan Is., [6m.], grt. one, sum 400f. | 29 26 | 122 11 |
| | — Patahecock I., [3c.], h. | 29 22 | 122 13·5 |
| | — E extreme | 29 27 | 122 15 |
| | Chusan Is., S extr., Tinker rk. | 29 36 | 122 9 |
| | — Taouhwa I., 7m., sum. 1680f. | 29 48 | 122 16 |
| | — Chookea I., NS 6½m., pk. 1160f. | 29 54 | 122 24 |
| | — Outermost, Tong-ting, [2c.], 161f. | 29 51·5 | 122 35 |
| | Cone I., small | 30 4 | 122 27 |
| | Chusan I., 7 l., Ting-hae, citadel | 30 1 | 122 6 |
| | Chin Hae | 29 57 | 121 43·5 |
| | Ning Po, pagoda | 29 51·7 | 121 33·5 |
| | Friendly Bluff, Talung I., 980f. | 30 6 | 121 34 |
| | Fisherman's Is, EW, E extr., Brothers, T | 30 10 | 122 56 |

| (74) | Places | Lat. N | Lon. E |
|---|---|---|---|
| CHINA, E. Coast | Fisherman's Is., Monte Video, 2m., T, 996f. | 30° 8′ | 122° 46′·7 |
| | Steep I., lt. Fl. 243f. | 30 12 | 122 36 |
| | Lukon Is., 313f., [½m.], T | 30 26 | 122 56 |
| | Beehive rk., T, 46f. | 30 22 | 122 41 |
| | Ts'i-san I., EW 8m., Pennell Pt. | 30 25 | 122 16 |
| | Childers rk., T | 30 37 | 122 50·5 |
| | Barren Is., [1m.], rky., T, 150f. | 30 45 | 123 8·5 |
| | Saddle Grp., 13m., E Sad., S pt., T, 692f. | 30 42 | 122 49 |
| | — N. Saddle, EW 2m., T, N pt., lt. Rev. 273f. | 30 51·5 | 122 40 |
| | Rugged Is., EW 10m., SW Horn, 50f. | 30 36 | 121 57·2 |
| | Gutzlaff I., [½m.], lt. F 270f. | 30 48·5 | 122 10 |
| | Yang-tse Kiang, beac. 35f. | 30 51 | 121 52 |
| | Ariadne rks., [1c.] | 31 9 | 122 14·7 |
| | Amherst rks., [1c.], 26f. | 31 11 | 122 22 |
| | Wusung, fort, lt. F 50f. | 31 23 | 121 30 |
| | SHANGHAI, BRIT. CONSULATE | 31 14·7 | 121 29·0 |
| | Nankin, city, porcelain tow. | 32 2 | 118 49 |
| | Hankow, Bouncer I., lt. F. | 30 33 | 114 30 |
| | Sha-wei-shan, rk., lt. F 229f. | 31 25 | 122 14 |
| | Tsung Ming I., 10 l., E pt. | 31 28 | 121 51 |
| | A shl, pt., NNE 6 l. | 31 44 | 121 57 |
| | A shl., 5m., s | 32 0 | 122 0 |
| | Is. in G. of Whang-ho, outer ○ | 33 0 | 120 40 |
| | Whang-ho, or Yellow R. ○ | 34 2 | 120 10 |
| | Hae-chow, city ○ | 34 35 | 119 30 |
| | Tower Pt. | 36 21 | 119 33 |
| | Kyau-chau Harb., NE hill | 36 3 | 120 14 |
| | Ka-tih-neaou I. | 36 11 | 120 57 |
| | Surveyors I. | 36 16 | 121 24 |
| | Urh Taou, or Staunton I. | 36 45·7 | 122 16·2 |
| | Shan Tung prom., lt. F 220f. | 37 24 | 122 42·5 |
| CHINA, N.E. Coast | Alceste I., small, rks. off | 37 27 | 122 40·5 |
| | Wei-hai-wei Harb., N pt., entr., Leneung I. | 37 32 | 122 10 |
| | Che-fow C., SE-d. | 37 36 | 121 26·2 |
| | Chung-shan I., S extr., 7m., S pt. | 37 55 | 120 45 |
| | Miautau Is., Ta-Hi Shan, W pt. | 37 58 | 120 36 |
| | Howki I., lt. Fl. 328f. | 38 4 | 120 39 |
| | N extr., Siao-kin-Tao, [1m.] | 38 21 | 120 51 |
| | Hwang-ching-tao I., EW 2m. | 38 23 | 120 55 |
| Gulfs of Pechili and Liaulung | Chimatau Promontory | 37 41 | 120 13 |
| | Laichau Bank | 37 28 | 119 44 |
| | Sharp Pk., 2436f. | 37 0 | 120 0 |
| | Pei-ho R., S Taku fort | 38 58 | 117 43 |
| | Sha-lui-tien I., lt. F 50f. | 38 53 | 118 32 |
| | Great Wall, E extr. Ninghai | 39 58 | 119 49 |
| | Halutan Prom. | 40 44 | 121 2 |
| | Neuchwang | 40 43 | 122 14 |
| | Hulu shan B., N pt. | 39 30 | 121 14 |
| | Iron I., 750f. | 38 57 | 121 0 |
| | Lian-ti shan Promontory | 38 43 | 121 11 |
| | Cap rk., 400f. | 38 48 | 121 35 |
| | Talien Whan Bay, entr. San-shan-tow Is., S extr. | 38 52 | 121 51 |
| | Encounter Rk., 11f. | 38 34 | 121 33 |

## MARITIME POSITIONS

| | (75) Places | Lat. N | Lon. E |
|---|---|---|---|
| | Round I., small, 200f. | 38° 40′ | 122° 12′ |
| | Rock, like a junk, Shi-siau | 38 56 | 122 45 |
| | Hai yun-tau I., S pk. 1370f. | 39 3 | 123 10 |
| | **ISLANDS EAST OF CHINA.** | | |
| *Pescadores, or Ponghu Is.* | Pescadores Is., Junk I., 260f. | 23 12·6 | 119 25·7 |
| | — East I., N end | 23 15·9 | 119 40 |
| | — High I., 247f. | 23 19·2 | 119 19·5 |
| | — Yih Pan I., N pt. | 23 24·2 | 119 19·5 |
| | — Pachau I., [1⅓m.], N pt. 158f. | 23 23·4 | 119 29·2 |
| | — Table I., W pt. 180f. | 23 28·7 | 119 30·2 |
| | — Ponghu, I., Makung ⊞, Obs. I. | 23 32 | 119 33·5 |
| | — W pt., Fisher's I. | 23 33 | 119 28 |
| | — North rk. | 23 47 | 119 35·2 |
| | — Round I. | 23 32·7 | 119 42·7 |
| | Nine-feet rf. | 23 28 | 119 45 |
| *Formosa* | Formosa, S cape, lt. F 180f. | 21 55 | 120 50·7 |
| | Lambay I., [2½m.], summit | 22 20·5 | 120 22 |
| | Ape Hill, 1110f., Ta-kau | 22 38 | 120 16 |
| | Fort Zealandia, lt. F 60f. | 23 0 | 120 10 |
| | Port Kok-si-kon | 23 6 | 120 4·5 |
| | Wauckau Bank, ⅔ | 23 31 | 119 59 |
| | Table Hill, 360f. | 24 54·0 | 120 57·5 |
| | Tam-sui harb., ⊡. White Fort | 25 10·4 | 121 25·0 |
| | Sum. Eastward, 2800f. | 25 12 | 121 30 |
| | Syau-ki Pt | 25 18·4 | 121 31 |
| | Pinnacle I., [¼m.], ‖ S | 25 26 | 121 57·5 |
| | Crag I., [1m.] | 25 29 | 122 6·7 |
| | Agincourt I., [1m.] | 25 38 | 122 8 |
| | Kelung harb., ⊞, Ruin rk. | 25 8·6 | 121 45·5 |
| | Kelung I., [⅓m.], 580f. | 25 12 | 121 48 |
| | East extreme of Formosa | 25 2 | 122 0 |
| | Sau-o Bay, Obs., W side | 24 35·5 | 121 49·5 |
| | Mt. Morrison, 12,850f. | 23 29 | 120 58·5 |
| | Blackrock B., outer rk. | 23 6·5 | 121 25 |
| | Samasana I., [1m.], rky. | 22 39·4 | 121 27·2 |
| *Meiu-co-si-mu Is.* | Kumi I., I-nah-Kwoh, ⚓ 6m. | 24 25 | 122 59 |
| | Hummock I., [¼m.], mid. | 24 13 | 123 36 |
| | Sandy I., EW 3m., W pt. | 24 4 | 123 49 |
| | Koo-kien-san I., ⚓ 15m., (W SW), W lim. | 24 18 | 123 43 |
| | — N extr. | 24 26 | 123 47 |
| | Patchusan I., ⚓ 6 l. N pt. | 24 37 | 124 19 |
| | — Port Haddington, ⊞, W pt. entr. | 24 25·0 | 124 5·2 |
| | Typinsan I., ⅘ 16m., ⚓, E pt. | 24 43 | 125 29 |
| | — I. off N extr., Ee-ki-mah | 24 55 | 125 14 |
| | — I. off SW part, Koo-re-mah | 24 42 | 125 13 |
| | Hoa-pin-su I., 1181f., NE side | 25 47 | 123 29 |
| | Ti-a-usu I., EW 4m., ⚓, mid. | 25 57 | 123 40 |
| | Raleigh rk., 270f. | 25 55 | 124 34 |
| *Liu-kiu Is.* | Koomisang I., 1108f., EW 8m., (rk. S 2m.), NW pt. | 26 22 | 126 44 |
| | Tusima I., 60f. | 26 35·5 | 126 51 |
| | Tunashee I., sum. 603f. | 26 21 | 127 10 |
| | Agunyeh pk., 300f. | 26 34·7 | 127 14 |

| | (76) Places | Lat. N | Lon. E |
|---|---|---|---|
| *Liu kiu Is.* | Kerama Is., W one, High I., 916f. | 26° 10′ | 127° 15′ |
| | Great Liu-kiu. Okinawa, ⚓ 19l., Nafakiang, Abbey Pt. | 26 13 | 127 41 |
| | — C. Yakimu Pt., (rf. ⅘ 8m.) | 26 4 | 127 41 |
| | — E extr., C. Sidmouth, l. off | 26 47 | 128 21 |
| | — N extr., C. Hope, Heto | 26 51 | 122 17 |
| | — Kiu, Herbert I., ⅘ 2¼m., entr., Port Oonting or Melville, ⊞, sum. 354f. | 26 42 | 128 2 |
| | — Sugarloaf, 8 l., 575f. | 26 43 | 127 49·5 |
| | Montgomery Is., ⚓ 5 l., ‡, N pt. | 27 5 | 128 2·5 |
| | Yori-sima, 413f. | 27 2 | 128 26·5 |
| | Yerabu-sima, pk. 687f. | 27 21·5 | 128 35 |
| | Kakirouma I., 2207f., C. Ohotabu | 27 38 | 128 55·5 |
| | Sulphur I., Iwo-simas, 541f. | 27 52 | 128 14 |
| | — C. Sanafana | 27 52·5 | 128 53 |
| | Ioro sima, C. Kataki | 28 00 | 129 9 |
| | Amami oo Sima, Yiomi | 28 17 | 129 19 |
| | — Iono Misaki | 28 31 | 129 42 |
| | Kikai ga sima, pk. 864f. | 28 17·5 | 129 59 |
| | Sandon rks., 30f. | 28 44·5 | 129 47 |
| | Yoko sima, 1700f. | 28 48 | 129 2 |
| | **JAPAN.** | | |
| | Tsus-sima, NS 7 l., The Sound | 34 19 | 129 13 |
| | " South I., Ko-Saki Pt. | 34 5·5 | 129 12 |
| | Colnett I., or Kotsu Sima, 800f. | 34 15 | 130 6 |
| | Iki I., NS 3 l., islet off N end | 33 52 | 129 40 |
| *Goto Is.* | Goto Is., Uku sima, pk. 842f. | 33 16·5 | 129 6·5 |
| | — Hira sima, pk. 663f. | 33 1 | 129 14·5 |
| | — ⚓ 21 l. SW ext. Ose Saki, lt. R | 32 37 | 128 36 |
| | Tama-no-Ura, ⊞, S pt. entr. | 32 41 | 128 37·5 |
| | Tori Sima, Pallas rks., S rk., 60f. | 32 14·5 | 128 6·5 |
| | Me Sima grp., Uri Sima, (Asses' Ears), 607f. | 32 1·5 | 128 23·5 |
| | Hirado or Spex St., Tasko lt. | 33 23·5 | 129 33·5 |
| | Nangasaki, Minage Pt. | 32 44·4 | 129 51·2 |
| | Sagatsu no Ura, Kame-ura B., ⊞, entr. | 32 18 | 130 1 |
| | Taka-sima or Symplegades, 210f. | 31 27 | 129 43·5 |
| | Tsukarase or Retribution rks., 96f. | 31 18·5 | 129 44 |
| *Kiusiu Id.* | Kami no Koshiki, pk. 1402f. | 31 50 | 129 54 |
| | Shimo no Koshiki, S pt. | 31 37 | 129 41 |
| | Kusakaki Sima High I., 530f. | 30 51 | 129 26 |
| | Hasima Saki | 31 45 | 130 11·5 |
| | Noma no hana | 31 25 | 130 7 |
| | Okaimon Daki Pk., 3020f. | 31 11 | 130 32 |
| | Kogosima, lt. F 45f. | 31 35·5 | 130 33·7 |
| | C. Tschitschagoff, Satano Misaki, lt. F 200f. | 30 59 | 130 39·5 |
| | C. Hisaki | 31 16·5 | 131 7·5 |
| | O shima, lt. Fl. 287f. | 31 31 | 131 25 |
| | To Saki, 290f. | 31 47 | 131 29·5 |
| | Akatmidsu Hd. | 32 29 | 131 46 |
| | E extr., Kiusiu, Sura Saki | 32 55·7 | 132 6 |

## MARITIME POSITIONS.

| (77) | Places | Lat. N | Lon. E |
|---|---|---|---|
| *Linschoten Is.* | Kuro-sima, or Sta. Clara, 2028f. sum. | 30°50′ | 129°56′ |
| | Iwoga-sima, Volcano I., 2331f. | 30 47·5 | 130 18 |
| | Take-sima, Apollos I., 742f. | 30 49 | 130 26 |
| | Nagarobe or Julie, [1 l.], 2297f | 30 27 | 130 13 |
| | Yakuno-sima, ⚹ 5 l., C. Yatake | 30 27 | 130 30 |
| | Tanega sima, NS 6 l., †, N pt | 30 50 | 131 4 |
| | Disaster I., Fira Sima, 812f. | 29 41 | 129 33 |
| | Pinnacle I., Nuka Sima, 3400f | 29 51·8 | 129 52 |
| | Kutsino-sima, 2230f. | 30 0 | 129 56 |
| | Suwa-sima, act. volcano, 2706f. | 29 38 | 129 44 |
| | Tokara Sima, Pennell, 860f. | 29 7·5 | 129 14 |
| | Sikok I., W. pt., or C. Misaki | 33 20·5 | 132 1 |
| | — S extr., or Isa-saki, 1500f. | 32 44·2 | 133 1·7 |
| | — C. Muroto-saki | 33 14 | 134 11·5 |
| | — Kamoda-saki, Sima | 33 50·5 | 134 49·5 |
| | Izumi Tomangai, lt. F | 34 17 | 135 1 |
| | Hiogo, (Kobé), Kawa-saki | 34 40·5 | 135 11·2 |
| | Akashi Palace | 34 39·5 | 134 59·5 |
| | Naruto passage, Nagasé | 34 14 | 134 39 5 |
| | Seto-Uchi, Sakaide | 34 19 | 133 51 |
| | — Imabari Palace | 34 4 | 133 0 |
| | — Matsuyama | 33 51 | 132 45·5 |
| *Nipon, S. and E. Coasts* | Nipon, S pt., Siwo Misaki I., lt. F 163f. | 33 26 | 135 46 |
| | C. Sima | 34 17 | 136 54 |
| | Omai-saki, lt Rev. 173f. | 34 36·5 | 138 13 5 |
| | Fusi-Yama, 12,450f. | 35 20·7 | 138 44·2 |
| | Iro-o-Saki, lt. F 185f. | 34 36 | 138 50 |
| | Vries I., [2250f. vol.], Hafu | 34 40 | 139 27 |
| | Isurugi Saki, lt. Fl. | 35 8·5 | 139 40 |
| | Yedo G., Yokohama, Naval Store | 35 26·4 | 139 39·2 |
| | C. King, No-Sima lt. F 133f. | 34 54 | 139 53 |
| | Inuboye-saki, lt. Rev. 168f. | 35 39 | 140 56 |
| | Toyoma | 36 58 | 141 1·5 |
| | Kinkuwasan I., 1470f., lt. F 178f. | 38 17 | 141 36 |
| | Todo Saki | 39 33 | 142 5 |
| | Siriya Saki, lt. F 150f. | 41 26 | 141 29 |
| *Is. S.E. of Japan* | Kosu-sima, volcano 2000f. | 34 12 | 139 9 |
| | Redfield rks., 20f., Southern | 33 56·8 | 138 49·2 |
| | Mikura I., [1 l.], mid. | 33 52 | 139 34 |
| | Broughton rks., 60f. (Kanamba) | 33 39 | 139 17·7 |
| | Fatsizio, 2840f., S end | 33 2 | 139 50 |
| | Aoga-sima, 1000f. | 32 29 | 139 43 |
| | Bayonnaise Id., 26f. | 31 55 | 139 54 |
| | Smith I., 421f. | 31 26 | 140 1 |
| *Nipon, W. Coast* | Nipon, N pt., Omasaka-sima | 41 34 | 140 55 |
| | Tatsupi-saki, 362f. | 41 16 3 | 140 21 |
| | Bittern rks., 18f. | 40 31 | 139 31 |
| | Hatamura | 40 2 | 139 46 |
| | Tabu sima, E extr., 150f. | 39 11·9 | 139 34·2 |
| | Awa-sima, NE extr., 680f. | 38 29·6 | 139 16 |
| | Sado I., ⚹ 13 l., N pt. Wasaki | 38 19·9 | 138 31 |
| | — South pt. | 37 50 | 138 13 |
| | Yutsisima, [3m.], †, 40f. | 37 49 | 136 55 |
| | Astrolabe rk., Nana sima, 200f. | 37 35 | 136 54 |
| | Rokko saki, C. Noto, lt. F 152f. | 37 31 | 137 18 |
| | Ohama Harb., lt. F | 35 30 | 135 41 |
| | Oki Is., ⚹ 2015f., N pt. | 36 21 | 133 18 |
| | Mino Sima I., [1 l.], 492f. | 34 47 | 131 6 |

| (78) | Places | Lat. N | Lon. E |
|---|---|---|---|
| | Tsu no Sima, lt. Fl. 142f. | 34°21′ | 130°51 |
| | Simonoseki Strait, Shirasu, lt. F 44f. | 33 59 | 130 47 |
| | — Isaki, lt. F 122f. | 33 57·6 | 131 1 |
| *Yezo I.* | Yezo I., ⚹ 95 l., S extr., or C. Sirakami, lt. R 120f. | 41 24 | 140 13 |
| | Ko-sima I., 1000f. | 41 21 | 139 48 |
| | O. Sima I., [2m.], 2359f. | 41 30 | 139 22 |
| | Hakodate, Kamida Creek ... ⊕ | 41 47 | 140 43 7 |
| | C. Yesan, 2063f. | 41 47·5 | 141 11·5 |
| | Volcano B., P. Endermo Hr. | 42 19·9 | 140 59·5 |
| | C. Yer mo, (rks. off), 3500f., lt. | 41 55 | 143 16 |
| | Akishi B. | 43 2·4 | 144 51 7 |
| | E. extr., C. Noyshap, lt. F | 43 25 | 145 46 |
| | Skotan I., pk. 1400f. | 43 45 5 | 146 36 |
| | Kunashir I., ⚹ 21 l., C. Moimoto | 44 25 | 146 32 |
| | C. Sirotoko | 44 18 | 145 23 |
| | N extr., C. Soya, Sonai, lt. Fl. 132f. | 45 31 | 141 54 |
| | Refunsiri I., C. Karanunai | 45 17 | 140 59 |
| | Tarari Is., Choresiri, 577f. | 44 24 | 141 16 |
| | Oterrani, lt. F 162f. | 43 14 | 141 0·7 |
| | C. Novosilzoo, lt. Fl. 248f. | 43 19 | 140 22 |
| | C. Sutsuki | 42 37 | 139 51 |
| | Okusiri I., Gomiga saki | 42 15 | 139 33 |
| | **KOREA AND TARTARY.** | | |
| *Korea, W. Coast* | Low Barren Is., [1 l.], S one | 39 12 | 124 34 |
| | Pillar rk., 135f. | 38 7 | 124 39 |
| | Sir Jas. Hall's grp., Chong do. I. | 37 46 | 124 44 |
| | Seoul R., ent. Kuroda I. | 37 30 | 126 3 |
| | Clifford Is., W. I., 412f. | 36 37 | 125 33 |
| | Korean Archipelago, Guérin I., 582f. ○ | 36 7 | 126 0 |
| | — Nan San Do, 579f. | 35 21 | 126 2 |
| | — Modeste I., 1191f. | 34 42 | 125 14 |
| | — Ross I., 1905f. | 34 4 | 125 7 |
| *Is. off S. Coast Korea* | Port Hamilton. Obs. spot ⊕ | 34 1·4 | 127 18·5 |
| | Quelpart, ⚹ 11 l., Beaufort I. off NE part | 33 29·7 | 126 56·5 |
| | Sentinel I., 340f. | 34 33 | 128 42 |
| | Sir H. Parkes Sd. Obs. I. | 35 6·8 | 128 39·5 |
| | Fusan Hr., lts. F | 35 7 | 129 2 |
| | C. Clonard | 36 4 | 129 38 |
| | Dagelet I., Matsu Sima, pk. 4000f. | 37 31 | 130 52 |
| | C. Duroch | 38 46 | 128 16 |
| | Port Lazaref | 39 19 | 127 25 |
| | Broughton B., isl. Hodo | 39 41 | 127 45 |
| *Coast of Tartary* | C. Bruat, 1542 | 40 51 | 129 40 |
| | Tuman Ula R., entrance | 42 17·6 | 130 42 |
| | Expedition Bay, Tchurkhoda | 42 37·9 | 130 48·7 |
| | C. Gamova | 42 33·4 | 131 14·7 |
| | Vladivostock, Scharnhorst's Station | 43 6·8 | 131 52·7 |
| | Askold I., lt. Fl. 590f. | 42 43·8 | 132 21·7 |
| | C. Kruilov | 42 40 | 133 4 |
| | Siau wuhu Bay, S pt. Siaichu R. | 42 54·2 | 133 50 |
| | St. Vladimer Bay, Orekhova Pt. | 43 53·7 | 135 27 |
| | Suffren C., 1300f. | 47 19 | 139 4 |
| | Barracouta Hr., Tullo I. | 49 1·8 | 140 19 |

## MARITIME POSITIONS

| Region | Places | Lat. N | Lon. E |
|---|---|---|---|
| **(79)** | | | |
| Saghalin Island | C. Siourkum | 50° 6′ | 140° 43′ |
| | Castries B., lt. F 262f. | 51 25·5 | 140 55 |
| | Amur R., Nikolaevsk Cathedral | 53 8·1 | 140 43 |
| | Saghalin I., C. Jonquiere, lt. F 360f. | 50 53 | 142 7 |
| | Tcharaikove-ossa Pt. | 48 46 | 141 50 |
| | Kosounai Road | 47 58·7 | 142 13·7 |
| | Monneron I., Totomosiri I., 1400f. | 46 14 | 141 11 |
| | C. Notoro, lt. F 135f. | 45 54 | 142 2 |
| | Kamen Opasnosti, 20f. | 45 45 | 142 10 |
| | Korsakovsk Road, lt. F. | 46 40 | 142 44 |
| | C. Siretoko | 46 1 | 143 26 |
| | C. Tonin | 46 50 | 143 27 |
| | Robben I., 48f. | 48 32 | 144 45 |
| | Tichmenev | 49 13 | 143 9 |
| | C. Patience | 48 42 | 144 55·5 |
| | C. Delisle de la Croyère | 51 1 | 143 47 |
| | C. Loevenstern | 54 3 | 143 15 |
| | C. Elizabeth | 54 24 | 142 47 |
| | C. Maria | 54 17 | 142 18 |
| | C. Golovatcheff | 53 25 | 141 53 |
| Okhotsk Sea | C. Khabaroff | 53 30 | 141 3 |
| | Reinecke I. | 54 18 | 139 52 |
| | Shantar Is., EW 20 l., E one, I Procofieff, [4m.], E pt. | 55 2 | 138 27 |
| | R. Onda, mouth | 54 44 | 135 24 |
| | St. Jonas I., [1m.], ✱₀, 1200f. | 56 25 | 143 18 |
| | Port Aian | 56 25·5 | 138 21 |
| | Okhotsk | 59 22 | 143 14 |
| | C. Bligan | 58 40 | 151 37 |
| | C. Piaghin | 59 13 | 156 15 |
| | Ghijinsk, lt. F | 61 53 | 160 37 |
| | Penjinsk | 62 30 | 162 56 |
| Kuril Is. | Yetorup I., ⸸ 43 l., S pt., C. Rickard | 44 25 | 146 56 |
| | — N pt., C. Vries | 45 40 | 148 45 |
| | Urup I., ⸸ 17 l., SW pt. | 45 37 | 149 32 |
| | Pyramid rk., off N and E pt. | 46 19 | 150 27 |
| | Broughton I., [1 l.], *h*, ✱₀ | 46 44 | 150 28 |
| | Simusir I., ⸸ 10 l., S pt., or C. Rollin (Siauuni) | 46 49 | 151 37 |
| | Broughton B. | 47 13 | 151 56 |
| | Rashua I., [pk.], (rks. SW-d.) | 47 51 | 152 47 |
| | Matua I., Saryche Pk. | 48 6 | 153 12 |
| | Raikoke I., [1 l.], sum. | 48 16 | 153 15 |
| | Musir Is., *δ* | 48 35 | 153 44 |
| | C. Oneta, Shiashkotan I., ⸸ 4 l. | 48 56 | 154 8 |
| | Kharim-kotan I., [1 l.], pk. | 49 11 | 154 35 |
| | Onekotan I., ⸸ 2 l., S pt. | 49 19 | 154 47 |
| | Makanrushi I., [2 l.], mid. | 49 51 | 154 32 |
| | Paramushir I., ⸸ 20 l., S pt. | 50 1 | 155 23 |
| | Shirinki I., [2 l.] | 50 15 | 154 58 |
| | Shumshu I., NS 3 l., mid. | 50 46 | 156 26 |
| | Alaid I., [2 l.], mid. | 50 54 | 155 32 |
| | **KAMCHATKA.** | | |
| | C. Ongon | 58 0 | 157 50 |
| | Bolsheretsk, ent. R. | 52 45 | 156 14 |
| | C. Lopatka | 50 53 | 156 46 |
| | Mt. Vilutchin, 7060f. | 52 42 | 158 22 |
| | Avatcha B., ⊞, E entr., lt. F 526f. | 52 52·5 | 158 47·0 |
| | — St. Peter and St. Paul, Ch. | 53 1·0 | 158 43·5 |
| **(80)** | | | |
| Kamchatka | C. Shipunski | 53° 6′ | 160° 4′ |
| | Kronotsky, pk., 10,610f. | 54 47 | 160 37 |
| | C. Kronotsky | 54 54 | 162 35 |
| | Kluchevski, volc., 16,131f. | 56 8 | 160 48 |
| | C. Kamchatka | 56 0 | 163 15 |
| | Behring I., ⸸ 16 l., NW pt. | 55 17 | 165 42 |
| | — South pt. | 54 43 | 166 42 |
| | Copper, or Medni I., S pt. | 54 33 | 168 11 |
| | C. Stolbovoi, *h*, ⊥ | 56 40 | 163 25 |
| | C. Ozernoi | 57 37 | 163 15 |
| | Karaghinsky I., ⸸ 20 l., N pt. | 59 13 | 164 38 |
| | — South pt. | 58 28 | 163 27 |
| | C. Olutorsky | 59 57 | 170 19 |
| | C. Navarin, *h* | 62 16 | 178 56 |
| | **NORTH-EAST COAST OF ASIA.** | | |
| Asia, E. Coast | Bay of Archangel Gabriel, NE pt., or C. King | 62 28 | 179 14 |
| | C. St. Thaddeus | 62 42 | 179 30 |
| | R. Anadyr, C. Alexandra | 64 42 | 177 22 |
| | Kresta Gulf, C. Meechken | 65 29 | 181 15 |
| | C. Behring | 65 0 | 184 6 |
| | C. Tchukotski | 64 17 | 187 46 |
| | Plover Hd. | 64 21 | 186 40 |
| | Arakam I., E pt. | 64 46 | 187 54 |
| | Metchignie B., entr., pt. *l* | 65 31 | 187 51 |
| | C. Krléougoune | 65 29 | 189 0 |
| | St. Lawrence B., E pt. entr | 65 37 | 189 11 |
| | East Cape, SE extr., 2521f. | 66 3 | 190 16 |
| N. Coast | C. Serdze Kamen (Behring, 1728) | 67 0 | 188 6 |
| | Jinretlen (Nordenskiold, 1879-80) | 67 7 | 186 26 |
| | Burney, or Koliutchin I., S pt | 67 27 | 185 55 |
| | Herald I., 900f. | 71 19 | 184 43 |
| | Kellett land, or Wrangell I., C. Hawaii | 70 58 | 182 20 |
| | Mount Long, 2500f. | 71 7 | 181 18 |
| | C. North of Cook, 105f. | 69 4 | 179 31 |
| | C. Jakan | 69 40 | 176 34 |
| | C. Shelagskoi | 70 2 | 171 10 |
| | Bear Is., E or Column I. | 70 38 | 162 20 |
| | — West one | 70 50 | 160 35 |
| | De Long Is., Jeannette I. | 76 45 | 159 0 |
| | — Bennett I., C. Emma | 76 40 | 149 0 |
| | E Mouth of Indigirka R., pt. | 71 0 | 151 40 |
| | C. Sviatoi | 72 52 | 141 0 |
| | Lyakhow I., S pt. | 73 10 | 143 15 |
| | Liakhov Is., EW 70 l., New Siberia, C. Kamennoi | 75 10 | 151 0 |
| | — North I., Figurin | 76 16 | 141 0 |
| | C. Mufasch, mo. of the Iana | 71 35 | 135 0 |
| | Lena R., mo., N, or lt. ho. pt. | 73 27 | 127 36 |
| | Oleneka R., Dschanila I. | 73 22 | 119 5 |
| | C. Cheluiskin, N extr. of Asia | 77 40 | 104 15 |
| | C. Vega | 77 36 | 103 20 |
| | Einsamkeit I. | 77 40 | 86 0 |
| | Yenisei Gulf, E pt., Dixon Harbour | 73 15 | 81 0 |
| | Gulf of Obi, Drovianoi Pt. | 72 43 | 73 18 |
| | — White I., C. Schubert | 73 7 | 72 5 |
| | — Obdorsk | 66 32 | 66 41 |

## MARITIME POSITIONS

| Region | (81) Places | Lat. N | Lon. E |
|---|---|---|---|
| | **EASTERN ARCHIPELAGO.** | | |
| | Pontianak R., Pa ḋjang I. ... | 0° 2' | 109°10' |
| | Bangkai Pt. | 0 19 | 108 56 |
| | Setinjang I. | 0 21 | 108 45 |
| | Burong Is., Lamukutan, N pk. | 0 48 | 108 42 |
| | Sambas R., Fort Sorg | 1 11 | 108 58 |
| | Tanjong Api, *l*, ⚓, 8 2m., w' | 1 57·5 | 109 19 |
| | Tanjong Dato, *h*. | 2 5 | 109 40·5 |
| | Marundam I., small, 120f. | 2 3·5 | 109 6·5 |
| | Tanjong Sipang, a rk. (rks. 5m.) | 1 48 | 110 21 |
| | Tajong Po, lt. F 490f. | 1 44 | 110 32·5 |
| | Sarawak R., New fort | 1 33 | 110 21 |
| | Sirik Pt., *l*, lt. F. | 2 46 | 111 21 |
| | Mt. Silungun, 1500f. | 3 48 | 113 47 |
| *Borneo, N. W. Coast* | Tanjong Barram, *l*, rf. off ? | 4 36 | 113 58 |
| | Mt. Mulu, 8000f. | 4 7 | 115 14 |
| | Bruni, or Borneo, city palace | 4 52·2 | 114 54·2 |
| | Mcaro I., E pt. | 5 0·4 | 115 4 |
| | Labuan I, Ramsay Pt. | 5 16·5 | 115 15 |
| | Pulo Tega, 8, *N d* 3 l. N end | 5 44 | 115 38·5 |
| | Castle Pk., 1500f. | 5 47 | 116 5 |
| | Pulo Gaya, ⚓ 4m., lt F | 6 0 | 116 3 |
| | Samarang Bk., 3) | 5 36 | 114 53 |
| | Vernon Bk., a Fury rks. | 5 44 | 115 2·5 |
| | Saracen Bk., SW extr. | 6 6 | 115 18 |
| | Mangaloon I., small, 88 | 6 11 | 115 35 |
| | Ambong B., ⚓ | 6 18 | 116 19 |
| | Kini Balu, Mtn., 13,700f. | 6 7 | 116 33 |
| | Matanani Is., [5m.], W pt. | 6 42 | 116 16 |
| | N. Furious shl., ? | 7 1 | 116 17 |
| | N extr., Sampanmango Pt., Kalampunian I., off | 7 4 | 116 43 |
| | Balambangan I., ⚓ 5 l., 2 ⊞ SE, 440f., Kalutan I. | 7 13 | 116 49 |
| | Banguey I., ⚓ 7 l. NW, pk., 1876f. | 7 17·5 | 117 5·7 |
| | — E side, Bancowan I., S pk. | 7 12·5 | 117 18·5 |
| | Mangsi Is., ⚓ 3 l., (rfs. WSW 3 l.). 8' l. | 7 32 | 117 16 |
| | — N one, Salingsingan I. | 7 34 | 117 16 |
| | Balabac I., NS 7 l., 1900f., S pt., or C. Melville | 7 49 | 116 59 |
| *Palawan* | Calandorang B., lt. F 119f. | 8 0 | 117 2·7 |
| | Palawan, ⚓ 80 l., S extr., or Pt. Bulilnyan | 8 20 | 117 10 |
| | Bulanhan hill, N end of range, 3,500f. | 8 40 | 117 24 |
| | Albion head | 9 17 | 117 58 |
| | York breakers, [½m.], 1 foot | 9 53 | 118 8 |
| | Table Pt. | 10 0 | 118 38 |
| | Ulugan B., NW head | 10 8 | 118 45 |
| | — Watering B. | 10 10 | 118 48 |
| | High I, off Port Barton, 1050f. | 10 31 | 119 4 |
| | Malampaya Sd., Pancoh | 10 52 | 119 23 |
| | Tapiutan I., (Rugg. Is.), N pt. | 11 14 | 119 15 |
| | Cabuli I., [1m.], 560f. | 11 26 | 119 29 |
| | Dumaran I., ⚓ 5 l., E pt., Pirate Hd. | 10 35 | 120 0 |
| | Carlandagan I., NS 2m., E pt. | 10 39 | 120 15 |
| | Barbacan, Stockade | 10 21 | 119 23 |
| | Port Royalist, lt. F 43f. | 9 44 | 118 43 |
| | Detached I., East I., [1m.], *l*. | 8 53 | 118 15 |
| | Kanaren I., [½m.], 800f. | 11 14 | 120 16 |

| Region | (82) Places | Lat. N | Lon. E |
|---|---|---|---|
| | Nangaloo Is., [1 l.], NE pt. | 11°25' | 120°10' |
| | Yloe I., [3 l.], S pt., rock off | 11 16 | 119 42 |
| | Linicapan, NW pt. | 11 28 | 119 43 |
| | Tres Reyes, rks., [½m.] | 11 34 | 120 6 |
| | Delian I., [1m.] | 11 51 | 120 19 |
| | Tara I., ⚓ 3m., 730f., N pt. | 12 20 | 221 21 |
| | Busuanga I., ⚓ 12 l., N pt. | 12 20 | 119 53 |
| | Colocoto rks., [1m.] | 12 28 | 120 2 |
| | Culion I., ⚓ 7 l., Culion | 11 54 | 120 0 |
| | **Philippine Islands.** | | |
| | Hunter Rock | 12 41 | 120 11 |
| | Merope shl., [2m.] | 12 44 | 120 15 |
| | Apo shl., ⚓ 2 l.? Is. ⚓, Apo I. | 12 40 | 120 24 |
| *Mindoro Strait* | Falmouth Bank, NS 2 l., N pt. | 11 54 | 120 58 |
| | Panagatan shl., EW 3m, 3f. | 11 52 | 121 16 |
| | Semirara Is., N pt., [5m.], ⚓ | 12 7 | 121 20 |
| | — S pt., or Pirate I., ⚓ o w, (a lake), SE pt. | 11 58 | 121 22 |
| | Kiniluban, [1 l.], remkble. spire on W extr. | 11 26 | 120 46 |
| | Manignin I. | 11 36·5 | 121 40 |
| | Pontud bank | 11 21 | 121 40 |
| | Manamoc I. and rfs., [2 l.], pk. | 11 18 | 120 42 |
| | Cuyos I. | | |
| | — Grt. or Cuyo I., Town ... ⊖ | 10 51 | 121 1 |
| | — E extr. or Tagauayan ... ○ | 10 58 | 121 13 |
| | — S extr., Imalaguan, 303f. ○ | 10 45 | 121 4·5 |
| | — SW extr., islet, Paya, 90f. ○ | 10 48 | 120 36·5 |
| | Sombrero rk., [10 yds.] ... ⊖ | 10 43 | 121 33 |
| | White rk., 24f. ⊖ | 10 26 | 121 2 |
| | Ambolon I., S end, (shls. SE d) | 12 11 | 121 1 |
| | Port Mangarim Town | 12 21 | 121 5 |
| | Pt. Lumintau ⊖ | 12 31 | 120 54 |
| | Sablayan Pt. | 12 50 | 120 45 |
| *Mindoro* | Mamburao R. ⊖ | 13 15 | 120 33·5 |
| | C. Calavite ⊖ | 13 26 | 120 17·5 |
| | Paluan B., vill., w | 13 23·5 | 120 29·2 |
| | Mt. Calavite, 2000f. | 13 28·7 | 120 24 |
| | Pt. Escarseo | 13 31·6 | 120 59? |
| | Silonay I. | 13 27 | 121 13 |
| | Pt. Dumali, (sum. ⚓ 3m.) | 13 6 | 121 34 |
| | Pt. Dayagan | 12 38 | 121 32 |
| | Pt. Pandan | 12 17·5 | 121 23 |
| | Libagao I., [2m.], 410f. | 12 12 | 121 25 |
| | Ilin I., Pt. Ilin | 12 9 | 121 6 |
| | Golo I., SE end | 13 38·5 | 120 25·5 |
| | Lubang I., ⚓ 4 l., *h*, N pt. | 13 52 | 120 5·5 |
| | — Looc Bay | 13 43·8 | 120 16·7 |
| | Cabras, or Goat I., lt. Fl. | 13 54 | 120 2 |
| | C. Santiago, (Minerva rk. ESE 5m.) | 13 46 | 120 40 |
| | Fortune I., [1m.], 450f. | 14 4 | 120 29 |
| | Friar, 120f. off Pt. Limbones | 14 18 | 120 37·5 |
| | Cavite, lt. F 80f. | 14 29·5 | 120 54·5 |
| *Luzon* | MANILA CATHEDRAL | 14 35·5 | 120 58 |
| | Orani | 14 48 | 120 33 |
| | Corregidor I., lt. Fl. 639f. | 14 23·3 | 120 34 |
| | Pt. Luzon, or Hornos | 14 25·5 | 120 28 |
| | Port Subec, Grande I. | 14 47 | 120 13 |
| | Pt. Capones, large I. off, *h*, ⚓ c | 14 55·5 | 120 05 |
| | Yba, town | 15 20 | 119 58 |

## MARITIME POSITIONS

| | (83) Places | Lat. N | Lon. E |
|---|---|---|---|
| *Luzon, W. Coast* | Masingloc, town | 15° 33 | 119° 57′ |
| | Hermana mayor I., summit | 15 48 | 119 47·2 |
| | Pt. Caiman, rf. SW | 15 55 | 119 46 |
| | Tambobo Pt. | 16 0·5 | 119 43·5 |
| | Bolinao, Tel. Station | 16 24 | 119 56 |
| | Port Sual, lt. F 79f. | 16 6 | 120 7·5 |
| | Dagupan R., lt. F 29f. | 16 5 | 120 19·5 |
| | Pt. San Fernando, lt. F 29f. | 16 37·5 | 120 17·5 |
| | Pt. Darigayos | 16 51 | 120 20·0 |
| | Port Santiago | 17 18 | 120 27 |
| | Pt. Dile | 17 34 | 120 21 |
| | Mt. Bulagao, 3629f. | 17 38·5 | 120 31 |
| | Pinget I., S pt. | 17 40 | 120 22 |
| | Culili Pt. | 18 5 | 120 28·7 |
| | C. Bojeador, *l*, β 2m. | 18 30 | 120 34·5 |
| | Pt. Mayraira | 18 40 | 120 52 |
| | Caraballo Hill | 18 31·5 | 120 54 |
| | Cabicungan Pt. | 18 38·2 | 121 6 |
| | Aparri, town, ‡′ 10 | 18 21·3 | 121 37 |
| | C. Engano, Hermanos Is. | 18 35·5 | 122 6·5 |
| *Babuyan Is.* | Dedicas rks., *k*, pkd. | 19 3 | 122 9·5 |
| | Guinapac rks., *k*, T, ‖ W | 18 58 | 122 4 |
| | Camiguin I., $\frac{2}{12}$ 4 l., (Port S Pio Quinto, ‡′ W, w), volc., vis. 20 l., Font I. | 18 55 | 121 48 |
| | Fuga, or New Babuyan, EW 5 l., Port Musa, ‡, at W End | 18 52 | 121 16 |
| | Dalupiri, vis. 11 l., ‡₀, rks. S-d., N pt. | 19 9 | 121 13 |
| | Calayan, [3 l.], *k*, T, rf., NW pt. | 19 22 | 121 22 |
| | Wyllie rks., 2, $\frac{2}{12}$ 2m., N part | 19 30 | 121 39 |
| | Claro Babuyan, [5 l.], *k*, volc. E end | 19 31 | 122 1 |
| *Batan Is.* | Balintang, or Richmond Is., 3, [1 l. ?], *k*, ⊥, T, δ₀, N one, vis. 8 l. | 20 1 | 122 18 |
| | Sabtan I., NS 5m., S pt. | 20 17 | 121 53 |
| | Ibugos, NS 2m., S pt. | 20 19 | 121 49 |
| | Dequez, (Goat Is.), [¾m.], W. pt. | 20 21 | 121 48 |
| | Batan, or Monmouth, $\frac{2}{12}$ 9m., r, w′, N sum. 3806f. | 20 28·5 | 120 1·2 |
| | — San Domingo, Cathedral | 20 27·5 | 121 59·0 |
| | Diogo, (Grafton I.), [¾m.], 848f. | 20 41·5 | 121 57 |
| | Ibayat, (Orange I.), $\frac{2}{12}$ 8m., r, ‡ W, N sum., or Sta. Rosa, 680f. | 20 47·3 | 121 52·7 |
| | Mabudis, $\frac{4}{12}$ 1½m. | 20 54 | 121 57 |
| | Y'Ami, [¾m.], (North Islet is SSW 2m.) | 21 5 | 121 58 |
| *Bashee Is.* | Gadd's rk., or Cumbrian break | 21 43 | 121 37·2 |
| | Little Botel Tobago, [½m.] | 21 57·7 | 121 36·5 |
| | Botel Tobago, $\frac{6}{15}$ 8m.? ♆, NE pk. 1850f. | 22 5 | 121 33·5 |
| | Vela Rete rks., [2m.], 25f. | 21 45·1 | 120 8·2 |

| | (84) Places | Lat. N | Lon. E |
|---|---|---|---|
| *Luzon, E. Coast* | Yligan Pt. | 18° 20′·5 | 122° 18′ |
| | Mt. Dos Cuernos, 4008f. | 17 30 | 122 6 |
| | Tumango Port, N pt. entr. ○ | 16 43 | 122 14 |
| | C. St. Ildefonso ○ | 16 5 | 121 46 |
| | Port Lampon | 14 43 | 121 34 |
| | Polillo I., $\frac{2}{12}$ 7 l., Banla Pt., (Is. SE-d.) ○ | 15 5 | 122 6 |
| | — South point ○ | 14 43 | 122 4 |
| | Jomalie I, [3 l.], E pt. ○ | 14 35 | 122 17 |
| | Maulamat I. ○ | 14 30 | 122 19 |
| | Cabelete I., [4m.]. S pt. ○ | 14 15 | 121 50 |
| | Alabat I, [3 l.], *l*, N pt. ○ | 14 14 | 121 55 |
| | Jesus Pt. ○ | 14 22 | 122 26 |
| | Samur I. ○ | 14 31 | 122 43 |
| | Matandumaten, *l*, Is. ○ | 14 17 | 123 5 |
| | San Miguel B., Canton I., W of entr. [1m.] ○ | 14 4 | 123 5 |
| | I. Batavanan, $\frac{2}{12}$ 3m., N pt. | 14 9 | 123 17 |
| | Sisiran Port, ⊞, Basi | 13 55 | 123 36 |
| | Palumbanes I., EW 3m., W pt. | 14 5 | 124 4 |
| | Catanduanes I., $\frac{2}{12}$ 12 l., shl. N of, [1 l.], Iot pt. ○ | 14 8 | 124 13 |
| | — S. or Taguntun Pt. ○ | 13 31 | 124 9 |
| | Volcano of Isaro | 13 39 | 123 21 |
| | Volcano of Albay, 8274f. | 13 16 | 123 41 |
| | Rapurapu I., [3 l.], Unguy Pt. | 13 11 | 124 10 |
| | Pt. Montugan, rfs. 3m. | 13 8·5 | 124 13·7 |
| | Volcano of Bulusan | 12 47 | 124 2 |
| | St. Bernardino I., [2c.], ♠₀, ‖ E and W, 150f. | 12 46 | 124 15 |
| | S extr. of Luzon, Calintan I. | 12 31 | 124 5 |
| | Los Naranjos Is., [2 l.], Raza I. | 12 22 | 124 0 |
| | Capul, $\frac{2}{12}$ 7m., N pt. | 12 29 | 124 8 |
| | Port Sorsogon, ⊞, town | 13 0 | 123 59 |
| | Ticao I., $\frac{2}{12}$ 5 l., N pt., S Miguel I. | 12 43 | 123 36 |
| | — Port San Jacinto, on E side, ⊞, w, r | 12 32·3 | 123 45·5 |
| | Masbate I., Bugui Pt. | 12 36 | 123 15 |
| | — Jintotolo I. | 11 51 | 123 7·5 |
| | — Port Barreras, on N side, ⊞, N pt. entr. | 12 33 | 123 24 |
| *Luzon S. Coast* | Burias I., Busin lt F. | 13 8 | 122 58 |
| | Cabeza de Bondo, 1250f. | 13 12 | 122 35 |
| | Marinduque I., $\frac{2}{12}$ 8 l., Marlanga Pt. | 13 12 | 122 2 |
| | — St. Andre, pt. 751f, ⊞ | 13 33 | 121 52 |
| | Pagvilao I., $\frac{2}{12}$ 1 l., S Pt. | 13 53 | 121 45 |
| | Pt. Locoloco | 13 39 | 121 25 |
| | Mt. Labo, sum. 3363f. | 13 40 | 121 18 |
| | I. Verde, $\frac{6}{15}$ 5m., NE pt. | 13 33·5 | 121 5 |
| | Batangas, town, r | 13 45 | 121 3 |
| | Pt. Natoco | 13 38 | 121 2 |
| | Maricaban I., EW 2 l., rfs. E and W pts., W pt. | 13 41 | 120 50·5 |
| | Maestre de Campo I., [1 l.], Port Concepcion | 12 54 | 121 44 |
| | Dos Hermanas, Isabel I., 150 . | 13 0 | 121 56·5 |
| | Banton I., [1 l.], NE pt. | 12 57 | 122 6 |
| | Simara I., [2m.], N end | 12 50 | 122 7 |
| | Tablas I., NS ab. 12 l., Cabezo, 2405f. | 12 38·5 | 122 10 |
| | — P. Loog Town, ⊞ | 12 16 | 121 59 |
| | Romblon I. Port, lt. F. | 12 36 | 122 17 |

## MARITIME POSITIONS

| | (85) Places | Lat. N | Lon. E |
|---|---|---|---|
| | Silmyan I., ✱ 5 l., pk 6424f., Pt. Cavit | 12°16′ | 122°38′7 |
| | Cresta del Gallo I., [1m.], S | 12 11·5 | 122 42·5 |
| Samar Strait | Samar I., ✱ 42 l., Batag I., NS 5m., N pt. | 12 43 | 125 5 |
| Samar Strait | — Port Palapa, Calapan I. | 12 37 | 125 0 |
| Samar Strait | — Borongon, town | 11 42 | 125 25 |
| Samar Strait | — S and E extr. I. | 10 54 | 125 52 |
| Samar Strait | — Manicani I., [1 l.], S pt. | 10 58 | 125 38 |
| Samar Strait | Canduay I., lt. F 33f. | 11 26 | 124 53 |
| Samar Strait | Parasan Pt. | 11 44 | 124 46 |
| Samar Strait | Sibugay I., N end, [1 l.] | 12 0 | 124 27 |
| Samar Strait | I. de la Mesa, [1 l.], Bagai pul I. | 11 53·5 | 124 17·5 |
| Samar Strait | Bilian, ✱ 7 l., Tincansan I. | 11 41 | 124 20 |
| Samar Strait | Carnasa I., small, S pt. | 11 30 | 124 6 |
| Samar Strait | I. del Gato, rk. | 11 27 | 124 1 |
| Samar Strait | Tagapula, ⚓ 6m., E pt. | 12 5 | 124 15 |
| Leyte | Leyte I., ✱ 37 l., Gigantangan islet | 11 35 | 124 16 |
| Leyte | Port Palompon, town | 11 2 | 124 24 |
| Leyte | Camotes Is., NW one, Tulang | 10 44 | 124 18 |
| Leyte | Ylongus, town | 10 23 | 124 44 |
| Leyte | South pt., Leyte I. | 10 0 | 125 2 |
| Leyte | Limasana I., S end | 9 54 | 125 4 |
| Leyte | Panaon I., 2313f., S pt | 9 55 | 125 16·5 |
| | Bohul, EW 15 l., Namanuco Pt. | 9 47 | 124 36 |
| | — West point, or Pt. Duljo | 9 35 | 123 42 |
| Zebu | Zebu, ⚓ 35 l., Tañon Pt. | 9 25 | 123 19 |
| Zebu | — Zebu town, ⊞, fort, lt. F 42f. | 10 17·5 | 123 54 |
| Zebu | — NE, or Bulalaque Pt. | 11 17 | 124 4 |
| | Doon Is., SW I. ○ | 11 2 | 123 36 |
| | Calangaman I., at E extr. of a rf. | 11 7 | 124 15 |
| Negros | Siquijor, ⚓ 7 l., Pt. Minalutan | 9 10 | 123 42 |
| Negros | Negros I., ⚓ 38 l., Siaton Pt. | 9 2 | 122 59 |
| Negros | — Pt. Sojoton, T | 9 59 | 122 27 |
| Negros | — North Pt., Ylacaon I. | 11 2 | 123 11 |
| Panay | Panay ⚓ 32 l., S pt., ⚓, ⊥, Juraojarao islet | 10 24 | 121 57·5 |
| Panay | S. Jose de Buenavista | 10 44·5 | 121 55 |
| Panay | Nalupapt rf. | 11 13 | 121 59 |
| Panay | Manignin | 11 37 | 121 40 |
| Panay | Pt. Pucio, 620f. | 11 46 | 121 50 |
| Panay | Borocay I., 436f., N pt. | 11 59 | 121 54 |
| Panay | Pontud, [1½m.] | 11 50 | 122 15 |
| Panay | Port Batan, ⊞ | 11 36 | 122 30 |
| Panay | Olutaya Islet | 11 38 | 122 50 |
| Panay | Zapato Mayor | 11 45·5 | 123 2 |
| Panay | Jintotolo I., [1 l.], 120f. | 11 50 | 123 8·5 |
| Panay | Pt. Bulacaue | 11 37 | 123 9·5 |
| Panay | Gigantes Is., [2 l.], Vaidajon | 11 38 | 123 22 |
| Panay | Culebra Islet | 11 22 | 123 14 |
| Panay | Baliguian Islet | 11 12 | 123 20 |
| Panay | Ilo Ilo Fort, lt. F 21f. | 10 42 | 122 36 |
| Surigao Is. | Suluan, [1 l.] | 10 46 | 125 58 |
| Surigao Is. | Malhon I., [4 l.], E pt. | 10 43 | 125 49 |
| Surigao Is. | Dinagat I., Pt. Desolation | 10 28 | 125 38 |
| Surigao Is. | Gibuson I., N pt. | 10 28 | 125 28 |
| Surigao Is. | Siargao I., Sapao Pt., 620f. | 10 4 | 126 3·5 |
| Surigao Is. | P. Sibunga, entr., ⊞ | 9 41 | 126 1 |
| | Bilas Pt., N pt. Mindanao | 9 49 | 125 26 |
| | P. Surigao, ⊞, town | 9 47 | 125 31·7 |

| | (86) Places | Lat. N | Lon. E |
|---|---|---|---|
| Mindanao | Pt. Cauit | 9°17′5 | 126°14′ |
| Mindanao | Catel, town ○ | 7 48 | 126 22 |
| Mindanao | Pt. Pusan | 7 14 | 126 25 |
| Mindanao | C. St. Augustin, or Pandagitan ○ | 6 14 | 126 6 |
| Mindanao | Palmas I ○ | 5 30 | 126 28 |
| Mindanao | Davao R., lt. F 27f. | 7 1 | 125 36 |
| Mindanao | F. Sirangani I., NS 4 l., ⚓, b, hill, S end | 5 24 | 125 25 |
| Mindanao | Pt. Tinaka, vis 12 l., T | 5 35 | 125 16 |
| Mindanao | Glan Masila R., lt. F 33f. | 5 45 | 125 15 |
| Mindanao | Volcano, 3600f. | 5 45 | 125 25 |
| Mindanao | Leno Bay ○ | 6 45 | 124 00 |
| Mindanao | Mindanao, R. entr. ○ | 7 16 | 124 11 |
| Mindanao | Pollock Cove, ⊞, w, P, fort | 7 21 | 124 11·5 |
| Mindanao | Bongo I., ⚓ 5m., SW pt. | 7 18 | 123 59 |
| Mindanao | Tignma | 7 46·5 | 123 25 |
| Mindanao | Pt. Flecha | 7 22 | 123 22 |
| Mindanao | Oluntanga I., S pt. | 7 16·7 | 122 48·5 |
| Mindanao | Cocos I., small, 690f. | 6 44 | 122 14 |
| Mindanao | Sta Cruz Is., 2, E one | 6 52·5 | 122 3·7 |
| Mindanao | Samboanga, w, r, Gov. Ho. lt. F 35f. | 6 55 | 122 4·5 |
| Mindanao | Caldera Port | 6 57·5 | 121 57·5 |
| Mindanao | Sibuco B. | 7 20 | 122 4 |
| Mindanao | Pt. Balangonan, ⟶ | 7 47 | 122 5·5 |
| Mindanao | Murcielagos I. | 8 7·5 | 122 26 |
| Mindanao | Pt. Sindangan | 8 11 | 122 39 |
| Mindanao | Pt. Blanca | 8 32 | 123 4·5 |
| Mindanao | Aliquay I., l, ✱, T S | 8 45 | 123 13 |
| Mindanao | Silino I., l, ✱, T S | 8 51 | 123 24 |
| Mindanao | Pt. Tabud, lt. F 43f. | 8 42 | 123 22 |
| Mindanao | Misamis town | 8 9 | 123 47·5 |
| Mindanao | Pt. Sulauang | 8 38 | 124 29·5 |
| Mindanao | Cagayan, anchorage | 8 30 | 124 40 |
| Mindanao | Pt. Bagacay | 8 59 | 124 49 |
| Mindanao | Camiguin I., [4 l.], 5338f. | 9 11 | 124 44 |
| | **Sulu Sea.** | | |
| Sulu Sea | Sultana Bank | 9 59 | 121 22 |
| Sulu Sea | Cagayanes Is., 5, l, ✱, (rf. N end) | 9 47 | 121 20 |
| Sulu Sea | Calusa, [3c.] | 9 36 | 121 6 |
| Sulu Sea | Anuling I. | 9 44 | 121 25 |
| Sulu Sea | Cavelli I., 124f., [✱], NE extr. | 9 14·2 | 120 52·7 |
| Sulu Sea | — Reefs, SW extr. | 9 10·5 | 120 45·7 |
| Sulu Sea | Jessie Beazley rf. | 9 2·5 | 119 48 |
| Sulu Sea | Toob Bataha, shl., ⚓ 7 l., rk. S extr. | 8 49 | 119 55·5 |
| Sulu Sea | — Shl., SW-d, S rk. | 8 43·5 | 119 51 |
| Sulu Sea | St. Michael's I., Manuk Manukan, 32f. | 7 42·6 | 118 28 |
| Sulu Sea | — Bancawang, 123f. | 7 44·8 | 118 33 |
| Sulu Sea | — Bancoran, 140f. | 7 56·6 | 118 41 |
| Sulu Sea | Cagayan Sulu Is., 3, large one, ⚓, ✱, rk. at entr. of circ. basin ⊕ | 6 59·1 | 118 29 |
| Sulu Sea | — Keenapoussan I. | 7 11·3 | 118 26 |
| Sulu Sea | — S extr., Mulegee Is., T, 8o | 6 53 | 118 24·7 |
| Sulu Sea | Mambahenanan | 6 34 | 118 31·5 |
| Sulu Sea | Talantam bk. | 5 42 | 119 27 |
| Sulu Sea | Pearl Bank, ent. | 5 48 | 119 39 |
| Sulu Sea | Tawi Tawi, Bongola | 5 3 | 119 47·5 |
| Sulu Sea | Manuc Manca, S pt. | 4 47·2 | 119 50·5 |

## MARITIME POSITIONS

| | (87) Places | Lat. | Lon. E |
|---|---|---|---|
| | | North | |
| *Sulu Archipelago* | Sibutu I., N pt. | 4° 54'8 | 119° 27' |
| | Doc-Can, W pt. | 5 52·5 | 119 56 |
| | Cap, N end | 5 59 | 120 10 |
| | Pangootaran Is., Ubian I., 72f., S pt. | 6 7·7 | 120 27·5 |
| | Kulassien, rfs., E pt. | 6 26 | 120 43 |
| | Salleolookit Is. | 6 41 | 121 22 |
| | Griffin rks. | 6 46 | 121 24 |
| | N extr., Teynga I., small, *l*, ✝ | 6 53 | 121 37 |
| | Sangboys Is. small, S end | 6 50 | 121 36 |
| | Basilan I., EW 11 l., 3970f., P, Pt. Matanal | 6 38 | 122 19 |
| | — Pasanhan, ⊞, w, Isabela fort | 6 42 | 121 57·5 |
| | Cocos I., 690f. | 6 44 | 122 15 |
| | Sibago, *h*, E islet, 935f. | 6 44 | 122 23 |
| | Bubuan, E pt., 794f. | 6 21 | 121 57 |
| | Tapeantana, small, pk.. 938f. | 6 18 | 121 57 |
| | Bulan, EW 4 l., *l*, w, E pt. | 6 8 | 121 52 |
| | Simisa, N pt. | 5 59 | 121 35 |
| | Sulu, EW 12 l., w, r, b, Port, lt. F 35f. | 6 3·2 | 120 59·5 |
| | Suladde I., E pt. | 5 50 | 120 48 |
| | Pata Pk., 1434f. | 5 49 | 121 9 |
| | Kabingan Is., 2, *l*, ✝, Boacou | 5 43 | 121 0 |
| | Siassi Pk., 1714f. | 5 32 | 120 52 |
| | Simaluc Pk., 127f. | 5 26·7 | 120 15 |
| | Sigboye passage, Dangerous Pt. | 5 13 | 120 43 |
| | **Borneo.** | | |
| *Borneo, N.E. Coast* | Banguey, NW pk., 1876f. | 7 17·5 | 117 5·7 |
| | Bancawan I., S pk. ○ | 7 12·5 | 117 18·5 |
| | Mallawallee I., NW pk., 582f. | 7 3·5 | 117 17·2 |
| | Pt. Sugut | 6 26·5 | 117 43·5 |
| | Lankayan I., ✝, 100f. ○ | 6 30 | 117 55·5 |
| | Libarran I, 140f. | 6 7 | 118 1·5 |
| | Bagnan I., 228f. | 6 6 | 118 27 |
| | Sandakan B., 3 ⊞, w', b, Bahala I., pk., 643f. | 5 52 | 118 9 |
| | Kinabatangan R., Driftwood Pt. | 5 38·5 | 118 38 |
| | Usang Pt., Hull Rock ⊕ | 5 17 | 119 17·2 |
| *Borneo, E. Coast* | Darvel, B. Silam | 5 0 | 118 10 |
| | Si Amcel I., 800f. | 4 20 | 118 53 |
| | Sipadan I., 120f. | 4 7 | 118 36 |
| | Ligitan. grp., Mabul I., 120f. | 4 15 | 118 36 |
| | Sombakong, (mouth of R.) | 3 44 | 117 50 |
| | Sesajab R., Tibu Pt. | 3 26 | 117 42 |
| | Bulungan, town | 2 51 | 117 21 |
| | Maratua I., NS 5m., N pt. | 2 18 | 118 34 |
| | Pantai R., mouth | 2 2 | 117 53·5 |
| | Mauras rf., Sambit I., [8 l.], rfs. | 1 47 | 119 6 |
| | Mangka Liat Pt. | 1 1 | 119 1·5 |
| | Krindingan I. | 0 5 | 117 37 |
| | | South | |
| | Mahakkan R., Bayor Pt. | 0 43 | 117 38 |
| | Balik Pappan B., N entr. pt. | 1 15 | 116 50 |
| | Passier R., entr., Muara | 1 52 | 116 24 |
| | Aru Pt., ⊥, ✝, (shls. 3 l.) ○ | 2 10 | 116 36 |
| | Pamukan B., Mirra Pt., *l*, ✝, (riv. 8) ○ | 2 33 | 116 31 |
| | Pulo Laut, NS 18 l., P, Pemantjing Pt. ⊖ | 3 12 | 116 16 |
| | Brothers I. | 4 26 | 116 10·5 |
| | Sembargelap Is., Marahi I. | 3 39 | 116 36 |
| | St. George shl., [¾m.], ι | 4 12 | 116 14·5 |
| | Moresses, Siri Is., 8 3m., pk. | 4 22·5 | 115 48 |

| | (88) Places | Lat. | Lon. E |
|---|---|---|---|
| | | South | |
| *Borneo, S. and W. Coasts* | Dunalder I., *l*, ✝, … | 4° 14' | 116° 7' |
| | S. pt. Borneo, Tanjong Salatan | 4 10 | 114 40 |
| | Baruto R., Burung Pt. | 3 34 | 114 30 |
| | Tanjong Malatayo | 3 38 | 113 35 |
| | Sampit B., Bandaran Pt. | 3 16 | 113 8 |
| | Flat Hook, or C. Puding | 3 33·5 | 111 50 |
| | Kotarvaringin B., Samadra I. | 2 54 | 111 24 |
| | Tanjong Sambar | 3 0 | 110 18 |
| | Fox's shl., 2 | 3 30 | 110 10 |
| | Clemencia Reef, β | 3 22 | 110 8 |
| | Rendezvous, or Kumpul, ⚓ 4 l., ⚓' W, SW pt. | 2 45 | 110 3 |
| | Minto hill, 328f. | 2 15 | 110 4 |
| | Succadana, town ○ | 1 14 | 109 58 |
| | Mt. Maja, 1733f. | 1 7 | 109 29 |
| | Padang Tikar Pt. | 0 40 | 109 16 |
| | **Strait of Macassar.** | | |
| *Strait of Macassar* | Laurot, or Little Pulo Laut Is. [10 l.], Sand W extr. | 4 49 | 115 45 |
| | Sibbald's bks., western ○ | 5 46 | 117 4 |
| | Komba I., (shl. S end) | 5 15 | 117 4 |
| | Siri, 4 Is., vis. 7 l., ✝, Sibaru | 5 5 | 117 3 |
| | Laurel shl. | 4 30·5 | 117 6 |
| | Gt. Doangdoangan | 5 23 | 117 55 |
| | Kalu Kalukoan Is., Rotterdam | 5 16 | 117 36 |
| | Medenblik, or Edam | 5 3 | 117 55 |
| | Laars bk., Dewakan I., (shl. 12 l., S-d) | 5 24 | 118 26 |
| | Tonyn I. | 5 29 | 118 39 |
| | Lanjuákan Is., Lankai | 5 1 | 119 5 |
| | Teignmouth shl., W. limit | 4 55 | 118 39 |
| | North Watcher | 4 33 | 119 14 |
| | Kapo Posang | 4 42 | 118 58 |
| | Dry sand bk. | 3 31 | 117 28 |
| | Triangles, 3, [1 l.], S one, ✱ ○ | 3 5 | 117 51 |
| | Hannah shl., centre ○ | 2 20 | 117 3 |
| | Little Paternosters, 13 Is. and bks., *l*, ✝, (S lim. uncert.; bks. NW 3 l.), NW Id., w, Teleonsing | 2 15 | 117 8 |
| | — East I., w, Balabalágan | 2 33 | 117 58 |
| | **Celebes.** | | |
| | Layken Pt. | 5 37 | 119 30 |
| | Tana-keke I., [4m.], ✝, N pt. | 5 27 | 119 18 |
| | Sammalóna | 5 7 | 119 20 |
| | Macassar, Rotterdam fort, N bast., lt. F | 5 8·2 | 119 23·2 |
| | Pt. Lero | 4 3 | 119 35·5 |
| | C. Mandar, *h*, T | 3 35 | 118 57 |
| | C. Kait | 2 51 | 118 47 |
| | C. William, *h*, (an Id. off) ○ | 2 37 | 118 50 |
| | Palos B., ⊞, town | 0 55·5 | 119 51 |
| | — Dangola | 0 39·5 | 119 44 |
| | | North | |
| | C. Temul, rf., W 5m., N pt. | 0 4 | 119 43 |
| | South Watcher | 0 7 | 119 39 |
| | C. Dondo, (rf. NE 10m.), *h*, T ⊖ | 0 58 | 120 17 |

## MARITIME POSITIONS

| (89) Places | Lat. | Lon. E |
|---|---|---|
| ***Celebes, N. Coast*** | North | |
| C. Rivers, vis. 30 l., Slime islets, 80f., ☨, ⌐ ......... | 1°20′4 | 120° 44′5 |
| Pienjang I. .......................... | 1 19 | 121 3 |
| C. Kandie, or Dako .......... | 1 20 | 121 25 |
| Josina rfs., Bongkie I. ......... | 1 5 | 122 57 |
| Mt. Soputan, 5994f. ............ | 1 7 | 124 45 |
| Manado, Fort Amsterdam ... | 1 30 | 124 46·5 |
| Mt. Klobat, 6694f. ............... | 1 28 | 125 2 |
| Toua Manado I., [3m.], 2737f. | 1 39 | 124 42 |
| — Nuin I. [1½m.], 765f. ...... | 1 47 | 124 47 |
| Talisse I., ☨ 6m., 1168f., N pt. | 1 54 | 125 6 |
| Banka, ☨ 7m., E pt ............ | 1 48 | 125 11 |
| C. Coffin .............................. | 1 41 | 125 10 |
| Limbe I., ☨ 3 l. N pt. ......... | 1 33 | 125 17 |
| Kema. w, r, fort.................... | 1 22 | 125 5 |
| Belang Town ........................ | 0 56 | 124 47 |
| C Flesko, Kalapa I. ............ | 0 26 | 124 27 |
| Gorontalo R., r, w, lt. F 95f... | 0 30 | 122 58 |
| | South | |
| Parigie.................................... | 0 47 | 120 9 |
| C. Tellogonda........................ | 0 58 | 120 34 |
| Una Una I., N pt. ............... | 0 9 | 121 35 |
| C. Apie ........................○ | 0 47 | 121 36 |
| Grt. Waleah I., N end ......... | 0 13 | 122 12 |
| ***Celebes, E. Coast*** | | |
| C. Talabo, h, E pt ............○ | 0 46 | 123 27 |
| Toko B., Onee Malubu Pt. ○ | 1 58 | 121 33 |
| Peling I., E pt. ...............♀ | 1 17 | 123 31 |
| Bangkulu I., S end .........♀ | 1 57 | 123 5 |
| Nederburgh Pt., ♁ 5m. ......... | 2 53 | 122 17 |
| Low Ambeli I. ........................ | 3 6 | 122 33 |
| Labengki I., [5m.], E pt ...... | 3 27 | 122 28 |
| Manui I., [3 l.], h, NE pt. ... | 3 35 | 123 12 |
| Pt. Nipa Nipa, N extr. ......... | 3 54 | 122 39 |
| Kendarie B., Wowebalu Pt. ... | 4 0 | 122 38 |
| Wawoni I., [5 l.], E pt. ...... | 4 5 | 123 11 |
| Bouton I., ☨ 27, l., N pt..... | 4 23 | 123 4 |
| — East pt., l ........................ | 5 13 | 123 15 |
| — South pt........................ | 5 42 | 122 48 |
| — Bouton town, fort, r, $P_1$. ... | 5 28 | 122 37 |
| South I., S pt........................ | 5 43 | 122 30 |
| ***Celebes, Gulf of Boni*** | | |
| Kabaena I., [5 l.], pk. 4000f. | 5 19 | 121 55 |
| Mengkoka B., Taboa............. | 4 3 | 121 40 |
| Berayu ................................ | 2 40 | 120 42 |
| Palopa B. ............................ | 2 55 | 120 13 |
| C. Djenee ............................ | 3 18 | 120 29 |
| C. Patiro.............................. | 4 38 | 120 27 |
| Boni, city, 5m. inland ......... | 4 32 | 120 18·5 |
| Salengketa Pt. .................... | 4 50 | 120 22 |
| Boni rk. .............................. | 5 15 | 120 32 |
| C. Lassa, or Biera ............... | 5 35 | 120 28 |
| Sarontang ............................ | 5 39 | 120 30 |
| Salayer I., ☨ 13 l., N pt. ...... | 5 45 | 120 29 |
| Whale rf., s .......................... | 6 7 | 120 19 |
| Bulekombo, $ww_o$, fl. st ......... | 5 31·5 | 120 12 |
| Mansfield shl., l, Bolloh ...... | 5 45 | 120 12 |
| Mt. Lampo Batang ............... | 5 21 | 119 56 |
| C. Bulu Bulu ........................ | 5 42 | 119 45 |
| **Java.** | | |
| Button, Toppers I................. | 5 54·2 | 105 55·8 |
| Pulo Babi, EW 3m., W pt. ... | 5 48·7 | 106 15 |
| Bantam, fl. st........................ | 6 1·7 | 106 8·7 |
| Mt. Karang, 5833f. ............... | 6 14·5 | 106 0·7 |
| Pontang Pt. .......................... | 5 56·3 | 106 16 |

| (90) Places | Lat. S | Lon. E |
|---|---|---|
| ***Java N. Coast*** | | |
| Hoorn Is., EW 4m., rk. W-d., Payung Dekat...... | 5°47′7 | 106°28′ |
| Batavia, Observatory ☨ 0ʰ, G.M.T. 7ʰ 7ᵐ 14·5ˢ ... | 6 7 6 | 106 48·5 |
| — Edam I., lt. F 182f. ......... | 5 57·5 | 106 50·5 |
| Karawang Pt., ☨ ................ | 5 56·3 | 107 0·7 |
| Tanj. Sedari. ☨ NW lim....... | 5 58 5 | 107 21 |
| Sedari rf., [3m.], s, ‖ S ......... | 5 56 | 107 25 |
| Pamanukan Pt. ...................... | 6 12 | 107 46 |
| Indarimayn Pt., ☨. ☨, E extr. | 6 14 | 108 18 |
| Boompjes Is., lt. R 191f. ...... | 5 56 | 108 22·5 |
| Cheribon, lt. F 46f. ............ | 6 43 | 108 34 2 |
| — Pk., 10,075f. .................... | 6 54 | 108 24 7 |
| Tegal, lt. F 49f. .................... | 6 51 | 109 8 |
| Pekalongan, lt. F 50f. ......... | 6 51·5 | 109 41·7 |
| Mt. Selamat, (vol.), 11,224f.... | 7 14·5 | 109 13 |
| Bapang shl., [2m.], s............ | 6 34·5 | 109 50 |
| Mt. Sumbing, 10,945f. ......... | 7 23 | 110 4 |
| Samarang, lt. Fl. 107f. ......... | 6 57 | 110 24·5 |
| Japara, Po. Panjang.............. | 6 34 6 | 110 37 |
| Mandalika I., lt. F. 280f. ...... | 6 23 | 110 54 7 |
| Laut, Juana, lt. F 49f. ......... | 6 41·5 | 111 9 |
| Leran Pt. .............................. | 6 38 | 111 27 5 |
| Aur Aur Pt. ........................ | 6 46 | 111 56·7 |
| Panka Pt., l, fl. st ............... | 6 53 | 112 34 |
| Sourabaya, citadel, lt. F 42f... | 7 13 5 | 112 44 |
| ***Java E. Coast*** | | |
| Madura, EW 29 l., NW pt., C Modung..................... | 6 54·3 | 112 49 |
| — East pt., Lapa Pt. ............ | 6 58 5 | 114 7 |
| — Sumenep B., fort ............. | 7 2 | 113 54 |
| Pajangan I., [1m.]................ | 6 58 | 114 26 |
| Hog I., or Sapudi, ☨ 9m, W pt., lt. F 192f. ............ | 7 5·3 | 114 16 |
| Po. Kamudi .......................... | 7 6 | 114 47·7 |
| Pasuruan, lt F 52f. .............. | 7 37 5 | 112 55 |
| Besuki, lt. F 39f. ................ | 7 43 5 | 113 41·7 |
| Pt. China ............................ | 7 35 | 114 2 7 |
| C. Sedano ............................ | 7 49 | 114 28 |
| Karang Maas, Meinders rk., lt. F 56f. ......................... | 7 0·5 | 114 26 |
| Mt. Merapi .......................... | 8 3 7 | 114 15·5 |
| Banjuwangie, Ft. Utrecht lt. F. .................................. | 8 12·8 | 114 23 |
| Tanj. Soloka, E pt. of Java ... | 8 42·5 | 114 36 |
| South pt. of Java, Ba uenan ... | 8 46·7 | 114 31·5 |
| ***Java S. Coast*** | | |
| Nusa Barung I., EW 9m., ⚓, ☨, Kamal Pt. ......... | 8 27·5 | 113 25·7 |
| Semiru, Mt., 12,140f. ......... | 8 6 5 | 112 55·7 |
| Arjund. Mt., 10,320f............ | 7 45·7 | 112 35·5 |
| Sempo I., EW 5m., S pt. ...... | 8 27 | 112 42 5 |
| Segoro Wedi B., Klappa I. ... | 8 22 | 111 43·5 |
| Skel rk. .............................. | 8 24 | 111 42 5 |
| Pachitan B., E pt., entr. ...... | 8 15 | 111 5 |
| Kembangan I., ☨ 14m., inlet of Tylatiap, lt. R 655f. | 7 46·6 | 109 2 |
| C. Sanchang ........................ | 7 44 | 107 50 |
| C. Genteng.......................... | 7 23 | 106 24 |
| Zand Bay, ☨ ꟷ, Panchur Pt. | 7 11 | 106 24 |
| Po. Tinjil, or Trouwers I., ☨ 4m., W pt.................. | 6 58·3 | 105 46 7 |
| Kelapa, or Breakers I., EW 3m., rks. W pt. ........... | 7 0 | 105 33 |
| C. Sangian Sira, (rks. SE), T, 1575f. sum. ............ | 6 49 | 105 16 |
| Java Hd., First pt., lt. Fl. 260f. | 6 45·3 | 105 12·7 |

## MARITIME POSITIONS

| (91) | Places | Lat. S | Lon. E |
|---|---|---|---|
| | **Java Sea to Flores Sea.** | | |
| Is. and Shoals in the Java Sea | Woerden Castle, rk., or Pamanukan, (shl. ‡ ╋ 3m.) | 6° 1·5′ | 107°52·5′ |
| | Pulo Rackit, Boompjes, [1½m.], lt. R 91f | 5 56 | 108 22·5 |
| | Karimun, Java Is., EW 13 l., ♆, b, W extr., or Katang rk. | 5 48·3 | 110 8 |
| | — Karimun I., ⚓ 5m., SW pt., fl. st. | 5 53·5 | 110 26·2 |
| | Hastings rk., ‡ | 6 5·5 | 112 30 |
| | Bavean I., ╋ 12m., 2000f., w, r, N pt., Mantegi | 5 43 | 112 41 |
| | — Sankapura Bay | 5 51·5 | 112 39 |
| | Arrogant rk., [¼m.], T | 5 12 | 112 57 |
| | Grt. Solombo, ⚓ 6m., ✝, flat hill, 620f. | 5 33 | 114 27 |
| | Little Solombo, [3m.], l, ✝ 118f. | 5 27 | 114 26 |
| | Arends, [3m], N end | 5 2 | 114 33·5 |
| | Karang Takat grp., ⚓ 4 l., rks., W pt. | 7 0 | 114 55 |
| | Kangeang, ⚓ 9 l., Ketapang B. | 6 50 | 115 17 |
| | Pandjang. EW 3 l., E pt., (rks. off) | 7 10 | 115 55·5 |
| | Urk, [2m.], l, ✝, Id. | 7 4·6 | 115 11·5 |
| | P. Maurit's rf. | 6 19 | 115 29 |
| | Belliqueux rf. 4} | 6 31 | 116 0 |
| | Turkey, Polo or Anak Kangeang Is, and shls., N I., Ara han | 6 31 | 115 44 |
| | Sakala or Hastings I., l. | 6 57 | 116 15 |
| | Paternoster Is., Pulo Tengah, NW, Paposa, (rks. 2 l.) | 7 30 | 117 10·5 |
| | NE Paternoster Bankawang | 6 38 | 118 21 |
| | Postilion Is., ⚓ 12 l., l, ✝, T, N island, Jailamu | 6 33 | 118 47 |
| | — E. I., Puman Tawan | 6 50 | 119 11 |
| | — Lamarua I., small | 7 18·5 | 118 6 |
| | Brill shl., Taka Renataya, [4m.], T, β, lt. F, Fl. 68f. | 6 7 | 118 57·5 |
| Is. and Shoals Southward of Celebes | Mamalaki I., small, rfs., ‖ E. | 6 43 | 120 19 |
| | Rusah I., ╋ 2 l., S pt. | 6 44 | 120 26 |
| | Vesuvius rk. | 7 6 | 120 24 |
| | Jampea I., ⚓ 5 l. (Kambangi B., SE side, ⚓′, w′), S pt. | 7 7 | 120 39 |
| | Kalao I., EW 6 l., rks., W-d. 2 l., P,,, SW pt. I. | 7 18 | 120 52 |
| | Bonerato I., ╋ 4m., (‖ W, 8₀), Bonerato | 7 20 | 121 5 |
| | Marianne shoal (1820), [2 l.], SW I. ○ | 7 29 | 121 10 |
| | Kalao Toa I., Cornelia Rd. | 7 25 | 121 48 |
| | Madu I., ╋ 2 l., W pt. rks., T | 7 31 | 121 43 |
| | Kabia, or Perch I. | 6 54 | 122 12 |
| | Post-horse Id. (Kauna) | 7 27 | 122 1 |
| | Angelica rf., [4m.], centre | 7 47 | 122 16 |
| | Rusa Rajah, ✝, ‖ S, 4593f, pk. | 8 17 | 121 44 |
| | Rusa Linguete, 1902f., (rf. 2m.), pk. | 8 5 | 122 6 |
| | Hegadis Pk. | 6 7 | 122 40 |
| | Token Besi Is., S lim., Binongka, S pt. | 6 2 | 124 5 |

| (92) | Places | Lat. S | Lon. E |
|---|---|---|---|
| | Token Besi Is., Kaka Rf., South rk | 6° 7′ | 124°16′ |
| | — N limit, Wangy Wangy, vis. 7 l, sum. | 5 18 | 123 35 |
| | — St. Matthew's Is., ⚓ 5 l., ‖₀ SE pt. | 5 27 | 124 21 |
| | Veldthoen I., [5m.], l, ✝, Moro Maho, centre | 6 7 | 124 37 |
| | **Bali to Flores.** | | |
| Bali | Bali, ⚓ 33 l., h, Mt. Agung, 10,500f. | 8 21 | 115 31 |
| | Badong B., Bukit pt. | 8 49 | 115 5 |
| | Beliling, lt. F 58f. | 8 6 | 115 5 |
| | C. Pasir | 8 6·5 | 114 25·5 |
| Lombok | Lombok, ╋ 23 l., Mt. Rinjani, 11,810f. | 8 25 | 116 27 |
| | — Labuan-Tering B. | 8 44 | 116 3 |
| | — Pandanan pt. (C. Banko) | 8 44 | 115 49 |
| Sumbawa | Sumbawa, EW 51 l., SW pt., Tafelberg | 9 0·5 | 116 44 |
| | — Sumbawa, town | 8 28 | 117 24 |
| | Flat I., Madang [1 l.], E end | 8 8 | 117 25 |
| | Gulf of Saleh, Rakit I., pk. | 8 38 | 117 58 |
| | Setonda I., W pk. | 8 6 | 117 44 |
| | Mt. Tambora, 9070f., volcano | 8 14 | 117 58 |
| | Joro Batu Pt. | 8 14 | 118 29 |
| | Bima Bay, ⊞. fort | 8 27 | 118 43 |
| | Sangeang I., 6180f., pk | 8 11 | 119 4 5 |
| | Sapeh Pt. | 8 45 | 119 8 |
| | Gili Banta I., [2 l.], T, pk. | 8 25 | 119 16 |
| | Leeuwenkop pt. | 8 51 | 118 51 |
| | Komodo, or Mangarei, NS 7 l., h, ⊥, Schoorsteen | 8 45 | 119 22 |
| | **Flores, Timor, and Sumba Islands.** | | |
| Flores | Flores, EW 67 l., Alligator B. | 8 48 | 119 50 |
| | Terang and Bari Bays, Bari | 8 20 | 120 11 |
| | Potta Rd., Potta | 8 18 | 120 42 |
| | Giliting | 8 35 | 122 16 |
| | Tower I., EW 1 l., 1200f. | 8 53 | 120 14 |
| | Endo B., ⚓, Aloso Pt. | 8 52 | 121 39 |
| | Lobetobie, volcano, 7120f. | 8 35 | 122 48 |
| | Flores Head, or Iron Cape | 8 3 | 122 47 |
| | Larantuka Road | 8 18 | 123 1 |
| | Kambing, S entr. Flores Strt. | 8 39 | 122 51 |
| | Adonara, ╋ 12 l., town | 8 14 | 123 9 |
| | Solor, ╋ 9 l., S pt, islets off | 8 36 | 122 52 |
| | Komba I, vol., 1800f. | 7 47 | 123 31 |
| | Lomblen, ╋ 12 l, E pt | 8 14 | 123 54 |
| | — Mt. Lamararap, 5880f. | 8 31 | 123 25 |
| | Pantar, ╋ Babi I., off SW pt | 8 25 | 123 52 |
| | — North East pt. | 8 10 | 124 14 |
| | Ombay, EW 17 l., Dalolo | 8 12 | 124 23 |
| | — East pt., Leisumbu | 8 18 | 125 10 |
| Timor | Timor, ╋ 85 l., SW or Oysina Pt. | 10 23 | 123 29 |
| | Koepang, ft. Concordia, lt. F 47f | 10 9·9 | 123 35 |
| | Wedge Pt. | 9 33 | 123 40 |
| | Sutranha, ‡ 18 | 9 20 | 124 5 |
| | Gula I., small | 9 14 | 124 0 |
| | Lifou, r, w | 9 10 | 124 25 |
| | Atapopa, lt. | 8 59 | 124 50 |

## MARITIME POSITIONS

| (93) | Places | Lat. S | Lon. E |
|---|---|---|---|
| *Timor* | Dilhi, town, r, Custom ho., lt. F | 8°33′ | 125°36′·7 |
| | E pt., ⚓′ 11, Po. Jackee, or Nusa Bessie, sum. 350f. ... | 8 26 | 127 20 |
| | Kalaeko, town | 9 6 | 126 12 |
| | Noy Mini B., ⚓ | 10 5 | 124 18 |
| | Semao, ♯ 5 l., S pt. | 10 22 | 123 25 |
| | Rotti, ♯ 14 l., vis. 12 l., Cyrus B. on SE side, w, r | 10 52 | 123 5 |
| | — Pulo Dana, off S pt. | 10 58 | 122 55 |
| | Pulo Dau, ♯ 4m., l, ✱, N end | 10 48 | 122 41 |
| *Sumba* | Savu, EW 7 l., W C. Mesara... | 10 34 | 121 41 |
| | — East pt., l, (rks. off) | 10 27 | 122 0 |
| | Banjoan, EW 7m., SW pt., l | 10 37 | 121 31 |
| | Dana, or New I., [1 l.], S part, 120f. | 10 49 | 121 16 |
| | Sumba or Sandalwood I., ♯ 24 l., C. Lambuya, (rks.) | 9 42 | 119 0 |
| | Palmedo Road | 9 25 | 119 45 |
| | Paddeway B., ⊞, [5m.] 11, r, 8₀. Arif town anchge. | 9 37 | 120 12 |
| | E point, C. Mandyeli | 10 12 | 120 51 |
| | C. Blackwood | 10 23 | 120 29·7 |
| | **Banda Sea.** | | |
| | Cambing, or Passage I., ♯ 4 l., h. S pk., 3273f. | 8 18 | 125 35 |
| | Babi I., sum. ○ | 8 2 | 125 45 |
| | Wetta, ♯ 19 l., Sau town, on SE side, ⚓ | 7 53 | 126 24 |
| | Gunong Api, volc.. 1378f. | 6 39 | 126 36 |
| | Lucipara, 5 Is., N Id. | 5 28 | 127 29 |
| | Kissa I., 803f., Pura landing | 8 6·7 | 127 8·5 |
| | Roma, [3 l.], h, Uwakekee | 7 42 | 127 20 |
| | Letti I., Serwaru, Church | 8 10·2 | 127 40·5 |
| *Serwatty Is.* | Moa, ♯ 6 l., ⚓ E, Buffalo Pk., 4100f. | 8 12 | 128 2 |
| | Lakor, [3 l.], l, E end | 8 14 | 128 13 |
| | Luang, [1 l.], h, 1″ ○ | 8 12 | 128 39 |
| | Sermatan, [5 l.], W pt., Eto ○ | 8 11 | 128 48 |
| | Damma Is., NS 5l., 8117f. Kulewatte Harbour | 7 9 | 128 40 |
| | Tau, [3 l.], 2000f., ∥₀ Lajani ○ | 7 2 | 129 7 |
| | Nila, [3 l.], 3898f. sum. | 6 52 | 129 28 |
| | Serua, 2 Is., [3 l.], W. I. | 6 17 | 130 0 |
| | Bird I., or Po. Mano, 880f. | 5 33 | 130 18 |
| | Wetan, ⚓ E, 1160f. | 7 50 | 129 33 |
| | Baba, w, P., S pt. 3000f. | 8 2 | 129 45 |
| | Masella, S pt. 839f. | 8 11 | 129 51·5 |
| *Tenimber Is.* | Tenimber Is., ∥₀; Timor Laut, ♯ 34 l., S end, Jermata | 8 0 | 131 14 |
| | Selaru, Woody I., small | 8 22 | 130 48 |
| | Oliliet, village, 413f. | 7 55 | 131 27 |
| | Larat, ♯ 6 l., Lamdesar | 7 17 | 131 58 |
| | Vordate, ♯ 2 l., ✱, Sobiani... | 6 58 | 131 55 |
| | Sera I., Aba | 7 44 | 130 56 |
| | Mulu I., Nuskalbur | 6 38 | 131 37 |
| *Arru Is.* | Arru Is., NS 35 l., l, ✱, r. P., S extr., Ennu I., 100f. | 7 6 | 134 31 |
| | — SW limit, Bayn | 6 48 | 134 7 |
| | — Po. Babi, small | 5 55 | 134 9 |
| | — NW extr., Wassir | 5 32 | 134 13 |
| | — C. Watale Juhong | 5 17 | 134 32 |
| | — Dobbo Harb., ⊞, pt. | 5 45 | 134 14 |
| | Tjando Is., N lim. ○ | 5 20 | 132 33 |

| (94) | Places | Lat. S | Lon. E |
|---|---|---|---|
| *Ki Is.* | Grt. Ki I., ♯ 15 l., ✱, 3000f., C. Borang | 5°17′ | 133° 9′ |
| | — Nuja | 5 42 | 132 57 |
| | — Madua Pt. | 6 3 | 132 53 |
| | Little Ki I., Rumadan I. | 5 28 | 132 42 |
| | — Ki Doulan, vill., T, w, r, b, (⚓′ 3m. N), pi r ... | 5 34·7 | 132 45·7 |
| | Nusa Tello Is., Fadd I. ○ | 5 40 | 131 58 |
| | — Koor I., S pt. ○ | 5 25 | 132 0 |
| | Uran I. | 4 46 | 131 52 |
| | Kelmui I., S pt. | 4 47 | 131 44 |
| *Banda Is.* | Matabella Is., 2 groups, ‖. grt., Kasiwooi, S pt. | 4 31 | 131 38 |
| | Manovolko I., Sera | 4 9 | 131 23 |
| | Suruaki-Wiselent ○ | 4 1 | 131 14 |
| | Goram I., [3 l.], NE pt. | 3 59 | 131 26 |
| | Banda Is., 5, W, or Po. Rhun | 4 33 | 129 38 |
| | — NW one, or Swanji | 4 18 | 129 40 |
| | — Banda, ♯ 6m., Fort Nassau | 4 32 | 129 53 |
| | — East one, Rozengain ○ | 4 36 | 130 2 |
| *Bouro* | Bouro I., ♯ 27 l., Palpatu Pt., T | 3 6 | 126 1 |
| | — Mt. Tumahu, 8530f. | 3 15 | 126 2 |
| | Cajeli B., r, w′, b, Fort Defence | 3 22·8 | 127 6·5 |
| | East point, or Pt. Pela | 3 21 | 127 16 |
| | South pt., or Baton P kka | 3 54 | 126 37 |
| | Amblaw I., [2 l.], NE pt. | 3 52 | 127 17 |
| | Manipa I., h, (rk. 1½m. W), E pt., Lubu | 3 20·5 | 127 40 |
| | Kelang, h, ‖ W, W pt. | 3 12 | 127 38 |
| | Boano, h, ⊥, SW pt. | 3 1 | 127 51 |
| *Ceram* | Ceram, ♯ 59 l., Pt. Secal | 3 33 | 127 55 |
| | — Sawaai Harb. | 2 57 | 129 12 |
| | Wahaay Harb., vill., w‴, r, b, fort | 2 48 | 129 29 |
| | Pasahafi Pt. | 2 52 | 129 42 |
| | Lama Pt. | 3 0 | 130 24 |
| | Leuwarden shl., [2m.], T, rks. | 2 55 | 130 33 |
| | Waru B., ⚓′, w, r, Baru | 3 22 | 130 35 |
| | Po. Parang, or Leuwarden I., S pt. | 3 21 | 130 48 |
| | Po. Madurang, small | 3 37 | 130 59 |
| | Great Keffing I., E pt. ○ | 3 51 | 130 47 |
| | Ceram Laut, Gesser I. ○ | 3 3 | 130 52 |
| | — Kon ○ | 3 57 | 131 12 |
| | Amboina I., ♯ 11 l., SW, or Alang Pt., T | 3 47 | 127 57 |
| | Amboina City, Fort Victoria... | 3 41·2 | 128 10·7 |
| | Noessaniva Pt., T | 3 46 | 128 6 |
| | Haruku I., ♯ 8m., SW pt. Islet | 3 38 | 128 26 |
| | Saparua I., ♯ 11m., fort | 3 4·5 | 128 38 |
| | Nusa Laut, ♯ 7m., Nalahia B. | 3 38 | 128 46 |
| *Sula Is.* | Bowakan | 1 54 | 123 45 |
| | Hammond's I., [3 l.], S pt. | 1 52 | 124 1 |
| | Taliabu, EW 18 l., Lekitobi | 1 57 | 124 27 |
| | Mangola, 16 l., EW ‖₀, Lisamatula I., 1164f. | 1 50 | 126 25 |
| | Vesuvius B., ⚓ | 1 58 | 125 30 |
| | Sula Besi, NS 10 l., S and E pt., Ipa | 2 24 | 126 6 |

## MARITIME POSITIONS

| Region | (95) Places | Lat. | Lon. E |
|---|---|---|---|
| | | South | |
| Pitt Passage | Oby Latta, [2 l.]. S pt., 2400f. | 1°29′ | 127°16′ |
| Pitt Passage | Gomomo, 850f., W pt. | 1 52 | 127 33 |
| Pitt Passage | Po. Gasé, [5m.], T, rks. SE, S pt. | 1 39 | 128 22 |
| Pitt Passage | Tapa I., NW pt. | 1 12 | 127 17 |
| Pitt Passage | Bisa, E pt. | 1 16 | 127 37 |
| Pitt Passage | Oby Major, ♣ 19 l., SE pt., Wai | 1 44 | 128 0 |
| Pitt Passage | Lookisong I., ⚓ 3 l., ✝, N pt. | 1 32 | 128 8 |
| Pitt Passage | Kekik I., *h* | 1 30 | 128 37 |
| Pitt Passage | Lawin I., *h* | 1 29 | 128 42 |
| Pitt Passage | Po. Pisang, vis. 11 l. | 1 24 | 128 53 |
| Pitt Passage | Grosvenor shl., [4m.], sf | 1 19 | 129 26 |
| Pitt Passage | Bu Is., ✝, P. Esplee ○ | 1 10 | 129 25 |
| Pitt Passage | Grand Canary, w, E pt., NW pt. | 1 45 | 129 37 |
| Pitt Passage | Mysole, EW 14 l., Lungu | 1 53 | 129 42 |
| Pitt Passage | Hasil I., S pt. | 1 11 | 128 28 |
| | **Gilolo.** | | |
| Gilolo Passage | Gilolo, ♣ 67 l., SE, or Cocoanut Pt. | 0 56 | 128 27 |
| Gilolo Passage | Weda Is., [3 l.]. E lim. ○ | 0 40 | 128 39 |
| Gilolo Passage | Iyoi, [5m.], S pt. | 0 3 | 129 34 |
| Gilolo Passage | Gebv. ♣ 7 l., Port Fou, on SW side, ⊞, w, r | 0 6 | 129 21 |
| Gilolo Passage | | North | |
| Gilolo Passage | — North-West pt. | 0 2 | 129 15 |
| Gilolo Passage | Shampee Is., 3 or 4, NS 3 l. | 0 30 | 128 43 |
| Gilolo Passage | Canton Packet shl., sf. | 0 35 | 128 55 |
| Gilolo Passage | Catherine Is., 3, *l.* | 0 41 | 129 5 |
| Gilolo Passage | Ardassier Islet | 0 45 | 129 0 |
| Gilolo Passage | Aurora bk., sf. | 0 43 | 129 23 |
| Gilolo, E. Coast | Weda, ⚓ | 0 18 | 127 52 |
| Gilolo, E. Coast | Dilegisa Pt. | 0 15 | 128 31 |
| Gilolo, E. Coast | Po. Moar, ✝, *l*, ‖o | 0 7 | 128 55 |
| Gilolo, E. Coast | Wossa, village, w, r, b | 0 35·5 | 128 34 |
| Gilolo, E. Coast | Pt. Monat | 1 1 | 128 28 |
| Gilolo, E. Coast | Pt. Waigamele, (rks. 1 l.) | 1 9 | 128 38 |
| Gilolo, E. Coast | Pt. Salaway, (rks. 1 l.) | 1 33 | 128 43 |
| Gilolo, E. Coast | Watering-place, N of Galela Tiabu | 1 51 | 127 52 |
| Gilolo, E. Coast | Bisoa Pt. ○ | 2 13 | 127 55 |
| Gilolo, E. Coast | Rau, [2 l.], mid. | 2 23 | 128 11 |
| Gilolo, E. Coast | Morty, ⚓ 21 l., N pt., (rf.), T | 2 44 | 128 20 |
| Gilolo, E. Coast | — South-West pt., Lints I. | 1 57 | 128 13 |
| Is. on West Coast of Gilolo | Toakara, N pt. | 2 19 | 127 44 |
| Is. on West Coast of Gilolo | Talabu Pt. | 1 6 | 127 22 |
| Is. on West Coast of Gilolo | Dyilolo, town | 1 7 | 127 27 |
| Is. on West Coast of Gilolo | Ternate, ⚓ 6m., sum. 5180f., Fort Orange, on E side | 0 48·0 | 127 21 |
| Is. on West Coast of Gilolo | Tidore, [2 l.], sum. 5900f. | 0 40 | 127 25 |
| Is. on West Coast of Gilolo | Pottbakker I., [2m.], 1160f. | 0 33 | 127 22 |
| Is. on West Coast of Gilolo | Metir, [3 l.], sum. 2800f. | 0 27 | 127 24 |
| Is. on West Coast of Gilolo | Wolf rk. | 0 12 | 126 53 |
| Is. on West Coast of Gilolo | Makyan, [5 m.], sum. 4166f. | 0 20 | 127 23 |
| Is. on West Coast of Gilolo | | South | |
| Is. on West Coast of Gilolo | Latta-Latta Is., Japi | 0 17 | 126 59 |
| Is. on West Coast of Gilolo | Grt. Tawally, ⚓ 7 l., SW pt. Id. | 0 29 | 127 3 |
| Is. on West Coast of Gilolo | Batian, ♣ 17 l., *h*, Selang I., (mid. of S coast) | 0 54 | 127 34 |
| Is. on West Coast of Gilolo | — Padang, Coal Station | 0 44 | 127 25 |

| Region | (96) Places | Lat. | Lon. E |
|---|---|---|---|
| | | North | |
| Is. to N. W. and N. of Gilolo | Tifori, sum. 587f. | 1° 0′ | 126° 8′ |
| Is. to N. W. and N. of Gilolo | Mayo, N pt. 1280f. | 1 21·1 | 126 21·7 |
| Is. to N. W. and N. of Gilolo | Biarro, sum. | 2 7 | 125 25 |
| Is. to N. W. and N. of Gilolo | Roang, vol., 2330f. | 2 18 | 125 22 |
| Is. to N. W. and N. of Gilolo | Siao, pk., 5924f. | 2 44 | 125 23 |
| Is. to N. W. and N. of Gilolo | Makalébé I., 394f. | 2 42 | 125 12 |
| Is. to N. W. and N. of Gilolo | Nennung Is., South I ○ | 3 2 | 125 41 |
| Is. to N. W. and N. of Gilolo | Kalama, ‖ North I., N extr. | 3 15 | 125 27 |
| Is. to N. W. and N. of Gilolo | Sangir, ♣ 8 l., Taruna B., w, r | 3 33 | 125 28 |
| Is. to N. W. and N. of Gilolo | — North pt., Salima | 3 45 | 125 27 |
| Is. to N. W. and N. of Gilolo | Louisa shl. | 4 0 | 125 18 |
| Is. to N. W. and N. of Gilolo | Haycock Is., Kabalusu | 4 15 | 125 19 |
| Is. to N. W. and N. of Gilolo | — Meares, South pt. | 4 39 | 125 26 |
| Is. to N. W. and N. of Gilolo | Anda I. | 4 34 | 125 38 |
| Is. to N. W. and N. of Gilolo | Ariaga I. | 4 44 | 126 28·5 |
| Is. to N. W. and N. of Gilolo | Charruca shl. | 4 45 | 125 38 |
| Is. to N. W. and N. of Gilolo | Iphigenia rks., South rk. | 4 15 | 125 45·5 |
| Is. to N. W. and N. of Gilolo | Nanusa Is., Merampi Pk., 666f. | 4 46 | 127 7 |
| Is. to N. W. and N. of Gilolo | Talauer Is., NS 15 l., N pt., Mamaga | 4 34 | 126 48 |
| Is. to N. W. and N. of Gilolo | — Nusa I. | 4 18 | 126 43 |
| Is. to N. W. and N. of Gilolo | — Salibabu I., ♣ 5 l., S pt. | 3 48·5 | 126 42 |
| Is. to N. W. and N. of Gilolo | — Kaburuan, ♣ 3 l., S pt. | 3 45 | 126 49 |
| Is. to N. W. and N. of Gilolo | Northumberland shl., [2m.] | 3 39·5 | 126 51 |
| Is. N. W. of New Guinea | Eye I., [½m.] | 0 22 | 129 56 |
| Is. N. W. of New Guinea | Syang, [3m.], *l*, w, SW pt. I. | 0 18 | 129 55 |
| Is. N. W. of New Guinea | Wyang, or Vayag Is., ♣ 6 l., NW extr., Laborde Islet | 0 13 | 130 3 |
| Is. N. W. of New Guinea | — SE extr., Labishe I., [1m.], (rks. SE) | 0 5 | 130 15 |
| Is. N. W. of New Guinea | Een, or Ine Is., EW 4m., E pt. | 0 8 | 130 19 |
| Is. N. W. of New Guinea | Ormsby shl., T N, N pt. | 0 44 | 130 2 |
| Is. N. W. of New Guinea | Budd I., *l*, ✝ ⦶ | 0 27 | 130 51 |
| Is. N. W. of New Guinea | Aiu Is., about 20 small, *l*, 8, rfs. T, Wirisoi | 0 41 | 131 9 |
| Is. N. W. of New Guinea | Aiu Baba, [3m.] | 0 21 | 131 7 |
| Is. N. W. of New Guinea | Asia Is., 3, *l*, SW and smallest | 1 0 | 131 15 |
| Is. N. W. of New Guinea | Po Manuaran, [2m.], ‖ S, w | 0 2 | 130 57 |
| Is. N. W. of New Guinea | | South | |
| Is. N. W. of New Guinea | Buccleuch shl., [3m.], ? ?, ? | 0 16 | 131 30 |
| Is. N. W. of New Guinea | Waigiu, EW 22 l., SE pt., or Pt. Pigot | 0 21 | 131 12·0 |
| Is. N. W. of New Guinea | — Boni I., [¾m.], ⊞ SW-d., N pt. | 0 1·7 | 131 8 |
| Is. N. W. of New Guinea | — Offak Harbour, ⊞, w, entr. | 0 1·8 | 130 43 |
| Is. N. W. of New Guinea | — NW pt., C. Forrest | 0 5 | 130 12 |
| Is. N. W. of New Guinea | Buttons, [1m.] | 0 1 | 130 24 |
| Is. N. W. of New Guinea | Ruib, NS 6m., pk. | 0 2 | 130 9 |
| Is. N. W. of New Guinea | Balabalak, [2m.], W pt. | 0 2 | 130 4 |
| Is. N. W. of New Guinea | Gag I., [7m.], N pt. | 0 20 | 129 55 |
| Is. N. W. of New Guinea | Pigeon I., ✝, ⌒, W pt. | 0 39·7 | 130 34·2 |
| Is. N. W. of New Guinea | Battantà, EW 15 l., W pt. C. Mabo | 0 54 | 130 25 |
| Is. N. W. of New Guinea | — Marchesa Bay, Toe Pt. | 0 49·5 | 130 54·2 |
| Is. N. W. of New Guinea | Salawatti, 10 l., Dady Pt. | 0 58 | 130 38 |

## MARITIME POSITIONS

| | (97) Places | Lat. S | Lon. E |
|---|---|---|---|
| | **NEW GUINEA.** | | |
| *New Guinea, S. W. Coast* | Brebes Pt., or C. Wilson ...○ | 0°40′ | 131°57′ |
| | Threshold Pt. ...○ | 0 47 | 131 27 |
| | C. Spencer, or Foul Pt., (rfs. 2m.) | 0 52 | 131 15 |
| | Selé Pt. | 1 27 | 130 57 |
| | W. Brother, or Pinion I. | 1 47 | 131 6 |
| | Sabra Pt. | 2 2 | 131 57 |
| | Pisangs Is., Po. Sabuda, SW pt. | 2 39·5 | 131 38 |
| | Mac Cluer's Inlet, Head, or E lim. of the bay | 2 10 | 133 46 |
| | Tatingar Pt. | 2 48 | 132 1 |
| | C. Sapey, (sum. 3020f.), W pt. (Balk) | 3 41 | 132 42 |
| | C. Kaffura | 4 7 | 132 55 |
| | Po. Adi, or Wessels, ⚓ 8 l., W pt. ‡ | 4 9 | 133 20·5 |
| | Bird I., [¼m.] (Vogel) | 4 21 | 133 36 |
| | Lamansiere Hill, NW sum. 2460f. | 3 44 | 134 7 |
| | Triton B., Fort Dubus | 3 47 | 134 7 |
| | Lakahia Mt., 4564f. | 4 10 | 134 45 |
| | Charles Louis Mts., 9510f. | 4 9 | 136 15 |
| | C. Buru, vis. 10 l. | 4 12 | 134 45 |
| | Vlakke Pt. | 4 27 | 135 10 |
| | Wamuka R., mouth ...○ | 4 40 | 136 15 |
| | C. Steenboom | 4 50 | 136 29 |
| | Snowy Mountains, sum. 14,000f. | 4 13 | 137 7 |
| | Dourga Strait, E pt. | 7 22 | 138 34 |
| | C. Valsche, (W pt. of Frederick Henry I., ⚓ 36 l.) | 8 22 | 137 40 |
| *New Guinea, S. Coast* | St. Bartholomew I. | 8 17 | 139 28 |
| | Deliverance I., small, rfs. ...○ | 9 35 | 141 47 |
| | Mt. Cornwallis, vis. 9 l. | 9 25 | 142 31 |
| | Bristow I., [5m.], l, ✱, SE pt. | 9 9 | 143 14 |
| | Fly River, Tree I. | 8 41 | 143 36 |
| | Aird Hill, 1260f. | 7 28 | 144 20 |
| | Blackwood, Pt., l, ✱ | 7 52 | 144 28 |
| | Mt. Yule, 10,046f. | 8 14·5 | 146 46 |
| | C. Possession | 8 36 | 146 22 |
| | Port Moresby, Jane I. | 9 25·5 | 147 7 |
| | C. Hood | 10 7 | 147 42 |
| | C. Rodney, SE pt. | 10 12 | 148 22 |
| | Dufaure I., [1 l.], sum. | 10 29 | 149 48 |
| | South Cape, Suau | 10 43·5 | 150 14·2 |
| *Louisiade Islands.* | Adele I., [2c.], l, [✝], ‖o W... | 11 29 | 154 26·5 |
| | Rossel I., EW 7 l., l, ✱, ‖o W. C. Deliverance | 11 23·3 | 154 17·7 |
| | Sudest I., Mt. Riu 2645f. | 11 30·6 | 153 26 |
| | Fox, or Renard Is.? [4 l.], W pt. | 10 54 | 152 58 |
| | St. Aignan I., EW 10 l., E pt., C. Henry | 10 41 | 152 55 |
| | Deboyne Is., [2 l.?], N pt. | 10 40·5 | 152 23 |
| | Bonvouloir Is., E extr. | 10 25 | 152 6 |
| | Laseine Is., [2 l.], Dawson I. | 10 23 | 151 25·5 |

| | (98) Places | Lat. S | Lon. E |
|---|---|---|---|
| | Ouessant I., small | 11° 8·6 | 151°15′·5 |
| | Teste I., (Wari), East I. | 10 58 | 151 5·2 |
| | Moresby I., Fairfax Pk., 1740f. | 10 36·8 | 151 0·5 |
| | China St., Samari I. Mission | 10 36·8 | 150 39·7 |
| | Lydia I., (Nuakata), pk., 1010f. | 10 16 | 151 0·5 |
| | Possession B. | 10 34·6 | 150 42·2 |
| | East Cape, Anchor I., E pt. | 10 13·2 | 100 53·7 |
| | D'Entrecasteaux Is., S pt., C. Ventenat, (Is. S-d.) | 10 10·7 | 151 13·5 |
| | Welle I., [2 l.], E part, (rfs.) | 9 37 | 151 3 |
| | Goodenough I., pk., 7000f. | 9 21·5 | 150 14 |
| | C. Vogel, Glen I. | 9 45 | 150 4 |
| | C. Nelson | 8 59 | 149 20 |
| | I. Riche, Mitre rk. | 7 59 | 148 9·5 |
| *New Guinea, North Coast and Outlying Islands* | Pocklington shl., EW 10 l., rks., 8 E rk. | 10 45·4 | 155 51·7 |
| | Laughlan Is. 9, EW 5m., l, ✝, low E rk. | 9 19 | 153 40 |
| | Cannac rk., ✱, high | 9 18 | 153 28 |
| | Woodlark Is., ⚓ 13 l., P′, North point | 9 3·5 | 152 47 |
| | — West Rock | 9 16 | 152 13 |
| | Yanaba, Sharp I. ...○ | 9 29 | 152 40 |
| | Jouveney I., [2m.] | 8 45 | 151 45 |
| | Jurien I., [1 l.], mid. | 8 39 | 151 22 |
| | Lagrandière I., [2 l.], E pt. | 8 52 | 151 8 |
| | Trobriand Is., C. Denis | 8 24 | 151 4 |
| | Lusancay Is., & rfs., EW, & others W-d, unexplored, NE ext., North I. | 8 23 | 150 48 |
| | C. Cretin, Cretin Is. | 6 43 | 147 53 |
| | C. King William | 6 2 | 147 37 |
| | Mount Disraeli, 11,000f. | 5 58 | 146 29 |
| | C. Rigny | 5 29 | 145 58 |
| | Rich I., [1 l.], h | 4 49 | 146 13 |
| | Dampier I., ⚓ 5 l., ab 5000f. | 4 40 | 145 58 |
| | Vulcan I., [2 l.], conical, 4000f. | 4 5 | 145 2 |
| | C. della Torre | 3 51 | 144 31 |
| | Lesson I., [2m.], h, conical | 3 33 | 144 48 |
| | Blosseville I., [1m.], 1100f. | 3 36 | 144 34 |
| | Garnot I., [3m.], conical | 3 30 | 144 35 |
| | Jacquinot I., [3m.], ✝ | 3 24 | 144 24 |
| | Deblois I., [¼ l.] | 3 21 | 144 9 |
| | Roissy I., [1 l.], ✝ ✝. N pt. | 3 12 | 144 3 |
| | Victoria Bay, D'Urville I. | 3 16·4 | 143 29 |
| | D'Urville I., [3 l.], pk. near W end | 3 17 | 143 30 |
| | Gilbert I., [4m.], l E pt., (rf.) | 3 13 | 143 17 |
| | Bertrand I., l, ‖ W, ✝ | 3 10 | 143 10 |
| | Torricelli Mountns., W sum. 4 l. inland | 3 21 | 142 12 |
| | Eyries Mt., very h, W sum. 3 l. inland | 2 50 | 141 15 |
| | Mt. Bougainville | 2 40 | 140 51 |
| | Humboldt B., Obsn. I. | 2 36 | 140 42·3 |
| | Cyclops Mt., vis. 20 l., E sum. | 2 31 | 140 30 |
| | Pt. Brama, bili | 2 18 | 139 52 |
| | Aru I., [1½m.], 2 Is. W-d. | 2 7 | 139 27 |
| | Jamna I., [1m.] | 1 56 | 139 12 |
| | Jomi or Moa Is., ⚓ 2 l., N I. | 1 37 | 138 41 |

## MARITIME POSITIONS

| Region | (99) Places | Lat. S | Lon. E |
|---|---|---|---|
| New Guinea, Geelvink Bay | C. D'Urville. *l*, ♆,(riv. W-d.?) | 1°24' | 137°47' |
| | Kurudu I., E pt. | 1 48 | 137 2 |
| | Jappen I., Ansus Harbour | 1 44 | 135 49 |
| | Nau I. | 2 19 | 136 19 |
| | Terschelling Is., E pt. | 2 55 | 135 54 |
| | Haerlem Is., [4 l.], W one | 3 5 | 135 52 |
| | Pt. Pinxter, W pt. | 3 24 | 135 46 |
| | Hoog, South pt. | 2 51·5 | 135 5 |
| | Angermns I., E pt. | 2 38 | 135 3 |
| | Meosaui I. | 1 57 | 134 48 |
| | Job I. | 2 33 | 134 24 |
| | C. Oran Swari | 1 22 | 134 17 |
| | Mefur I., 164f. | 1 1·5 | 134 53 |
| | Mysory Is., $\frac{S}{E}$ 20 l., *h*, E pt. | 1 10 | 136 45 |
| | — Mt. Schouten. Kaiori, 1640f. | 0 47 | 135 37 |
| | — W pt., C. Saavedra | 0 38 | 135 19 |
| | Mioskaroar I. | 0 18 | 135 3 |
| | **Arfak Mountains, 9157f.** | 1 11 | 133 59 |
| | **Port Dorei, Manaswari I.** | 0 54 | 134 7 |
| | C. Mamori | 0 48 | 134 8 |
| | C. Maiami | 0 29 | 133 12 |
| | C. Good Hope | 0 19 | 132 21 |
| | Mt. Diceras, 8m. inland | 0 32 | 132 17 |
| | Mispalu Is., Amsterdam I. | 0 19 | 132 9·0 |
| | **AUSTRALIA, North Coast.** | | |
| | Duythen Pt. | 12 34 | 141 41 |
| | Pera Hd., *l*. ⊥ | 12 59 | 141 40 |
| | C. Keerweer | 13 58 | 141 34 |
| | Van Diemen's Inlet, w. entr. | 16 58 | 141 1 |
| | Norman R., Kimberly Tel. Stn. | 17 26·6 | 140 56 |
| | Albert R., Kangaroo Pt. | 17 35·1 | 139 49·5 |
| Gulf of Carpentaria | Wellesly Is., N extr., rocky islet | 16 18 | 139 26 |
| | — Pisonia I., small | 16 29 | 139 56 |
| | — E extr., Bountiful Is., 2, $\frac{N}{S}$ 3m., E pt. | 16 39 | 139 59 |
| | — Sweers I., $\frac{N}{S}$ 5m., ⚓, w, f, b, S pt., Inspection Hill, 105f. | 17 8·2 | 139 41 |
| | Sir Ed. Pellew's Is., $\frac{S}{E}$ 12 l., N extr., a rk. | 15 29 | 137 4 |
| | — Vanderlin I., $\frac{N}{S}$ 6 l., N pt., or C. Vanderlin | 15 34 | 137 8 |
| | — West I., NE pt. | 15 32 | 136 46 |
| | Maria I., $\frac{N}{S}$ 7m., N pt. | 14 50 | 135 54 |
| | Groote Eylandt, NS 12 l., SE pt., (an I. S 5m.) | 14 16 | 136 58 |
| | — Central Hill, vis. 10 l. | 13 57 | 136 41 |
| | North-East Is., [7m.], E extr. | 13 39 | 137 1 |
| | Bickerton I., [4 l.], sum. | 13 45 | 136 15 |
| | Woodah I., $\frac{N}{S}$ 4 l., S pt. | 13 34 | 136 13 |
| | Nicols I., [3m.] | 13 27 | 136 19 |
| | C. Shield | 13 20 | 136 23 |
| | C. Grey | 13 0 | 136 42 |
| | Mt. Caledon | 12 53 | 136 33 |
| | Mt. Alexander | 12 39 | 136 44 |
| | C. Arnhem | 12 16·5 | 137 0 |
| | Brumby Is., NE pt. | 11 46·5 | 136 42 |
| | C. Wilberforce ○ | 11 53 | 136 35 |
| | Truant I., small | 11 39 | 136 48 |
| | Wessel's Is., C. Wessel, 180f. | 10 59 | 136 45 |
| | Arnheim B., entr., Mallison's I., W pt. | 12 11 | 136 6 |
| | Brown's Strait, Pt. Dale | 11 36 | 136 5 |

| Region | (100) Places | Lat. S | Lon. E |
|---|---|---|---|
| North Coast | Crocodile Is., North I. | 11°41' | 135° 9' |
| | C. Stewart, rky. | 11 57 | 134 46 |
| | Liverpool R., Haul-round I. | 11 54 | 134 15 |
| | Pt. Cuthbert, (shls. 3 l. out ‖) | 11 43·5 | 133 51 |
| | Goulburn Is., North I., $\frac{N}{S}$ 7m., N pt. | 11 28 | 133 30 |
| | Pt. Brogden, rky. | 11 31 | 133 6·5 |
| | De Courcy Hd. | 11 21 | 132 57 |
| | Mac Cluer I., $\frac{N}{S}$ 2m., N pt. | 11 4 | 133 1 |
| | New Year I., small, w | 10 55 | 133 4·5 |
| | Money shl., [5m.], ɪ | 10 21·5 | 132 45·7 |
| | Croker I., NS 7 l., N pt., C. Croker, (rks NW-d.) | 10 58 | 132 37 |
| | Orontes rf., [1m.], ɪ | 11 4 | 132 6 |
| | Pt. Smith, [rks. 1m.] | 11 8 | 133 9 |
| | Port Essington, Gov. Ho. | 11 22 | 132 9·7 |
| | Vashon Hd., (shl. 2m.), N pt. | 11 7 | 132 0 |
| | C. Don, 130f. | 11 18 | 131 46 |
| Melville I., Van Diemen Gulf | Burford I., [1m.] | 11 31 | 131 56 |
| | Greenhill I., NS 5m., Webb Pt., (rf. off) | 11 39 | 132 4·7 |
| | Field I., [4m.] *l*, (off mo. of S. Alligator R.), W pt. | 12 5 | 132 21 |
| | C. Hotham, shl. NE-d. | 12 3 | 131 18 |
| | Vernon Is., [3 l.], S side of Clarence Strt., W pt. | 12 3 | 131 0 |
| | Melville I., $\frac{S}{E}$ 25 l., E pt. | 11 28 | 131 34 |
| | — Pt. Jahleel | 11 9 | 131 18·7 |
| | — N and W pt., C. Van Diemen, *l*, sandy, (shl. 5m.) | 11 8 | 130 20 |
| | Bathurst I., Brace Pt. | 11 18 | 130 16 |
| | — C. Helvetius | 11 41 | 129 58 |
| | — S extr., C. Fourcroy | 11 51 | 129 57 |
| | **North-West Coast.** | | |
| North-West Coast | Port Darwin, Palmerston, E extr. of Cable Ho. | 12 28·4 | 130 50·5 |
| | Port Paterson, ⊞, Raft Pt., on E side | 12 37 | 130 33·7 |
| | Paterson's B., Quail I., w''' | 12 31 | 130 26·7 |
| | Pt. Blaze | 12 51 | 130 11 |
| | Peron Is., $\frac{N}{S}$ 5 l., N pk. | 13 9 | 130 2 |
| | C. Ford, (rks. 2m.) | 13 28 | 129 55 |
| | Port Keats, ⊞, Tree Pt. | 14 1·5 | 129 38 |
| | C. Hay, (shls. ⊹ 5 l.) | 14 3 | 129 32·2 |
| | Pt. Pearce, 85f., (a rf. off) | 14 26 | 129 21·5 |
| | Cambridge G., Lacrosse I., $\frac{S}{E}$ 4m., W pt., 600f. | 14 43 | 128 17 |
| | — Wyndham | 15 28 | 128 3·2 |
| | C. Dussejour, (rk. off), sum over | 14 42 | 128 13 |
| | Mt. Casuarina, 800f. | 14 23 | 127 39 |
| | Lesueur I., [and rks. 1 l.] | 13 48 | 127 15·5 |
| | C. Londonderry, (Stewart Is., 20f., and rks. 3m.) | 13 42 | 126 54·7 |
| | C. Talbot | 13 46 | 126 45·2 |
| | Jones I., 10f., small, *l*, sandy | 13 43·2 | 126 25 |
| | C. Bougainville | 13 52 | 126 11 |
| | Troughton I., 20f., sandy, [rfs. 5m.] | 13 44 | 126 13·5 |
| | Shls., bks., [Holuthuria and others], unexplored, W lim. | 13 32 | 125 48 |
| | Cassini I., 20f., [3m.], rfs. N | 13 55 | 125 44 |

## MARITIME POSITIONS

| Region | (101) Places | Lat. S | Lon. E |
|---|---|---|---|
| North-West Coast | Admiralty Gulf, Port Warrender, Crystal Hd. | 14°28′ | 125°58′ |
| North-West Coast | C. Voltaire, flat hill, (1½m. inland) | 14 13 | 125 41·5 |
| North-West Coast | Condillac I., small | 14 6 | 125 38 |
| North-West Coast | Montalivet Is., W extr. shl. | 14 14 | 125 6 |
| North-West Coast | Maret Is., (rfs. W 2 l.), N pt. | 14 23 | 124 57 |
| North-West Coast | Lamarck I. | 14 45 | 125 2 |
| North-West Coast | C. Pond, islet off | 14 45 | 125 9 |
| North-West Coast | Pt. Hardy | 14 58 | 125 2 |
| North-West Coast | Port Nelson, ⊞, Careening B. beach | 15 6 | 125 1 |
| North-West Coast | Prince Regent's R., Mt. Trafalgar, sum | 15 16 | 125 4 |
| North-West Coast | Port George IV., ⚓′, ▼′, b, rfs., Augustus I., Adieu Pt. | 15 13·5 | 124 34 |
| North-West Coast | Colbert I. | 14 51 | 124 42 |
| Buccaneer Archipelago | Freycinet grp., W island | 15 0 | 124 32 |
| Buccaneer Archipelago | White rock islet | 15 4 | 124 19 |
| Buccaneer Archipelago | Red I. | 15 13 | 124 13·[illegible] |
| Buccaneer Archipelago | Champagny Is., ⚓ 7m., Degerai do. sum. | 15 19 | 124 10 |
| Buccaneer Archipelago | Adele I., [rfs 4m.], 8f., ◆₀ | 15 32 | 123 14 |
| Buccaneer Archipelago | Beagle bk., [ß 5m.], 15f. | 15 19 | 123 30 |
| Buccaneer Archipelago | Pt. Hall, sum | 15 40 | 124 21 |
| Buccaneer Archipelago | Doubtful B., Raft Pt., w | 16 3·5 | 124 26 |
| Buccaneer Archipelago | Cockell's Is., [2 l.], W pt. | 15 46 | 124 4 |
| Buccaneer Archipelago | Mac Leay Is., N extr. reef | 15 54 | 123 39 |
| Buccaneer Archipelago | Caffarelli I., ⚓ 2¼m., mid. | 16 3 | 123 18 |
| Buccaneer Archipelago | Brue rk. | 15 57 | 123 4 |
| Buccaneer Archipelago | Hidden I., W pt. | 16 14 | 123 27 |
| Buccaneer Archipelago | High I., [2m.], 290f. | 20 20 | 123 20 |
| Buccaneer Archipelago | Port Usborne, [¾m.], ▼, w | 16 39 | 123 30 |
| Buccaneer Archipelago | King's Sound, Pt. Torment | 17 0 | 123 35 |
| Buccaneer Archipelago | — Derby | 17 20 | 123 39 |
| Buccaneer Archipelago | — FitzRoy R. mo., Escape Pt. | 17 24·4 | 123 34 |
| Buccaneer Archipelago | — Pt. Cunningham, NW part | 16 41·5 | 123 7 |
| Buccaneer Archipelago | Skeleton Pt., w̄′ | 16 31 | 123 0 |
| Buccaneer Archipelago | Swan Pt. | 16 21 | 123 1·7 |
| Buccaneer Archipelago | C. Leveque, 83f., (an islet off) | 16 22 | 122 55·5 |
| Islands and Shoals N.W. of Australia | Rowley shls., Impérieuse shl. NS 3 l., N. Sandy I., 8f. | 17 32 | 118 51 |
| Islands and Shoals N.W. of Australia | — Clerke's rf., or Minstrel shl., N Sandy I., 8f. | 17 16 | 119 21 |
| Islands and Shoals N.W. of Australia | — Mermaid shl., [3 l.], passage on E side | 17 5 | 119 38 |
| Islands and Shoals N.W. of Australia | Scott rf., a lagoon, NS 6 l., ⊤ W, I. sand and crl., Sandy I., 8f. | 14 3 | 121 49 |
| Islands and Shoals N.W. of Australia | Seringapatam rf., EW 5m., sf., ⊤, N pt. | 13 34 | 122 3 |
| Islands and Shoals N.W. of Australia | Browse I., [1m.], *l*, 20f. | 14 7 | 123 33·5 |
| Islands and Shoals N.W. of Australia | D'Artagan shoal, 10 | 13 16 | 120 38 |
| Islands and Shoals N.W. of Australia | Corona shoal, 5 | 12 26 | 118 40 |
| Islands and Shoals N.W. of Australia | Dry sand, 10f., (Ship Cartier, 1800) | 12 32 | 123 38 |
| Islands and Shoals N.W. of Australia | Hibernia rf, 1810 | 12 0 | 123 24 |
| Islands and Shoals N.W. of Australia | Ashmore shl., Middle I. | 12 15 | 123 4 |
| Islands and Shoals N.W. of Australia | Troubadour (1843), 5 | 9 44 | 128 28 |
| Islands and Shoals N.W. of Australia | Coral bank, 7 | 9 57 | 129 27 |
| Islands and Shoals N.W. of Australia | Lynedoch, shl. [¾m.], 7 | 9 54 | 130 40 |

| Region | (102) Places | Lat. S | Lon. E |
|---|---|---|---|
| Australia, North-West Coast | C. Borda | 16°40′ | 122°43′ |
| Australia, North-West Coast | Beagle B., N Hd. | 16 50 | 122 32 |
| Australia, North-West Coast | Lacepede Is., W one, [and rks. 3 l.], 15f., sand | 16 50 | 122 8 |
| Australia, North-West Coast | C. Baskerville | 17 9 | 122 16·5 |
| Australia, North-West Coast | Pt. Coulomb, rf. 1m. | 17 21 | 122 10 |
| Australia, North-West Coast | C. Boileau, sandy | 17 38 | 122 10 |
| Australia, North-West Coast | Pt. Gantheaume | 17 58 | 122 11 |
| Australia, North-West Coast | C. Villaret, 150f. | 18 19 | 122 4·5 |
| Australia, North-West Coast | C. Latouche Treville, 250f. | 18 28 | 121 51·5 |
| Australia, North-West Coast | C. Bossut, Casurina rf. | 18 43 | 121 37 |
| Australia, North-West Coast | C. Jaubert, 45f. | 18 58 | 121 36·5 |
| Australia, North-West Coast | Mt. Blaze, 60f. | 19 59·5 | 119 35 |
| Australia, North-West Coast | Amphinome shls., outer ß | 19 43 | 119 19 |
| Australia, North-West Coast | Bedout I., 20f., rf. SW, [½m.] | 19 35 | 119 6 |
| Australia, North-West Coast | Turtle I., 35f., [½m.], rf., r̄ | 19 54 | 118 55 |
| Australia, North-West Coast | Port Headland, Hunt Pt. | 20 18·2 | 118 35·7 |
| Australia, North-West Coast | C. Thouin, rf. N. | 20 20·5 | 118 13 |
| Australia, North-West Coast | Geographe shls., 2, NW one, [1m.] | 20 16 | 117 55·5 |
| Australia, North-West Coast | Depuch I., w̄, 514f. | 20 38·4 | 117 44·5 |
| Australia, North-West Coast | Port Walcott, (Tien Tsin Hr.), Cossack, lt. F 97f. on Jarman I. | 20 39·1 | 117 13·[illegible] |
| Australia, North-West Coast | Port Robinson, Dixon I. | 20 38 | 117 3·[illegible] |
| Australia, North-West Coast | Legendre I., 55f., ⚓ 8m., NW pt. | 20 21 | 116 51 |
| Australia, North-West Coast | Dampier's Archipelago, ⚓ 10 l., Rosemary I., [3m.], W sum. 250f. | 20 29 | 116 36 |
| Australia, North-West Coast | Hampton Hr., Channel I. | 20 39·8 | 116 42 |
| Australia, North-West Coast | C. Preston | 20 50 | 116 12·5 |
| Australia, North-West Coast | Montebello Is., NS 4 l., I₀, Ritchie rf. | 20 18 | 115 23 |
| Australia, North-West Coast | — Tremouille Is., ◆, w̄, b, flag islet, 21f. | 20 28 | 115 35 |
| Australia, North-West Coast | — Tryal rks., NS 4m., N extr. | 20 35 | 115 27 |
| Australia, North-West Coast | Barrow I., ⚓ 4 l., r̄, (rf 16m. from S end), C. Dupuy | 20 40 | 115 27 |
| Australia, North-West Coast | Fortescue R., mouth | 20 59·8 | 116 6 |
| Australia, North-West Coast | Rosily I., 21f. | 21 18·5 | 114 59·5 |
| Australia, North-West Coast | Ashburton R., (Onslow), mouth | 21 40·7 | 114 56·[illegible] |
| Australia, North-West Coast | N Muiron I., pk. 70f. | 21 37 | 114 23 |
| Australia, North-West Coast | NW Cape | 21 46·5 | 114 10 |

### West Coast.

| Places | Lat. S | Lon. E |
|---|---|---|
| Exmouth Gulf, B. of Rest, N pt. | 22 15 | 114 7·[illegible] |
| Pt. Cloates | 22 43 | 113 41 |
| C. Farquhar, sand, *l* | 23 35 | 113 39·5 |
| C. Cuvier, 400f., ⊥, rock off | 24 13 | 113 23 |
| Bernier I., ⚓ 4 l., Koks Id. off N pt. ○ | 24 44 | 113 10 |
| Dorre I., ⚓ 6 l., ⊥, ⊤, (Dampier's rf. S 4m.), S pt., or C. St. Cricq | 25 17 | 113 4 |
| Gascoyne Rd., Gascoyne R., beacon | 24 53·5 | 113 39·5 |

## MARITIME POSITIONS

| (103) | Places | Lat. S | Lon. E |
|---|---|---|---|
| West Coast | Shark B., Dirk Hartogs I., ✠ 13 l., ⊥, N pt., or C. Inscription, W extr. of Australia | 25° 29'·4 | 112° 58' |
| | — Cape Peron, 66f. | 25 30·5 | 113 30 |
| | — Baba B. | 26 40·5 | 113 40 |
| | Steep Pt. | 26 8·5 | 113 8·5 |
| | Gantheaume B., Red Pt. | 27 42 | 114 10·5 |
| | Houtman rks., ✠ 16 l., ‡', ww$_o$, b, r, North I., [1½m.] | 28 18 | 113 35 |
| | — Wallabi grp., Evening rf., (Middle Channel S of do.), S pt. | 28 33 | 113 41 |
| | — North-East rf., [½m.] | 28 25 | 113 50 |
| | — Easter grp., [3 l.], (Zeewyk Chan. S of do.), Rat I., N pt. | 28 42·5 | 113 47·5 |
| | — Snapper bk., [2m.], ‡ | 28 42 | 114 1 |
| | — Pelsart grp., EW 4 l., SW part, Wreck Pt. | 28 59 | 113 58 |
| | Mt. Fairfax, 603f. | 28 45·4 | 114 41·7 |
| | Wizard Pk., 640f. | 28 29·7 | 114 47·0 |
| | Champion B., (Geraldton), Moore Pt., lt. R 110f. | 28 47·1 | 114 35 |
| | Port Dongara, or Denison, lt. F, Leander Pt. beacon | 29 17·1 | 114 55·2 |
| | Mt. Peron, (3 l. inland) | 30 7 | 115 9 |
| | Mt. Lesueur, (do.) | 30 13 | 115 10 |
| | C. Leschenhault | 31 18 | 115 30 |
| | Rottenest I., ╪ 5½m., lt. R 211f. | 32 0·3 | 115 30·2 |
| | FREEMANTLE, SCOTT'S JETTY | 32 3·3 | 115 44·5 |
| | Swan R., Perth, Gov. House | 31 57·4 | 115 51·7 |
| | Garden I., ✠ 5½m., NW pt. | 32 8·9 | 115 39·5 |
| | Coventry rk. | 32 22 | 115 30 |
| | Peel | 32 27 | 115 44 |
| | C. Bouvard | 32 34 | 115 40 |
| | Koombanah B., w, lt. F 117 | 33 19 | 115 39 |
| | Busselton, lt. F 63f. | 33 38 | 115 21 |
| | Naturaliste, rf., [½m.], ‡f. | 33 15 | 114 55 |
| | C. Naturaliste | 33 32 | 114 58 |
| | Geographe rk. | 34 20 | 114 54 |
| | **South Coast.** | | |
| South Coast ⊕ | C. Leeuwin, (rks. 2 l. out) | 34 21 | 115 6 |
| | Low Black Pt. | 34 25 | 115 29 |
| | Pt. D'Entrecasteaux, ⊥, vis. 10 l., (Id., *l*, rk., ✠ 3m. S) | 34 52 | 116 1 |
| | White topped rks. | 35 4 | 116 13 |
| | C. Chatham, vis 10 l., (Islets S) | 35 2 | 116 28 |
| | Pt. Nuyts, vis. 8 l. | 35 5 | 116 38 |
| | W Cape Howe, ⊥ | 35 9 | 117 40 |
| | Eclipse Is., [1 l.] | 35 12 | 117 53 |
| | Maude rf., ββ$_o$ | 35 13 | 117 56 |
| | Bald Hd., vis. 12 l., S pt. | 35 7 | 118 1 |
| | Breaksea I., lt. F 384f. | 35 4 | 118 3 |
| | King George's Sound, w, b, Princess Harb., ⊞, New Govt. buildings | 35 2·2 | 117 54 |
| | Mt. Gardner, sum. | 35 0 | 118 8 |
| | Bald I., ✠ 3m., (rk. S 1m.) | 34 55 | 118 27 |
| | Sealer's ledge | 35 10 | 118 27 |
| | Haul off rk. | 34 43 | 118 40 |
| | C. Knob, sum. | 34 31 | 119 14 |

| (104) | Places | Lat S | Lon. E |
|---|---|---|---|
| | Pt. Hood, (Doubtful Is., 3m. E-d.) | 34° 24' | 119° 34' |
| | East Mt. Barren, vis. 14 l. | 33 57 | 119 59 |
| | Seals' Is., (rks. N), *l* | 34 6 | 120 28 |
| | Rocky islets | 34 5 | 120 53 |
| | Esperance B., W pt., Observ. I., small | 33 56 | 121 46 |
| | C. Le Grand, (islets off) | 34 1 | 122 4 |
| | Lucky B. | 34 0 | 122 14 |
| | West grp., SWst I., [2m.] | 34 3 | 121 34 |
| | SW, or outer danger | 34 21 | 121 41 |
| | Mondrain I., NS 3½m., vis. 10 l., β, S sum. | 34 10 | 122 14 |
| | S extr. of Archip., Termination I., [1m.], vis. 9 l. | 34 30 | 121 58 |
| Recherche Archipelago | Twin rks., [rfs. 2m., T] | 34 24 | 122 12 |
| | Draper's I., [½m.] | 34 13 | 122 30 |
| | Twin pks., vis. 9 l., (pks. ╪ 2m.) | 34 1 | 122 47 |
| | A break at times, SW one | 34 18 | 122 53 |
| | Douglas Is., [1m.] | 34 10 | 123 6 |
| | Middle I., ╪ 4m., b, w$_o$, SW sum | 34 8 | 123 8 |
| | C. Arid., rky., SE pt. | 34 1 | 123 13 |
| | C. Pasley, sum. 1½m. inland | 33 56 | 123 28 |
| | Pt. Malcolm, *l*, sandy (rk. ╪ 3m.), rk. | 33 48 | 123 42 |
| | SE Isles, [1 l], mid. | 34 20 | 123 28 |
| | Pollock rf., [1m.], β, T | 34 34 | 123 30 |
| | Round I., small | 34 5 | 123 50 |
| | Eastern grp., NS 3 l., S extr. | 33 52 | 124 4 |
| | Pt. Culver, ⊥ | 32 55 | 124 30·5 |
| | Pt. Dover | 32 31·5 | 125 31 |
| | Low sandy pt. | 32 22 | 126 28 |
| | Hd. of Grt. Australian bight | 31 29 | 131 10 |
| | Nuyts rfs., outer detached | 32 9 | 132 7 |
| | Fowler B., Port Eyre Telegraph Office | 31 59·7 | 132 26·7 |
| | Pt. Bell, *l* | 32 13 | 133 8·2 |
| | Purdies Is., ╪ 5m., w$_o$, r$_o$, S I., 83f. | 32 17 | 133 14·2 |
| | Smoky B., Laura B. | 32 14·5 | 133 49 |
| | Is. of St. Francis, NS 2 l., w$_o$, r$_o$, Hart I., 65f. | 32 39 | 133 8·5 |
| South Australia ⊕ | Yatala rf. | 32 39 | 132 35 |
| | Pt. Brown | 32 33 | 133 51 |
| | Streaky B., Port Blanche | 32 48 | 134 13·2 |
| | Olive I., [1½m.], 82f., rfs. N | 32 44 | 133 58 |
| | C. Bauer, ⊥, W pt. | 32 44 | 134 4 |
| | Pt. Westall, ⊥ | 32 55 | 134 3·5 |
| | C. Radstock, ⊥ | 33 12·5 | 134 20 |
| | Pt. Weyland, ⊥, Venus Hr. | 33 15 | 134 37·5 |
| | Waldegrave I., 120f., W extr. | 33 36 | 134 46 |
| | Waterloo B., SE pt. | 33 39·3 | 134 52·5 |
| | Flinders I., ╪ 7m., N pt. 205f. | 33 41 | 134 31 |
| | Ward's Is., 162f. | 33 45 | 134 16·5 |
| | Pearson's Is., NS 2 l., 2 pks., S I. 460f. | 34 00 | 134 14 |
| | Pt. Drummond, ⊥ | 34 9 | 135 14 |
| | Coffin's B., Pt. Sir Isaac | 34 26 | 135 12 |
| | — Port Douglas, Coffin Hd. Station | 34 37 | 135 28·2 |
| | Greenly Is., [1 l.], pk. 755f. | 34 39 | 134 47 |
| | Whidbey Is., [2 l.], W grp., 862f., 4 hummocks, S extr. | 34 47 | 135 1·5 |

## MARITIME POSITIONS

| | (105) Places | Lat. S | Lon. E |
|---|---|---|---|
| Spencer Gulf ⊕ | Rocky Isl., small, *l*. | 34° 49′ | 134° 43′ |
| | Stuart rf. | 34 49·5 | 135 22 |
| | C. Wiles, ⊥ | 34 57 | 135 41 |
| | Lguanea I., ⚓ 2m., rf. S-d ... | 35 0 | 135 37 |
| | C. Catastrophe, S pt. ⊥ | 35 59 | 136 0 |
| | William's I., [1m.] | 35 1·7 | 135 58·5 |
| | Neptune Is., *l*, S I., 120f. | 35 20·5 | 136 7 |
| | Gambier's Is., S pt., peaked rks | 35 12 | 136 30 |
| | Dangerous rf. | 34 49 | 136 12·5 |
| | C. Donnington | 34 43·5 | 135 59·5 |
| | Port Lincoln, ⊞. w, Church... | 34 43·3 | 135 51·5 |
| | Pt. Bolingbroke, *l*, ⊥ | 34 33 | 136 4 |
| | Sir Jos. Banks grp., S extr., Stickney I., 100f. | 34 41 | 136 16·5 |
| | —Winceby I., 33f., N pt. | 34 29·2 | 136 17·5 |
| | South B., Shipping place | 34 23 | 135 55·5 |
| | Franklin Harbour | 33 44 | 136 57·2 |
| | Pt. Lowly, lt. Fl 57f. | 33 0 | 137 47·2 |
| | Port Augusta, fl. st | 32 29·7 | 137 45·7 |
| | Mt. Brown, ab. 3174f. | 32 30·7 | 138 1 |
| | Germein, lt. on pier F | 33 2 | 137 59·2 |
| | Port Pirie, jetty | 33 10·5 | 138 1 |
| | Port Broughton, jetty | 33 36 | 137 55·2 |
| | Pt. Riley, ⊥ | 33 53 | 137 56 |
| | Wallaroo, pier, lt. F 23f | 33 55·5 | 137 37·2 |
| | Tipara B., (Moonta). lt. | 34 3 | 137 34 |
| | Pt. Pearce, Wardang I. | 34 30 | 137 19·5 |
| | Port Victoria, Wauraltee, lt. F | 33 29·2 | 137 29 |
| | Port Minlacowie | 34 51 | 137 27·7 |
| | Port Turton, jetty | 34 56·5 | 137 21 |
| | Corny Pt., *ß*, lt. F 98f. | 34 54 | 137 0·5 |
| | C. Spencer, Sst. of 3 pts., 258f. | 35 18·5 | 136 53 |
| | Althorpe Is., lt. Fl. 350f. | 35 23 | 136 51·5 |
| | Port Moorowie | 35 7 | 137 31·5 |
| | Troubridge, lt. R 81f. | 35 7·5 | 137 49·7 |
| | Edithburgh, lt. F | 35 5·5 | 137 45 |
| St. Vincent Gulf ⊕ | Port Vincent, Surveyor Pt. ... | 34 47 | 137 51·7 |
| | Port Alfred, Kooley Wurta ... | 34 37·4 | 137 53·2 |
| | Androssan, lt. F | 34 26 | 137 55·5 |
| | Port Wakefield, lt. F | 34 12 | 138 8·7 |
| | PORT ADELAIDE, SNAPPER PT. | 34 46·8 | 138 30·7 |
| | Adelaide, town hall | 34 56·2 | 138 35·7 |
| | Mt. Lofty, 2330f. | 34 59·2 | 138 42·5 |
| | Glenelg, lt. F 29f. | 34 59 | 138 30·5 |
| | Port Noarlunga, jetty | 35 9·6 | 138 28 |
| | Port Willunga, S jetty | 35 16·4 | 138 27·5 |
| | C. Jervis, *h*, lt. F | 35 37 | 138 6 |
| | Kangaroo I., EW 28 l., N pt., Pt. Marsden | 35 34·5 | 137 38 |
| | C. Borda, lt. R 510f. | 35 45·7 | 136 35·2 |
| | — SW extr., C. Couedie, 95f. | 36 4·5 | 136 42·2 |
| | — Pelorus rk., 40f. | 36 7·3 | 137 31·5 |
| | — C. Willoughby, lt. R 247f.... | 35 51 | 138 8 |
| S. Australia ⊕ | Port Victor, Harb. Master's house | 35 34·1 | 138 37·5 |
| | Murray R., Goolwa jetty | 35 31·2 | 138 47·2 |
| | C Bernouilli, (C. Jaffa), lt. R 100f., *l*, sandy | 36 57 | 139 40 |
| | Robe, C. Dombey, obelisk, 76f. | 37 10·2 | 139 44·7 |
| | Rivoli B., Penguin I., S pt. ... | 37 31 | 140 1·2 |
| | W. Cape Banks, sandy, lt. R 92f. | 37 54·5 | 140 23 |
| | C. Northumberland, lt. R 150f. | 38 4·2 | 140 40 |

| | (106) Places | Lat. S | Lon. E |
|---|---|---|---|
| Coast of Victoria ⊕ | Glenelg R., entrance | 38° 3′7 | 140° 59′5 |
| | C. Bridgewater, ⊥, 441f. | 38 22 | 141 24 |
| | C. Nelson, ⊥, lt. F 250f. | 38 26 | 141 33 |
| | Portland B., Laurence rk. | 38 24·6 | 141 40·5 |
| | Percy I., [1m.], ⊥, 153f. | 38 25·2 | 142 0·5 |
| | P. Fairy, (Belfast), Griffith I., lt F, Fl. 41f. | 38 23·8 | 142 15 |
| | Lady B., (Warrnambool), Middle I., (lts. F 100f. and 87f.) | 38 24·3 | 142 28·5 |
| | C. Otway, *h*, ⊥, lt. R 300f. ... | 38 51·7 | 143 31 |
| | Apollo Bay. *h*, lt. F | 38 45·7 | 143 41 |
| | Louttit Bay, Mt. Saint George, 657f. | 38 33·9 | 143 57 |
| | PORT PHILLIP, MELBOURNE, NEW OBSERVATORY | 37 49·9 | 144 58·5 |
| | — Pt. Lonsdale, lt. F 54f. | 38 17·7 | 144 37 |
| | C. Schank, lt. F, Fl. 328f. | 38 29·7 | 144 53·2 |
| | Phillip I., ⚓ 10m., ♆, W pt., Pt. Grant | 38 31·6 | 145 7 |
| | C. Liptrap, ⊥, pt. | 38 55 | 145 56 |
| | Glennie Is., NS 3m., 456f., S pt. | 39 7 | 146 15·5 |
| | Cleft I. | 39 10 | 146 20 |
| | S pt. of Australia, Wilson's Promontory, ⊥, lt. F 342f. | 39 8 | 146 25·5 |
| | Mt. Wilson, 2350f. | 39 3·5 | 146 24·5 |
| | **Bass Strait.** | | |
| | King I., NS 35m., N pt., C. Wickham lt. F 280f. | 39 35·6 | 143 57 |
| | — S Pt., *l*, C. Stokes | 40 10 | 143 56 |
| | — Harbinger rks., 2, ⚓ 2m., ‖ ≂, outer, or SW rk.... | 39 34 | 143 52 |
| | — New Year Is., w, NW rk... | 39 40 | 143 49 |
| | — Currie Hr., lt. Fl. 150f. | 39 56 | 143 51 |
| | Reid rks., [3m.], NW, 25f. ... | 40 15 | 144 10 |
| | Bell rf., 1m., S end | 40 24 | 144 5 |
| | Black Pyramid, 240f. | 40 28 | 144 21 |
| | Redondo, rk., ⊥, 1130f. | 39 14 | 146 23·5 |
| | Moncœur Is., small, E extr. ... | 39 14 | 146 34 |
| | Crocodile rk. | 39 21·5 | 146 30·5 |
| | Curtis I., [2m.], 1060f., (Sugar loaf, S 3m.) | 39 28·5 | 146 39 |
| | Devil Tower, ⌒, 350f. | 39 23 | 146 47 |
| | Hogan I., [1½m.], 430f. | 39 13 | 147 1 |
| | Judgment rk. | 39 30 | 147 10 |
| | Pyramid, 300f. | 39 49 | 147 16 |
| | Kent Is., 3. ⚓ 6½m., Deal I., w,, b, lt. R 957f. | 39 30 | 147 19 |
| | Wright rk., small, 200f. | 39 35 | 147 32 |
| | Endeavour rf., Beagle rf., and Craggy I., ⚓ 8m., S pt., or Craggy I. | 39 41 | 147 42 |
| Furneaux Is. | Sisters, 2, ⚓ 7m., NE one, sum. 636f. | 39 39 | 147 59·7 |
| | Flinders I., ⚓ 36m., W pt., or C. Frankland, ... | 39 52 | 147 46 |
| | — Strzleski pks., 2, at S part, 2550f. | 40 12 | 148 6 |
| | — Babel Is., off E side, sum. | 39 58 | 148 21·5 |
| | Hummock I., ⚓ 6m., Low Furneaux Is. off S pt. ... | 40 7 | 147 44·5 |

## MARITIME POSITIONS

| (107) | Places | Lat. S | Lon. E |
|---|---|---|---|
| Banks Strait | Goose I., [1½m.], ✦, S pt., lt. F 100f. | 40°19′ | 147°48′ |
| | Barren I., EW 23m., Mt. Munro, on NW part, 2300f. | 40 22·4 | 148 7·5 |
| | Preservation I., pk. | 40 29 | 148 4 |
| | Clarke I., ⚓ 8m., S pt. | 40 35 | 148 10 |
| | Look-out rk., (SW of do.) | 40 33 | 148 7·5 |
| | Moriarty bk., SE pt. | 40 36 | 148 17 |
| | **TASMANIA.** | | |
| West Coast | C. Grim, ⊥, *blk.* | 40 40 | 144 40·7 |
| | West Pt., sandy | 40 57 | 144 38 |
| | Mt. Norfolk | 41 28 | 144 57 |
| | Mt. Heemskerk, vis. 10 l. | 41 54 | 145 10 |
| | Macquarrie Harb., ▣, bar 8f., ✦, w, r, entr. L | 42 11·6 | 145 13·5 |
| | C. Sorell, *l*, rky. pt. | 42 11 | 145 10 |
| | Pt. Hibbs, β 2m. | 42 38 | 145 15 |
| | Rocky Pt., a rf. | 43 0 | 145 30 |
| | Mt. de Witt, vis. 12 l. | 43 10 | 145 50 |
| | Port Davey, ▣. w, b, pyramidal rk., entr. | 43 20 | 145 55 |
| | Sugarloaf rks. | 43 25 | 145 56 |
| | South-west C., 1000f., ⊥ | 43 35 | 146 1 |
| South Coast ⊕ | South C. | 43 39 | 146 53 |
| | Maatsuyker Is., ⚓ 7m., SW, or Needle rk. | 43 41 | 146 11 |
| | Mewstone, *h*, rugged, ‖ N | 43 44·5 | 146 23 |
| | Pedra Blanca, (Eddystone 1m. E), ‖₀ | 43 51·5 | 146 59·5 |
| | Sidmouth rk., [¼c.] | 43 47·5 | 147 7 |
| | Rurick rk. | 43 59 | 147 42 |
| | Recherche B., 2 ▣, w, b, S port | 43 34 | 146 54 |
| | Huon R., Swan Port, ▣, ✦, | 43 14 | 147 5 |
| | Actæon rf. | 43 34 | 146 59 |
| | Bruny, Id., ⚓ 9 l., S pt., or Tasman's Hd., ⊥ | 43 31 | 147 19·2 |
| | — SW pt., or C. Bruny, lt. R 335f. | 43 28·7 | 147 8 |
| | — Fluted Cape | 43 22 | 147 24 |
| | Hobarton, ▣, Fort Mulgrave | 42 53·4 | 147 20·5 |
| | Storm B., C. Raoul | 43 13 | 147 47 |
| | Port Arthur, ▣, w, r, Semaphore | 43 9·1 | 147 50·7 |
| | C. Pillar, ⊥, Tasman's I., off do., vis. 12 l. | 43 14 | 148 2 |
| East Coast | Hippolite rk., 70f. | 43 6 | 148 2 |
| | Maria I., NS 4 l., Oyster B., ww₀, W side, ⚓ | 42 40 | 148 2 |
| | — Pyramid, off S pt. | 42 45 | 148 3 |
| | — Sum. at N end, 3500f. | 42 37 | 148 7·5 |
| | C. Bougainville | 42 30 | 148 0 |
| | Schouten's I., ⚓ 6m., S islet off | 42 21 | 148 18 |
| | C. Degerando | 42 16 | 148 17 |
| | St. Patrick's Head | 41 34 | 148 18 |
| | Eddystone Pt., lt. F, Fl. 132f. | 40 59 | 148 20 |
| | Mt. Cameron, (8 l. inland of do.), 1730f. | 40 59 | 147 56 |
| | Black rf., [1½m.] | 40 50 | 148 16 |
| | Swan Is., [3m.], 90f.; w₀, lt. at E pt., R 100f. | 40 44 | 148 8 |

| (108) | Places | Lat. S | Lon. E |
|---|---|---|---|
| Tasmania, North Coast | C. Portland | 40°44′ | 147°57′·7 |
| | Waterhouse I., ⚓ 2½m., ✦, ⚓ SE s, N pt. | 40 46 | 147 38 |
| | Ninth I., small | 40 50 | 147 17·7 |
| | Mt. Arthur, 5 l. inland, 4300f. | 41 16 | 147 17 |
| | Tenth I., small | 40 56·2 | 147 0 |
| | Port Dalrymple, ▣, Low Hd., lt. R 142f. | 41 3·4 | 146 48·3 |
| | Flinders Pt. | 41 4 | 146 44 |
| | Emu Bay, NW, or Blackman Pt. | 41 3 | 145 57 |
| | Valentine Pk., 7 l. inland, 4000f. | 41 22 | 145 45 |
| | Table Cape, lt. F 390f. | 40 56·7 | 145 45·7 |
| | Rocky Cape, sum. 2m. inland, 1000f., (a rk. 2m.). | 40 53 | 145 31 |
| | Circular Hd., ⊥, 485f. N pt. | 40 43 | 145 17 |
| | Walker I., NS 3m., N pt. | 40 35 | 144 55 |
| | Three Hummock I., ⚓ 7m., w, SW side | 40 26·5 | 144 51·0 |
| | Hunter I., NS 13m., 300f., ✦₀, ✦, ⚓ E, N pt. | 40 24 | 144 48 |
| | North black rk. | 40 29 | 144 39 |
| | Albatross I., [1m.], 125f. sum. | 40 22 | 144 39·7 |
| | **AUSTRALIA, East Coast.** | | |
| S.E. Coast | C. Wellington | 39 4 | 146 29 |
| | Corner Inlet, ▣, entr. S pt. | 38 47 | 146 28 |
| | — Alberton, town | 38 40 | 146 42 |
| | Is. to SE-d., ⚓ 5m., E. or Cliffy I., lt. Fl 180f. | 38 57 | 146 42 |
| | Gabo I., [1½m], lt. F 179f. | 37 34·2 | 149 55 |
| Coast of New South Wales ⊕ | C. Howe, *l*, T, islet close off | 37 30·2 | 149 58·7 |
| | C. Green, pt., lt. Fl. 144f. | 37 15·5 | 150 3 |
| | Twofold B., Eden, ▣, b, w₀, Red Pt., lt. F 125f. | 37 4 | 149 54·7 |
| | Mt. Dromedary, 2706f. | 36 18·7 | 150 1·3 |
| | Montague I., [2m.], ⚓, W, rky., lt F, Fl. 250f. | 36 15·2 | 150 13·3 |
| | Pt. Upright, ⊥ | 35 38·7 | 150 19·5 |
| | Ulladulla. Warden Head, lt. F | 35 22·2 | 150 30·3 |
| | C. St. George, lt. alt. 224f. | 35 9 | 150 46·5 |
| | Jervis B., Corranbean | 35 3 | 150 40·7 |
| | Kiama, lt. F | 34 40·5 | 150 52·3 |
| | Wollongong, lt. F 56f. | 34 25·5 | 150 55 |
| | Botany Bay, ✦, ⚓₀ N pt. entr., C. Banks, 180f. | 34 0·5 | 151 15 |
| | Port Jackson, ▣, lt. electric, R 344f. | 33 51·2 | 151 17·3 |
| | Sydney, Fort Macquarie* | 33 51·5 | 151 13·0 |
| | Observatory | 33 51·7 | 151 12·5 |
| | Broken B., ▣, Baranju Hd., lt. F 370f. | 33 34·7 | 151 20 |
| | Catherine Hill B., Coaling jetty | 33 9·4 | 151 38·3 |
| | Newcastle, Nobby Hd., lt. 115f. | 32 55·2 | 151 48·3 |
| | Pt. Stephen's, T, lt. R 126f. | 32 45 | 152 12·5 |
| | Broughton Is., E pt. | 32 37·5 | 152 21 |
| | Sugarloaf Pt., lt. Rev. 258f. | 32 26·5 | 152 33 |
| | C. Hawke, pk., 777f. | 32 13 | 152 35 |
| | Three Brothers, 1700f., N one | 31 40 | 152 47 |
| | Port Macquarie, entr. | 31 25 | 152 57 |
| | Smoky C. | 30 56 | 153 6 |

* Garden Id., the usual place of observation, lies 0° 0′ 47″ E. of Fort Macquarie.

## MARITIME POSITIONS

*Coast of Queensland* ⊕

| (109) Places | Lat. S | Lon. E |
|---|---|---|
| N. Solitary I. | 29° 55'·5 | 153° 24' |
| Clarence R., entr., lt. F | 29 26 | 153 24 |
| C. Byron, E pt. of Australia | 28 37·6 | 153 39 |
| Mt. Warning | 28 23·1 | 153 17 |
| Fingal Pt., lt. F 80f. | 28 11·2 | 153 34 |
| Pt. Lookout, 260f. | 27 26 | 153 33 |
| C. Moreton, N part of Id., (rks ✝ 4m.), lt. R 382f. | 27 2·3 | 153 28 |
| Brisbane R., Lytton I., lts | 27 24·7 | 153 10 |
| Mt. Arthur, 1620f. | 26 17·5 | 152 50 |
| Double I., pt., lt. R 315f. | 25 56 | 153 12 |
| Grt. Sandy I., ✝ 23 l., E pt., or Indian Head | 25 0 | 153 22 |
| — N and E pt., Sandy Cape, w 7m., lt. R 400f. | 24 42·5 | 153 12·5 |
| — Shls. off N pt., Breaksea Spit, T | 24 25 | 153 12 |
| Maryborough R., Woody I., pk., lt. F 215f. | 25 18 | 152 58·5 |
| Burnett R., lt. F 37f. | 24 45 | 152 24·5 |
| **North East Coast.** | | |
| Bustard Hd., lt. F. Fl. 330f. | 24 1·5 | 151 46 |
| Lady Eliott I., lt. Fl. 60f. | 24 6·5 | 152 45·5 |
| Mast-Head Islet, ♆, 50f. | 23 32 | 151 45 |
| Capricorn grp., ⅔, NW I., (rfs. E), ♆, 50f. | 23 16 | 151 44 |
| — North rf., lt. F, Fl. 72f. | 23 10·8 | 151 56 |
| Port Curtis, (Gladstone), ⊞, Facing I., ⅔ 8m., Gatcombe Hd., lt. F 66f. | 23 53 | 151 22·7 |
| C. Capricorn, lts. R and F. | 23 29·5 | 151 14 |
| Keppel Is., Barren I., 548f. | 23 9·5 | 151 5 |
| Rockhampton | 23 24 | 150 32 |
| Atherton | 23 7·5 | 150 42 |
| Flat I., 175f. | 22 44 | 151 0 |
| C. Manifold, islet, 260f | 22 41 | 150 52 |
| Port Bowen, ⊞, w, Olsen. rk. | 22 31·7 | 150 47 |
| C. Townshend, N extr., 500f. | 22 12 | 150 30 |
| High Double Mt., 2545f. | 22 32·7 | 150 18·5 |
| Thirsty Sd., Pier Hd., 334f. | 22 6·5 | 150 3 |
| Turn I., 280f. | 21 59 | 149 49 |
| St. Lawrence Creek, (St. Lawrence). S. Red Bluff. | 22 17 | 149 37 |
| Northumberland Is., E one, or High Pk., 718f. | 21 57 | 150 42 |
| Percy Is., ⅔ 7 I., lt. F, Fl. 180f. | 21 39 | 150 14 |
| — Beverly Is., ⚓, Hull I., 272f. | 21 27·5 | 149 53 |
| — Prudhoe I., ⅔ 2m., 1074f. | 21 19 | 149 42 |
| West Hill I., 983f. | 21 49·4 | 149 30·7 |
| C. Palmerston, (w ⅔ 10m.) | 21 31·5 | 149 31 |
| Pioneer R., (Mackay), Flattop I., lt. F 174f. | 21 9·5 | 149 16 |
| Slade Pt. | 21 3 | 149 15 |
| C. Hillsborough, ⊥, 996f. | 20 54 | 149 3 |
| Sir Jas. Smith's grp., Linné Pk., 926f. | 20 40 | 149 12 |
| Repulse Is., N. I. pk., 265f. | 20 35·7 | 148 54 |
| C. Conway, pk. 1637f. | 20 31 | 148 54·5 |
| Cumberland Is., ⅔ 26 I., ♆, S and E one, Snare Pk., 300f. | 21 5·7 | 149 56·7 |

*N.E. Coast of Queensland*

| (110) Places | Lat. S | Lon. E |
|---|---|---|
| Cumberland Is., Bailey I., 120f. | 21° 3' | 149° 34' |
| — Shaw's Pk., N part of I., [4m.]. 1324f. | 20 28 | 149 6 |
| — Kenedy Sd., Brush I., 62f. | 20 29 | 149 4 |
| Dent I., lt. Rev. 120f. | 20 22 | 148 57 |
| Whitsunday I., pk. 1426f. | 20 16 | 148 58·5 |
| Hayman I., N pt., 844f. | 20 2 | 148 54 |
| Port Molle S' Hd., 225f. | 20 19 | 148 52 |
| Mt. Dryander, 2690f. | 20 15 | 148 34·5 |
| Gloucester Head, 1555f. | 19 58 | 148 27 |
| Port Denison, Obsy. Pt., W side of Stone I. | 20 2·2 | 148 16·5 |
| Nares rk., 26f. | 19 46·4 | 148 22 |
| Holborne I., [1m.], 360f. | 19 43·6 | 148 22 |
| Mt. Abbott, 2410f. | 20 5·5 | 147 44·5 |
| C. Upstart, (sum. 1510f), NW pt., (w ⅔ 1m.) ⊕ | 19 42·2 | 147 45 |
| C. Bowling Green, lt R 70f. | 19 19·5 | 147 26 |
| C. Cleveland, lt. R 206f. | 19 11·2 | 147 1 |
| Townsville Pilot Flagstaff | 19 15·5 | 146 50·0 |
| Mt. Eliot, 3980f. | 19 29 | 146 58·5 |
| Magnetic I., [5m.]. 1628f. | 19 8·5 | 146 49·5 |
| — Bay rk., lt. F 96f. | 19 7·2 | 146 45·5 |
| Palm Is., b, w, large one, ⅔ 8m., 1890f., SE pt. | 18 45·5 | 146 42 |
| Hinchinbrook I., Pt. Hillock, 270f. | 18 25 | 146 23 |
| — Mt. Bowen, 3650f. | 18 20·7 | 146 17·2 |
| — C. Sandwich, rks. 2m. | 18 13·5 | 146 20 |
| Cardwell | 18 14·5 | 146 3 |
| Rockingham B., Goold I., [2m.], w''' W, sum. 1375f. | 18 9·5 | 146 11·5 |
| Dunk I., ⅔ 3m. | 17 57 | 146 11 |
| Double Pt., rks. SE 5m. | 17 39·3 | 146 10·5 |
| Flyingfish Pt., lts F | 17 30·2 | 146 6·2 |
| Frankland Is., ⅔ 4m., S and E I., 220f. | 17 13·7 | 146 7 |
| Fitz Roy I., [2m.], w, b, NE pk., 860f., ⚓ W | 16 55·7 | 146 1 |
| C. Grafton, 1273f. | 16 52 | 145 57 |
| Cairns Landing-place, lts. F | 16 55·7 | 145 48 |
| Green I., [and rfs. 3m.], 90f. | 16 46 | 146 0 |
| Port Douglas, lt. Rev. 82f. | 16 29·3 | 145 29 |
| Low Is., lt. R 65f. | 16 23 | 145 35 |
| Snapper I., [1½m.], w₀, SE pt., 350f. | 16 17·7 | 145 31 |
| Archer Pt., lt. F 220f. | 15 36 | 145 2 |
| C. Tribulation | 16 4·4 | 145 30 |
| Endeavour R., Cooktown Pilot Station, lt. F 570f. | 15 27·5 | 145 15·2 |
| Turtle rf., [3m.], f, N pt. | 15 24 | 145 27 |
| C. Bedford, 818f., ⊥, (shl. 1m.) | 15 16·5 | 145 23 |
| C. Flattery, 2 pks., 863f., pt. | 14 59 | 145 23 |
| Lizard I., [3m.], 1167f. | 14 40 | 145 30 |
| Eagle I., [1m.], ⌐, ✱, (shl. S-d.) | 14 42 | 145 24·7 |
| Lookout Pt. | 14 50 | 145 15·7 |
| Coles' Is., ⌐, ✱, NE ext. | 14 33 | 144 57 |
| Howick's grp., ⅔, SE sum. | 14 32·4 | 145 1·5 |
| Noble I., [1m.], rky., h | 14 30·5 | 144 48·5 |
| C. Bowen | 14 31 | 144 42·5 |
| Pt. Barrow, rky | 14 22·5 | 144 42 |

## MARITIME POSITIONS.

| | (111) Places | Lat. S | Lon. E |
|---|---|---|---|
| | C. Melville, (shl. ⫨ 2½m.) ... | 14° 10′ | 144° 33′·5 |
| | Pipon Is., [2m.], *l*, ⚲, N pt.... | 14 6·5 | 144 34 |
| | Clack's I., small, *k*, rk., ⊥ ... | 14 4·7 | 144 17·5 |
| | Flinders grp., ⫨ 2 l., 994f., N pt. C. Flinders ......... | 14 8 | 144 16·2 |
| | Jane's Tableland, abt. 1000f. | 14 29 | 144 10 |
| | A dry sand, [1½m.] ............ | 14 8 | 144 2·5 |
| | Low Woody I., [1m.] ........ | 13 40 | 143 43 |
| | C. Sidmouth ...................... | 13 25 | 143 37·2 |
| | C. Direction, rf. 2m. ............ | 12 51 | 143 34 |
| *N.E. Coast of Queensland* | C. Weymouth, Restoration I., ⊥, pk. 446f., W pt., *l*, ♣, ⚲ ........................ | 12 37·5 | 143 27·5 |
| *N.E. Coast of Queensland* | Fair Cape, rf. 2m. ............... | 12 25 | 143 17 |
| *N.E. Coast of Queensland* | Forbes Is.. sum. 340f. ......... | 12 16 | 143 24 |
| *N.E. Coast of Queensland* | C. Grenville, E pt................ | 11 57·5 | 143 13·2 |
| *N.E. Coast of Queensland* | Conical Hill ........................ | 11 50·3 | 143 18·7 |
| *N.E. Coast of Queensland* | Sir Ch. Hardy's Is., [8m.], ww₀, N one, 320f. ......... | 11 54·7 | 143 28·5 |
| *N.E. Coast of Queensland* | Cockburn rf., Cockburn I., 300f. ......................... | 11 50·3 | 143 18·7 |
| *N.E. Coast of Queensland* | Bird Is., *l*, ⚲, West I. ......... | 11 46 | 143 4·7 |
| *N.E. Coast of Queensland* | Orfordness, Pudding-pan Hill, 403f. ................... | 11 19·7 | 142 48 |
| *N.E. Coast of Queensland* | Cairncross I., ⚲, 93f............. | 11 14·5 | 142 55 |
| *N.E. Coast of Queensland* | Busby I. ............................ | 11 15·5 | 142 53·5 |
| *N.E. Coast of Queensland* | Arnold I., ♦, 30f................. | 11 0·3 | 142 59·2 |
| *N.E. Coast of Queensland* | Shadwell Pk., 245f. ............ | 11 0 | 142 44 |
| *N.E. Coast of Queensland* | Z Reef, beacon .................. | 12 49·3 | 142 43 |
| *N.E. Coast of Queensland* | Grt. Albany Is., Ulrica Pt. ... | 10 45 | 142 37·2 |
| *N.E. Coast of Queensland* | Mount Adolphus Is., Mt. Adolphus, 548f. ............ | 10 38 | 142 39·2 |
| *N.E. Coast of Queensland* | North Brother .................... | 10 42·3 | 142 40 |
| *N.E. Coast of Queensland* | N. extr. of Australia. C. York I., small, rky., 283f., ⊥ ... | 10 41·2 | 142 31·5 |
| *N.E. Coast of Queensland* | C. York, Sextant bk. .......... | 10 41·7 | 142 32·7 |
| | **Barrier Reefs.** | | |
| *Barrier Reefs* | S limit of Grt. Barrier rfs., Swain's rfs. ..................... | 22 23·2 | 152 36 |
| *Barrier Reefs* | Hixson Cay ...................... | 22 20 | 152 41 |
| *Barrier Reefs* | NE lim. .............................. | 21 5 | 152 52 |
| *Barrier Reefs* | Flinders, rfs., S extr. ........... | 17 55 | 148 31 |
| *Barrier Reefs* | Herald's Surprise ........ ...... | 17 20 | 148 28 |
| *Barrier Reefs* | Endeavour opening ............ | 15 42 | 145 48·5 |
| *Barrier Reefs* | Lark Pass ........................... | 15 7 | 145 45 |
| *Barrier Reefs* | First Three mile opening, N pt. of rf., T ............ | 13 26·5 | 144 0 |
| *Barrier Reefs* | Second Three-mile opening, (rf. in mid.), pt. to E-d., T | 13 5 | 143 54 |
| *Barrier Reefs* | Cook entr., (1770), Providential Chan. ............... | 12 39 | 143 49 |
| *Barrier Reefs* | Southern, small, [1m.] ......... | 12 40·5 | 143 50·5 |
| *Barrier Reefs* | Northern, small, [1m.] ......... | 12 25 | 143 48 |
| *Barrier Reefs* | Black rks., N pt. ............... | 12 12·5 | 143 55 |
| *Barrier Reefs* | Yule's rf., [1 l.], E edge, T ... | 11 58 | 143 58 |
| *Barrier Reefs* | Nimrod's entr., [3c.] ........... | 12 6 | 143 47 |
| *Barrier Reefs* | Stead's entr., [½m.] ........... | 11 55 | 143 49 |
| *Barrier Reefs* | Grt. Detached rf., NS 4 l., E extr............................ | 11 44·5 | 144 6 |
| *Barrier Reefs* | — South-east pt. ............... | 11 51 | 144 5 |
| *Barrier Reefs* | Raine I., ⫨ 1½m., (entrance), ⌒, w₀, beac. 60f. ......... | 11 36 | 144 1·2 |
| *Barrier Reefs* | Pandora entr., [2m.]............ | 11 26·5 | 144 0 |
| *Barrier Reefs* | Olinda entr......................... | 11 14·5 | 144 5 |
| *Barrier Reefs* | Yules' opening, ⫨, [1m.], (current !) ..................... | 10 23 | 143 55·5 |

| | (112) Places | Lat. S | Lon. E |
|---|---|---|---|
| | Fly entrance, ⫨, [½m.] ......... | 10° 1′ | 144° 3′ |
| | Cumberland entrance ......... | 9 52·5 | 144 8 |
| | Murray Is., [4m.], grt. one, ⚲, pk. 700f. ............... | 9 55 | 144 1 |
| | Flinders' entr., ⫨ 4m., S pt., T ........................... | 9 35 | 144 10 |
| | **Islands and Shoals Eastward of Australia.** | | |
| *Islands and Shoals Eastward of Australia* | Ball's Pyramid, 1810f. ......... | 31 45 | 159 15·2 |
| *Islands and Shoals Eastward of Australia* | Lord Howe I., 2834f., w′ ...... | 31 31·5 | 159 5 |
| *Islands and Shoals Eastward of Australia* | Seringapatam and Elizabeth rf., mid. ............... | 29 56 | 159 4 |
| *Islands and Shoals Eastward of Australia* | Middleton rf. ...................... | 29 28 | 159 4 |
| *Islands and Shoals Eastward of Australia* | A rock................................ | 24 0 | 160 15 |
| *Islands and Shoals Eastward of Australia* | Capel bk., ⫨ ....................... | 25 15 | 159 18 |
| *Islands and Shoals Eastward of Australia* | Ferriers' bk., ⫨, $\beta\beta_o$ ............ | 23 23 | 155 32 |
| *Islands and Shoals Eastward of Australia* | Cato bk., $\beta$ ....................... | 23 14 | 155 33 |
| *Islands and Shoals Eastward of Australia* | Wreck rf., (Porpoise and Cato, 1803), EW 7 l., Eastern extremity, Bird Island, ♦ ................. | 22 10 | 155 28 |
| *Islands and Shoals Eastward of Australia* | Sir James Saumarez bks., [3 leagues], SW Cay...... | 21 51 | 153 30 |
| *Islands and Shoals Eastward of Australia* | Frederick, shoal, (ship, 1812) ....................... | 21 1 | 154 23 |
| *Islands and Shoals Eastward of Australia* | Kenn rf., ⫨ 9 miles, low, T, 8 ........................... | 21 15 | 155 49 |
| *Islands and Shoals Eastward of Australia* | Booby shoal, NW extreme ... | 20 57 | 158 31 |
| *Islands and Shoals Eastward of Australia* | Mid. Bellona ...................... | 21 24·3 | 158 52 |
| *Islands and Shoals Eastward of Australia* | Bellona shl., NW ............... | 20 47·7 | 158 27·2 |
| *Islands and Shoals Eastward of Australia* | Bellona shl., S ................... | 21 47·3 | 159 34 |
| *Islands and Shoals Eastward of Australia* | Ball's rks. ......................... | 21 0 | 160 36 |
| *Islands and Shoals Eastward of Australia* | Bampton shl., [17 leagues], South-West part, Avon Islands, 2, [2 miles], *l*, ⚲ | 19 33 | 158 16 |
| *Islands and Shoals Eastward of Australia* | Bampton I., 17f................. | 19 8 | 158 30 |
| *Islands and Shoals Eastward of Australia* | Reward I, 20f. .................. | 19 13·5 | 158 55·7 |
| *Islands and Shoals Eastward of Australia* | Mellish Cays, [4 l.], mid...... | 17 25 | 155 53 |
| *Islands and Shoals Eastward of Australia* | Lihou shoal. [15 l.], E lim. ? | 17 10 | 152 12 |
| *Islands and Shoals Eastward of Australia* | Tergrosse Islets, 2, rfs., W pt. | 17 43 | 150 42 |
| *Islands and Shoals Eastward of Australia* | Coringa shl., Id. 10f., rfs., Chilcott I. ................. | 16 50 | 149 57 |
| *Islands and Shoals Eastward of Australia* | Bougainville shls., 2, 8, NS 6 l., N pt. ?..................... | 15 31 | 147 7 |
| *Islands and Shoals Eastward of Australia* | Osprey shl., ⫨ 10m., S pt. ... | 13 50 | 146 34 |
| | **Torres Straits.** | | |
| *Prince of Wales Is.* | Possession I., ⫨ 3m., rky., ♦₀, ww₀, centre ......... | 10 5 | 142 19 |
| *Prince of Wales Is.* | Double I., [4m.], 218f., N sum. | 10 27 | 142 26 |
| *Prince of Wales Is.* | Prince of Wales' I., 5 l., Heath Pt. ................ | 10 35·7 | 142 11 |
| *Prince of Wales Is.* | — S pt., or C. Cornwall......... | 10 46 | 142 10 |
| *Prince of Wales Is.* | Wallis Is., shl., N one, 60f. ... | 10 51 | 142 1 |
| *Prince of Wales Is.* | Thursday I., Vivien Pt., fl. st. | 10 35 | 142 12 |
| *Prince of Wales Is.* | Goode I., lt. F 345ft............. | 10 33·7 | 142 8·2 |
| *Prince of Wales Is.* | Booby I., [¼m.], 30f., ♣, ⌒, r, ww₀, "Post Office" ⊕ | 10 36 | 141 54·0 |
| *Prince of Wales Is.* | Proudfoot shl., ⫨, lt. ves. occ. | 10 32 | 141 22 |
| | Eastern Fields, [7 l.], E end, ♦ | 10 5 | 145 45 |
| | Boot rf., NS 4 l., (shls. SE-d and SW-d), N pt.... | 9 58 | 144 40 |
| | Portlock rf., N limit ............ | 9 28 | 144 53 |

## MARITIME POSITIONS

| (113) | Places | Lat. S | Lon. E |
|---|---|---|---|
| *Torres Straits, Eastern Entrances* | East Cay | 9° 21' | 144° 12' |
| | Anchor Cay, (S lim. of Bligh's entr.) | 9 22 | 144 6 |
| | Bramble Cay, sandbk., 12f., ⌒, (Blk. rks. ‡ 3m.) | 9 8 | 143 51 |
| | Darnley I., or Erooh, (at W edge of rfs., ‡ 11m.), ww, P, hill 610f. | 9 35·3 | 143 45 |
| | Nepean I. | 9 34 | 143 39 |
| | Stephen's I., *l*, ‡ | 9 31 | 143 32 |
| | Pearce Cay | 9 30 | 143 16 |
| | Dalrymple I. | 9 37 | 143 18 |
| | Rennel I., village | 9 46 | 143 15 |
| | Yorke Is., 2, W Id, village | 9 45 | 143 25 |
| | Arden I. | 9 53 | 143 9 |
| | Aureed I., village | 9 58 | 143 16·5 |
| | Half-way I. and rfs., ‡ 4m., NW pt. | 10 6 | 143 17 |
| | Cocoa-Nut I., 2, [4m.], E pt. | 10 4 | 143 6·5 |
| | Dove I. | 10 0 | 143 1 |
| | Dungeness rf., S pt. | 10 4·5 | 142 56·5 |
| | Dungeness I., EW 4m., W pt. | 9 52 | 142 53 |
| | Warrior I., [1½m.], at S pt. of Warrior rf. | 9 48 | 142 57 |
| | Turtle-backed I., 268f., ‡ | 9 54 | 142 45·5 |
| | Long I., ‡ 4m., ⁎, rfs. E-d, W pt. | 10 2 | 142 48·7 |
| | Gabba I., Brothers, hills, *h* | 9 45 | 142 37 |
| | Poll rk. | 10 16 | 142 49 |
| | Harvey rks. | 10 19 | 142 40 |
| | Mt. Ernest, 807f. | 10 15·5 | 142 28·2 |
| | North Possession I. | 10 5·2 | 142 19 |
| | Banks I., Mt. Augustus, 1310f. | 10 10 | 142 19 |
| | Mulgrave I., peak, 686f. | 10 8 | 142 8·2 |
| | Duncan Is., Whale I., N pk. | 10 15·5 | 142 3·7 |
| | Jervis I., [2 l.], 525f. | 9 58 | 142 10 |
| | Cook Reef | 10 23 | 141 33 |
| | Alert Reef, [¼m.] | 9 52 | 140 38 |
| | **NEW ZEALAND.** | | |
| *West Coast, Middle Island* | Farewell Spit, bush end pt., lt. Rev. 120f. | 40 33·3 | 173 2 |
| | C. Farewell | 40 30 | 172 42 |
| | Mount Olympus, 5400f. | 40 52 | 172 35 |
| | Rocks Pt. | 40 58 | 172 4·5 |
| | C. Foulwind, lt. R 190f. | 41 45·5 | 171 28·7 |
| | Grey R., lts. F. | 42 26 | 171 13 |
| | Hokitika R., lt. F 122f. | 42 42 | 170 59 |
| | Abut Hd., extr. | 43 7 | 170 17 |
| | Mt. Cook, 13,349f. | 43 33·5 | 170 12·2 |
| | Cascade Pt., N extr. | 44 0 | 168 24 |
| | Milford So., Freshwater basin | 44 40·3 | 167 55·7 |
| | Pembroke Pk., 6710f.* | 44 35 | 167 54 |
| | George Sound, Anchorage Cove, N side | 44 55·3 | 167 26·7 |
| | Thompson Sound, Deas Cove, hd. | 45 11·7 | 166 58·2 |
| | Breaksea Id., NE pt. | 45 34·7 | 166 38·7 |
| | Five Fingers Pt., Dusky B. | 45 44·2 | 166 28 |

| (114) | Places | Lat. S | Lon. E |
|---|---|---|---|
| | West Cape | 45° 54' | 166° 26' |
| | Chalky I., (S entr. of Dark Cloud inlet). N pt. | 45 59 | 166 35·7 |
| | Puysegur Pt., lt. Fl. 180f. | 46 10 | 166 38 |
| | Sandhill Pt. | 46 16 | 167 22 |
| | Solander Id., [1m.], 1100f. | 46 36 | 166 55 |
| *Stewart I.* | Black rk. Pt. | 46 41·5 | 167 53·7 |
| | Mt. Anglem. 3200f. | 46 45 | 167 57 |
| | Codfish I., ‡ 3m., NW rocks | 46 46 | 167 37·7 |
| | Ernest I., W head of Mason B | 46 57 | 167 42 |
| | Wedge I., ‡ 1m., cent. | 47 13·5 | 167 21·5 |
| | SW Cape | 47 17 | 167 30 |
| | Port Pegasus, cove abreast Anchorage island | 47 11·7 | 167 41·7 |
| | Wreck rf., [½m.] | 47 6 | 168 18 |
| | Port Adventure, Entrance I., E pt. | 47 4·7 | 168 14·2 |
| | Paterson Inlet, Glory Cove, hd. | 46 58·5 | 168 10·7 |
| | North Trap, ‡ 2½m., 5f., E pt. | 47 22·2 | 166 55·2 |
| | South Trap, rf. NS 2m., S pt. | 47 33 | 167 53 |
| | Snares, [1 l.], 470f., ⌒, W Is. | 48 7 | 166 29 |
| *Middle I., South and East Coasts* | Centre I., lt. F 265f. | 46 28 | 167 52 |
| | Awarua, Bluff Hr., Starling Pt., lt. F 30f. | 46 37 | 168 23 |
| | Ruapuke I. (group ‡ 10m.), N pt. | 46 45 | 168 33 |
| | Slope Pt. | 46 41 | 169 3 |
| | Nuggett Pt., lt. F 250f. | 46 27·2 | 169 51 |
| | Saddle Hill | 45 55 | 170 22 |
| | C. Saunders, lt. Rev. 210f. | 45 53 | 170 46 |
| | Taeri I., [¼m.], mo. of T. riv. | 46 4 | 170 15 |
| | Otago Harb., Tairoa Hd., lt. F | 45 47 | 170 45 |
| | Whalers' Home Pt., Merangi, lt. F 170f. | 45 24 | 170 53 |
| | C. Wanbrow, Oamaru, lt. F | 45 7 | 171 1 |
| | Waitangi R., mo. | 44 55 | 171 12 |
| | Timaru, lt. F 85f. | 44 23 | 171 18 |
| | Banks' Peninsula, Akaroa Harb., ⊞, W head, lt. Fl. 270f. | 43 54 | 173 0 |
| | — East point | 43 46 | 173 9 |
| | Port Cooper, ⊞, Lytt. Cust. ho. | 43 36·7 | 172 44·2 |
| | Christchurch* | 43 32 | 172 37 |
| | Table Id. | 43 4 | 173 5 |
| | Huranui R.* | 42 55 | 173 18 |
| | Kaikora Penins., E pt. | 42 26 | 173 44 |
| | Kaikora Range, sum. 9700f.* | 42 1 | 173 41 |
| | Ben More, 4360f.* | 41 55 | 174 2 |
| | C. Campbell, lt. R 155f. | 41 44 | 174 18·2 |
| | Wairau R., lt. F 38f. | 41 30 | 174 5 |
| | Port Underwood, E head | 41 21 | 174 8 |
| *Middle I., N. Coast* | Brothers, lt. Fl. 258f. | 41 6 | 174 27 |
| | C. Jackson | 41 0 | 174 20 |
| | Stephen's I., [1m.] | 40 40 | 174 1 |
| | D'Urville I., Port Hardy, E arm, Wooding Pt. | 40 46·6 | 173 55 |
| | — Greville Harb., S head | 40 50 | 173 48 |
| | Current Basin, Cross Pt. | 40 56·3 | 173 52·2 |
| | Nelson, lt. F 60f. | 41 15·6 | 173 17 |
| | Astrolabe rd., Adele I., NE pt. | 40 58·9 | 173 5·2 |
| | Separation Pt. | 40 47 | 173 2 |
| | Clifton, anchorage | 40 50 | 172 52 |

* *Positions marked thus are provisional.*

## MARITIME POSITIONS

| | (115) Places | Lat. S | Lon. E |
|---|---|---|---|
| North I., East Coast | Kapiti I., 5m., sum. 1780f. | 40°52′ | 174°55′ |
| | Mana I., (off Porirua Harb.), 1½m., sum. NW pt. … | 41 5·8 | 174 48 |
| | C. Terawiti, extr. | 41 17·2 | 174 38·2 |
| | Port Nicholson, ⚓, East or Pencarrow Hd., lt. F 420f. | 41 22·0 | 174 52·0 |
| | WELLINGTON, PIPITEA PT. … | 41 16·5 | 174 47 |
| | — MOUNT COOK, OBSERVATORY | 41 18 | 174 45·7 |
| | Taourakira Hd., extr. | 41 26 | 174 56 |
| | C. Palliser, extr. | 41 37·5 | 175 17 |
| | Flat Rock, extr. | 41 15 | 175 58·5 |
| | Castle Pt., extr. | 40 54·5 | 176 14·2 |
| | C. Turnagain, E extr. | 40 29·5 | 176 38·5 |
| | C. Kidnappers, extr. | 39 38 | 177 8 |
| | Ahuriri Road (Napier) Bluff lt. F 160f. | 39 28·7 | 176 57 |
| | Mahia Peninsula, Table Cape | 39 6 | 178 1 |
| | Portland I., S extr., lt. R 300f. | 39 18 | 177 53 |
| | Poverty B., Gisborne lt. F | 38 41 | 178 3 |
| | Ariel rks., centre, δ | 38 44 | 178 18·5 |
| | Gable end Foreland, white gab. | 38 32 | 178 18 |
| | Tolago B., Motu Heka islet…* | 38 20·8 | 178 21·2 |
| | Open B., N pt. | 37 58 | 178 23 |
| | Mt. Hikurangi, 5535f.* | 37 53 | 178 3 |
| | East Cape islet, 420f. | 37 40 | 178 36 |
| New Zealand | Matakawa Pt. | 37 32 | 178 21 |
| | C. Runaway, extr. | 37 31 | 178 1 |
| | Waikana Pt.* | 37 38 | 177 46 |
| | Mt. Edgecumbe, E sum. 2575f. | 38 6 | 176 45 |
| | White I., 863f. | 37 30 | 177 12 |
| | Tauranga Harb., ⚓. Mt. Monganui, entr., E side … | 37 36·4 | 176 11 |
| | Motiti I., 3m., N pt. | 37 35 | 176 25 |
| | Mayor I., [2m.], 1110f. | 37 16 | 176 15 |
| | Tairua R. | 36 59 | 175 54 |
| | Mercury B., Oyster R. mo. … | 36 49 | 175 48 |
| | Alderman Is., [4m.]. E or outer | 36 56 | 176 7 |
| | Red Mercury I., [1½m.]. E pt. | 36 37 | 175 59 |
| | Great Mercury I., 4m., N pt. | 36 34 | 175 49 |
| | Richard's rk. | 36 35 | 175 58 |
| | Cuvier I., [1½m.], sum. | 36 26 | 175 48 |
| | Channel I. (*Takoupo*), 270f. … | 36 26 | 175 21 |
| | C. Colville | 36 28 | 175 22 |
| North I., North-East Coast | Coromandel Harbour, ⚓, Juhuia I. | 36 48·6 | 175 25·5 |
| | Riv. Thames, Grahamstown, lt. F | 37 8 | 175 33 |
| | Pauhenehe spit, lt. F 50f. | 36 54 | 175 12 |
| | Bean rocks, lt. F 50f. | 36 50 | 174 52 |
| | Auckland, ⚓, Dépôt Pt. … ⊕ | 36 50·1 | 174 49·2 |
| | Tiri Tiri I., lt. F 300f. on SE pt. | 36 38 | 174 56 |
| | Kawau B., Fish Pt., E entr. | 36 27·0 | 174 48·5 |
| | Great Barrier I., 2330, 7l., S pt. C. Barrier | 36 22 | 175 33 |
| | — Port FitzRoy, W pt. of E side | 36 12·0 | 175 22·5 |
| | — Wellington Hd. | 36 10 | 175 18 |
| | — Id. off N end, N or Aiguilles Pt. | 36 2 | 175 27 |
| | Horn rk. | 36 15 | 175 13 |
| | Simpson rk. | 36 1 | 175 9 |
| | Mokou Hinou Is., 1½m., lt. F 385f. | 35 57 | 175 9 |
| | Rodney Pt. | 36 17 | 174 51 |
| | Bream Tail | 36 3 | 174 37 |
| | Moro Tiri Is., EW 5m., E pt. | 35 54 | 174 49 |

| | (116) Places | Lat. S | Lon. E |
|---|---|---|---|
| N.E. Coast | C. Tewara, or Bream Hd. … | 35°52′ | 174°37′ |
| | Wangari Harb., ⚓, Passage I. | 35 51 | 174 31·5 |
| | Tutukaka Harb., N head | 35 38 | 174 34·0 |
| | Poor Knights' Is., N one, 630f. | 35 29 | 174 45 |
| | Wangararu Harb., Grove Pt. | 35 23·3 | 174 22·2 |
| | Waimangaroa pt., lt. F. on wharf.* | 35 19 | 174 8 |
| | C. Brett, (W hd. of B. of Is.) | 35 10 | 174 21 |
| | Port Russel, wharf, lt. F 20f. | 35 16 | 174 8 |
| | C. Wiwiki * | 35 9 | 174 10·7 |
| | Cavalli Is., great, NE extr … | 35 0 | 173 58 |
| | Stephenson I., NW pt. | 34 58 | 173 47·5 |
| | Wangaroa Harb., Peach I. … | 35 1·7 | 175 46·7 |
| | Flat Hd., (E. hd. of Doubtless B.)* | 34 55 | 173 35 |
| | Mongonui Harb., White's Pt. | 35 0·3 | 173 33·5 |
| | C. Karakara, extr. | 34 47·3 | 173 25·2 |
| | Parenga-renga Harb., coal pt. | 34 30·7 | 173 1·7 |
| | North Cape, islet | 34 25 | 173 4·5 |
| | C. Reinga* | 34 26 | 172 41 |
| | C. Maria Van Diemen, islet lt. Rev. 330f. | 34 28·5 | 172 38·7 |
| | Three Kings, 995f., NE one, NE pt. | 34 6·3 | 172 9·7 |
| New Zealand, North I. W. Coast; | Reef Pt., W. ent. of Ahaipara B. | 35 11 | 173 5 |
| | Herekino, S pt. | 35 18·2 | 173 11 |
| | Hokianga R., entr. fl. st. | 35 32·1 | 173 23 |
| | Monganui Bluff, 2040f., bluff | 35 46·3 | 173 34·7 |
| | Kaipara Harb., ⚓, shls. 1 l. out, N. entr. lt. Fl 278f. … | 36 24·3 | 174 7 |
| | Manukau Harb., ⚓, South Hd., lt. F 385f. | 37 3 | 174 33·2 |
| | Waikato R., Maratai Vill. | 37 24·3 | 174 47·2 |
| | Whaingaroa Harb., S entr. pt. | 37 46·5 | 174 53·2 |
| | Karehoa Mt., 2370f.* | 37 50 | 174 51 |
| | Gannet Id., summit, 70f. | 37 57 | 174 35 |
| | Aotea Harb., entr., N hd. | 37 59 | 174 49 |
| | Ka Whia Harb., ⚓. S hd. … | 38 4·9 | 174 49 |
| | Albatross Pt., N extr. | 38 6·2 | 174 43·5 |
| | Terua Pt. | 38 23 | 174 40 |
| | Mokau R., entr. | 38 42·5 | 174 38·7 |
| | Raleigh, lt. F. | 39 0 | 174 15 |
| | New Plymouth, lt. F 100f. … | 39 3·6 | 174 2 |
| S.E. Coast. | C. Egmont, extr., lt. F 103f. | 39 17 | 173 46 |
| | Mt. Egmont, 8270f. | 39 18 | 174 5 |
| | Patea R., Carlyle, lt. F 130f. | 39 47 | 174 31 |
| | Waitotara Pt.* | 39 52 | 174 44 |
| | R. Wanganui, N or Castle cliff, lt. F 65f. | 39 57 | 175 1 |
| | R. Manawatu, N lt. F 44f. … | 40 27·2 | 175 14·7 |

* *Positions marked thus are provisional.*

## MARITIME POSITIONS

| | (117) Places | Lat. S | Lon. |
|---|---|---|---|
| | **SOUTH PACIFIC OCEAN.** | | |
| | **Auckland Islands.** | | East |
| *Auckland Is.* | Bishop and Clerk | 55° 18′ | 158° 56′ |
| | Macquarrie I., NS 12 l., N pt. | 54 40 | 158 56 |
| | Judge and Clerk | 54 19 | 159 10 |
| | Campbell I. [3 l.], 1867f., South harb., Shoal pt. | 52 33·4 | 169 8·7 |
| | Auckland Is., NS 8 l., S.C. 2000f. | 50 56 | 166 4 |
| | West extreme | 50 50 | 165 57 |
| | Disappointment I., [1 l.] | 50 37 | 166 0 |
| | C. Bennet | 50 51 | 166 15 |
| | Sarah's Bosom, Terror Cove | 50 32·5 | 166 12·5 |
| | Bristow rk., 8 | 50 26 | 166 18 |
| | Antipodes I.. Depôt, 1320f. | 49 39 | 178 50 |
| | Bounty Is., EW 3½m., 290f. | 47 43 | 179 0 |
| | **Chatham Islands.** | | West |
| *Chatham Is.* | Chatham Is., Whare-Kauri, 20 l., S. isl., Tarakoikoia Pyramid, 566f. | 44 20 | 176 17 |
| | — Rangiauria, Pitt I., 7m., Moutapu pt. (rks. 2m.), 791f. | 44 14 | 176 11 |
| | — Great I., 13 l., S pt. Pt. Evêque | 44 8·5 | 176 35 |
| | — Port Waitangi, w, Pt. Hanson | 43 57 | 176 31 |
| | — E extr., Wakuru I. (rf. 2m.), E pt. | 43 44 | 176 10 |
| | — Bernier rk., 150f., [2m.], W pt. | 43 58 | 175 48 |
| | — North-west reef, extr. pt. | 43 31 | 176 53 |
| | **Islands off Coast of South America.** | | |
| *Islands off Coast of S. America* | Juan Fernandez I., 3000f., 4 l., Cumberland B. Fort | 33 37·6 | 78 53 |
| | — S. pt., Sta. Clara I., EW 2m. | 33 45 | 79 2 |
| | Masafuera I., 6023f. | 33 45·5 | 80 45 |
| | St. Ambrose I., 1512f., W rock (St. Felix, 472f.) | 26 21 | 79 59 |
| | Sala y Gomez, rks. [½m.], vis. 15m. | 26 27·7 | 105 28 |
| | Easter I., 4 l., 1767f., Perouse Pt., Cook's Bay | 27 10 | 109 26 |
| | Ducie I., 2m., 14f., NE pt. | 24 40·3 | 124 48 |
| | Elizabeth I., 5m., NE pt. | 24 21·3 | 128 19 |
| | Pitcairn I., 2m., 1000f., Adamstown | 25 3·6 | 130 8 |
| | Oeno I. [2½m.], N pt. | 24 1·3 | 130 41 |
| | **Low Archipelago.** | | |
| | Disappointment Is., 2, Wytoohe I., SE pt. ⊖ | 14 12 | 141 12 |
| | — *Tetopoto*, Otoohoo I. ⊖ | 14 6 | 141 24 |
| | Clermont Tonnerre I. (*Reao*), or Minerva, 10m., SE pt. | 18 34 | 136 20 |

| | (118) Places | Lat. S | Lon. W |
|---|---|---|---|
| *Low Archipelago* | Serle I. (*Pukaruha*), 7m., SE pt. | 18° 22′ | 136° 58′ |
| | Narcissus, or Clerke I. (*Tatakoto*), E end ○ | 17 18 | 138 19 |
| | Predpriatie I. (*Fakaina*), 4m., centre | 15 58 | 140 8 |
| | Araktcheeff I. (*Angatu*), 5m. centre | 15 51 | 140 50 |
| | Crescent I. (*Timoe*), 3m., S pt. | 23 20·5 | 134 29 |
| | Portland reef | 23 41 | 134 30 |
| | Gambier Is. (*Manga Reva*), 6 l., rfs., w, Flgstf. 1315f. | 23 7·5 | 135 0? |
| | Lord Hood I. (*Marutea*) [4 l.], W pt. | 21 31 | 135 38 |
| | Maria I. (*Moerenhut*) [4m.] | 22 0 | 136 12 |
| | Actæon Is., 3 [5 l.] (*Matarei Vavao, Melbourne I.*) | 21 25 | 136 25 |
| | Carysfort I. (*Tureia, Papakena*), 7m., NE pt. | 20 45 | 138 30 |
| | Barrow I. (*Vana Vana*), N pt. | 20 45 | 139 10 |
| | Marone or Cadmus I. | 23 8 | 137 8 |
| | Cockburn I. (*Fangataufa*), [4m.], lag. NE pt. | 22 12 | 138 42 |
| | Osnaburgh, or Matilda I. (*Mururoa*), 5 l., E pt. | 21 50 | 138 47 |
| | Bligh's Lagoon I. (*Tematangi*), 2 l., N pt. | 21 38 | 140 40 |
| | Cook Lagoon I. (*Vahitahi*), 3m., P, N pt. | 18 42 | 138 50 |
| | Thrum Cap (*Akiaki*) [¾m.], NW pt. | 18 30 | 139 14 |
| | Bow I. (*Hoa*), 8 l., w, lag. Morai on E side of entr. | 18 3·6 | 140 59·? |
| | — South pt. | 18 16 | 140 41 |
| | Moller I. (*Amanu*), 5 l., P, N pt. | 17 40 | 140 39 |
| | Resolution I., 2 Is. (*Tauerie*), [4m.], S pt. | 17 23 | 141 30 |
| | Good Hope I. (*Rekareka*) [2 l.], S pt. | 16 51 | 141 55 |
| | Barclay de Tolly I. (*Raroia*), 6 l., S pt. | 16 13 | 142 31 |
| | Wolkonsky I. (*Takume*), 13m., lag., N pt. | 15 44 | 142 9 |
| | Whitsunday I. (*Pinaki*) [1½m.], NW pt. | 19 24 | 138 43 |
| | Queen Charlotte I. (*Nukutavake*), EW 3m., E pt. | 19 17 | 138 49 |
| | Egmont I. (*Vairaatea, Puharunga*), 4 m., T, N pt. | 19 18 | 139 18 |
| | Byam Martin I. (*Ahunui*), [4m.], lag., b, N pt. | 19 37 | 140 25 |
| | Gloucester I. (*Paraoa*), EW 3m., NE pt. | 19 8 | 140 40 |
| | Cumberland I. (*Manuhangi*), 2½m. SE pt. | 19 12 | 141 16 |
| | Lasting I., or Pr. Wm. Henry (*Nengo-Nengo*), EW 5m., NE pt. | 18 46 | 141 45 |

## MARITIME POSITIONS

| | (119) Places | Lat. S | Lon. W |
|---|---|---|---|
| *Low Archipelago* | D. of Gloucester Is., 2, E, or Margaret I. (*Nuku-tipipi*) ⊖ | 20°42′ | 143° 5′ |
| | Anu Anurunga, W Id. ⊖ | 20 38 | 143 19 |
| | St. Paul's I. (*Kerekere-tue*), 4 l., N pt. ○ | 19 52 | 145 0 |
| | Two Groups I., 8 l. (*Maro-kau* and *Ravahere*), S pt. | 18 18 | 142 12 |
| | Melville I. (*Hikueru*), NW pt. | 17 35 | 142 41 |
| | Tekokoto [3m.], E. pt. | 17 20 | 142 37 |
| | Furneaux I. (*Marutea*), EW 7 l., W pt. | 16 54 | 143 20 |
| | Nihiru I., NS 3 l., N pt. | 16 41 | 142 53 |
| | Holt, or Yermaloff I. (*Taenga*), EW 5 l., Pass | 16 20 | 143 11 |
| | Philip's I., or Koutousoff (*Makemo*), 11 l., W pt. | 16 26 | 143 58 |
| | Sacken I. (*Katiu*), W pt. | 16 22 | 144 28 |
| | Romanzoff I. (*Tikei*), [3m.] | 14 56 | 144 33 |
| | K. George's I., Tiokea, Pyramid | 14 27 | 145 0 |
| | — Ura I., 4 l., S pt. | 14 44 | 145 14 |
| | Waterlandt, or Wilson's I (*Manihi*), 4 l., E pt. | 14 23 | 145 50 |
| | Peacock I. (*Ahii*), 4 l., W pt. | 14 33 | 146 24 |
| | Bird I. (*Reitoru*), N pt. | 17 48 | 143 7 |
| | Croker I. (*Haraiki*), N pt. | 17 29 | 143 31 |
| | Adventure I. (*Motutunga*), NW Pass | 17 3 | 144 25 |
| | Raeffsky I., or Seagull grp., S & W one, Clute I. (*Hiti*) | 16 42 | 144 9 |
| | Tchitchagoff I. (*Tahanea*), NW pt. | 16 46 | 144 58 |
| | Miloradovitch I. (*Faaiti*), NW pt. | 16 42 | 145 22 |
| | Wittgenstein I. (*Fakarava*), 10 l., SW Rotoava Pyramid | 16 2 | 145 36 |
| | Greig I. (*Niau*). [5m.], N. pt. | 16 7 | 146 23 |
| | Chain I. (*Anaa*), Tunhora pass | 17 20 | 145 30 |
| | Raraka, EW 5 l., entrance | 16 4 | 144 59 |
| | Kanehi I., 14m., S pt. | 15 56 | 145 11 |
| | Tiaro King's I., N pt. | 15 46 | 144 37 |
| | Carlshoff I. (*Aratika*), W pt. ○ | 15 33 | 145 34 |
| | Rurick Is. (*Arutua*), S pt. | 15 26 | 146 44 |
| | Hagemeister I. (*Apataki*), NE pt. | 15 18 | 146 15 |
| | Elizabeth I. (*Toau*), E pt., Otuni | 15 55 | 145 50 |
| | Aura I. (*Kaukura*), W pt. | 15 40 | 146 51 |
| | Dean, or Vliegen I. (*Nairsa*), 15 l., N Avatika, W pt. | 14 46 | 147 50 |
| | Krusenstern I. (*Tikehau*), Tuheiava pass. | 14 58 | 148 14 |
| | Aurora I. (*Makatea*), 230f. N pt. | 15 48 | 148 13 |
| | Lazareff I. (*Mataiwa, Malivi*, [5m.], W pt. | 14 54 | 148 40 |
| | **Society Islands.** | | |
| | Maitea I., 7 m., 1597f. | 17 53 | 148 5 |
| | OTAHEITE I. (*Tahiti*), 12 l., PT. VENUS, lt. F 82f. | 17 29·2 | 149 29 |
| | — Summit, Orohena, 7321f. | 17 37 | 149 28 |

| | (120) Places | Lat. S | Lon. W |
|---|---|---|---|
| *Society Is.* | Otaheite I., Papeete Harb., w Motu-uta Is., lts. F | 17°31′6 | 149°34′ |
| | Murea, or Eimeo, Mt. Tohivea, perforated pk., 3975f. | 17 32·5 | 149 48·7 |
| | Tetuaroa I., EW 5m., SE pt. | 17 2 | 149 32 |
| | Tapamanu I., or Sir C. Saunders (*Muaiti*), pk. | 17 38·7 | 150 37 |
| | Huaheine I., 2231f. Owharree harb. | 16 42·5 | 151 1·5 |
| | Ulietea, or Raiatea I., NS 14m., Uturoa harb. | 16 43 | 151 26 |
| | Regent pt., or Tahaa, Tautu I. | 16 33·7 | 151 30·5 |
| | Bola bola I., NS 8m., sum. | 16 30 | 151 45 |
| | — Oteavanua, ho. | 16 30 | 151 42 |
| | Tubai I., [5m.], N pt.? | 16 11 | 151 48 |
| | Marua, or Maupiti I., 800f. | 16 26·5 | 152 12 |
| | Howe I., Mopelia (*Mopihá*) | 16 52 | 154 0 |
| | Scilly Is., [2 l.], *l*, rfs., ⊖ | 16 31 | 154 43 |
| | Bellingshausen I. | 15 48 | 154 25 |
| | **Marquesas.** | | |
| *Marquesas* | Marquesas, w, r, b, E extr., Ariane rk., 13f. | 10 21 | 138 25 |
| | Magdalena I. (*Fatu-hiva*), NS 8m., 3150f., Hanavave Hr | 10 27·1 | 138 39 |
| | St. Pedro I. (*Motane*), 1640f., SE pt. rk. ○ | 10 1 | 138 48 |
| | Sta. Christina (*Tau-ata*), ab. 3280f., Resolution B., E side | 9 56·3 | 139 7 |
| | Dominica I., 3520f. (*Hiva-Oa*), Perigot B. (*Paumau*) | 9 44·8 | 138 52·7 |
| | Hood I. (*Fatuhuku*), [4m.], ab. 1180f. | 9 26·5 | 138 55 |
| | Washington I. (*Ua-huka*), [3 l.], ab. 2805f., Hannay B. (*Motu-Haane*) | 8 56 | 139 32 |
| | Adam I. (*Ua-pa*), 4042f., Hakahe-tau B. | 9 21 | 140 4·7 |
| | Nukahiva, [6 l.], ab. 3800f., head of Anna Maria B. | 8 55·3 | 140 4·7 |
| | Hergests rks. (*Motu-iti*), 130f. ⊖ | 8 41·7 | 140 36 |
| | Masse (*Eiao*), ab. 2000f., pk. ○ | 8 1 | 140 40·5 |
| | Coral, [& shl. 2 l.] ○ | 7 53 | 140 22 |
| | **Islands North-west of Low Archipelago.** | | |
| *Islands N. W. of Low Archipelago* | Starbuck I., [1 l.?], 15f., W. pt. | 5 37 | 155 56 |
| | Malden I., [3 l.], w, 30f., W pt. Settlement | 4 3 | 155 1 |
| | Jarvis I., 40f. [2m.], *l* | 0 23 | 159 54 |
| | Caroline Is., numerous, small, 18f. *l*, South island Settlement | 10 0 | 150 14·5 |
| | Vostok I., [½m.], ab. 80f., rfs., lag., Boat pass. | 10 6 | 152 23 |
| | Flint I., 50f. *l*, Settlement | 11 26 | 151 48 |
| | Suwarrow Is., 4, small, 15f. | 13 13 | 163 13 |
| | Penrhyn I., 4 l., *l*, lag., 50f., W pass. | 9 0 | 158 3·5 |

## MARITIME POSITIONS

| | (121) Places | Lat. S | Lon. W |
|---|---|---|---|
| | Reirson I., 60f.(*Rokahanga*), Church [2m.], *l*, ✝, P ... | 10° 2′ | 161° 55 |
| | Humphrey I., 65f., Church (*Monahiki*) ... | 10 23·5 | 160 59 |
| | Bernardo, or Danger Is., 3, small, ⁑ 125f., Puka Puka | 10 52·8 | 165 51·5 |
| | Tema Reef, ⁑ ... | 11 7 | 165 35 |
| | Nassau, or Ranger I.?, small, *l*, ▼, b, P$_o$, 70f. ... | 11 33·3 | 165 27 |
| | **Union Islands.** | | |
| *Union Group* | Gente Hermosa, 20f.[1½m.], or Swain's I., ✝ ✝, T, L$_n$ ... | 11 10 | 170 52 |
| *Union Group* | Duke of Clarence I., (*Nukunono*), NS 7m., lag. ‖$_o$, ✝ ✝, $_o$ SE I. | 9 13 | 171 44·7 |
| *Union Group* | Duke of York I. (*Oatafu*), 4m., lag. ‖$_o$, ✝ ✝, L$_n$ P′, ✝. S I., trees | 8 39·7 | 172 28 |
| *Union Group* | Bowditch I., 80f. (*Fakaafo*), 7m., lag. ‖$_o$, ✝ ✝, L$_n$ S pt. ... | 9 28 | 171 9·2 |
| | **Phœnix Islands.** | | |
| *Phœnix Islands* | Mary or Canton I., 15f., West Entrance ... | 2 8·9 | 171 42·5 |
| *Phœnix Islands* | Hull Is., 5, EW 5m., *l*, ⁑, lag., ✝ ✝, W pt. ... | 4 30 | 172 13·2 |
| *Phœnix Islands* | Sidney I., 15f., W pt., *l*, w$_o$ ... | 4 27·4 | 171 16 |
| *Phœnix Islands* | Phœnix [2m.], 20f., *l*, sand, T, North point ... | 3 42·5 | 170 42·5 |
| *Phœnix Islands* | Birnie I., 6f., & rfs. [2m.], ⁑, *l*, centre ... | 3 35 | 171 33 |
| *Phœnix Islands* | Enderbury I., 23f., 3m., ✝, Pier on W side ... | 3 8·5 | 171 10 |
| *Phœnix Islands* | Gardner, or Kemin I., 40f., *l*, lag. ‖$_o$, centre ... | 4 37·7 | 174 39·2 |
| *Phœnix Islands* | M'Kean I., [¾m.], 25f., L$_o$ | 3 35·2 | 174 16 |
| | **Rapa Island, &c.** | | |
| | Four Crowns, or Bass Is., 4, small, 346f. (*Morotiri*) | 27 55·5 | 143 28·5 |
| | Rapa, or Oparo I., 2172f., P′, w, ⊞, Aurei Bay, entr | 27 35·7 | 144 17·2 |
| | Osborne, or Nielson rf., 15f. East pt. ... | 27 1·6 | 146 1·7 |
| | Maria Theresa reef? ... | 37 0 | 151 13 |
| | L'Orne bank ... | 27 42 | 157 44 |
| | Haymet rocks? ... | 27 11 | 160 13 |
| | **Tubuai or Austral Islands.** | | |
| *Tubuai Is.* | Vavitao I. (*Ravaivai*), NE pt. | 23 50 | 147 40 |
| *Tubuai Is.* | Tubuai I. [2 l.], vis. 10 l., ⊞, ✝ ✝, ⚓, ▼, b, L′ Anchorage ... | 23 22 | 149 36 |
| *Tubuai Is.* | Ruu tú I. (*Oheteroa*), NS 4m., ab. 1300f., South pt. | 22 30 | 151 20 |
| | Rimitara I., [3m.], 315f. ... | 22 45 | 152 45 |
| | Hull I., [1 l.], ab. 66f., (β-⅛) ○ | 21 49 | 154 43 |

| | (122) Places | Lat. S | Lon. W |
|---|---|---|---|
| | **Cook Islands.** | | |
| *Cook Is.* | Mangaia I., [2 l.], ab, 650f. rfs. ⚓$_o$ | 21°55′ | 157°56′ |
| *Cook Is.* | Rarotonga I., [3 l.], 2920f. ⚓$_o$, L′, r, P′, NW pt. ... | 21 14 | 159 45 |
| *Cook Is.* | Parry, or Mauki I., 120f., [2m.], *l*, ✝, S pt. ... | 20 7 | 157 22 |
| *Cook Is.* | Mitiéro I., 92f., NS 4m., *l*, [✝], Tomb on W coast ... | 19 49 | 157 43 |
| *Cook Is.* | Vatiu I. (*Atiu*), 394f., [5m.], ⚓$_o$, L, SW Peak ... | 19 59 | 157 43 |
| *Cook Is.* | Fenua iti (*Tukutea*), 50f., [1m.], *l*, ✝ ✝, L, W, w$_o$, B, centre ... | 19 49 | 158 16 |
| *Cook Is.* | Hervey Is., 2, (*Manuai*, S, *Auotu*, N), 60f., 2 l., ‖$_o$, rfs. 3m., ✝, ⚓$_o$, N I ... | 19 11 | 158 49 |
| *Cook Is.* | Whytootackie I. (*Aitutaki*), [& rf. 3 l.], 360 f., N pt ... ⊖ | 18 57·5 | 159 49 |
| | Palmerston Is., NS 4m., ‖$_o$, ✝, ⚓$_o$, w$_o$, r, centre ... | 18 3 | 163 10 |
| | Beveridge, Middleton, or Nicholson shl., ⊞, NS 3 l., ⁑, (entr.), SW pt. ... | 20 2 | 167 49 |
| | Savage I. (*Niue*), NS 11m., ✝, T, P$_n$, NW pt. ... | 19 0 | 169 50 |
| | Antiope reef ... | 18 14 | 168 20 |
| | **Navigator Islands.** | | |
| *Navigator's or Samoa Is.* | Rose I., 33f., and rf. 1½m., *l*, lag., ... | 14 32 | 168 11 |
| *Navigator's or Samoa Is.* | Manua I., 6m., 2500f., ⊥, ✝ ✝, L$_o$, Tau village ... | 14 14·2 | 169 32 |
| *Navigator's or Samoa Is.* | Ofu I., EW 3m., ✝, West I. | 14 11·5 | 169 39·5 |
| *Navigator's or Samoa Is.* | Tutuila, 9 l., Hubner B. ... | 14 21 | 170 51·5 |
| *Navigator's or Samoa Is.* | — I. off N, or Coxcomb Pt., Vatia ... | 14 15·8 | 170 41·5 |
| *Navigator's or Samoa Is.* | — West cape I., lt. F ... | 14 21 | 170 52 |
| *Navigator's or Samoa Is.* | — Pango-Pango harb., ⊞, w, b, r, tower rk. W of entr. ... | 14 17·7 | 170 40 |
| *Navigator's or Samoa Is.* | Upolu, 16 l., 3200f., Nuulua islet off SE pt., 120f. | 14 2 | 171 22·2 |
| *Navigator's or Samoa Is.* | — Fangaloa B., Elds pt. ... | 13 54·2 | 171 29·7 |
| *Navigator's or Samoa Is.* | — Apia harb., ⊞, w‴, f. 2 lts. F., 13 & 197f. ... | 13 49·7 | 171 44·5 |
| *Navigator's or Samoa Is.* | — Tofua Mount, Crater, [1m.], 3200f. ... | 13 51 | 172 55·2 |
| *Navigator's or Samoa Is.* | — W extr. Manono I., 400f., [1m.], ✝, ‖$_o$ E, ... | 13 50 | 172 4 |
| *Navigator's or Samoa Is.* | — Safatu harb., ⊞ Village pt. ... | 13 56·5 | 171 47·7 |
| *Navigator's or Samoa Is.* | Apolima I., [½m.], 472f., T, ✝ ✝ ... | 13 49·2 | 172 6 |
| *Navigator's or Samoa Is.* | Savaii, I., 14 l., 5400f., ✝, w, r, E pt. rf. ... | 13 42·3 | 172 8·5 |
| *Navigator's or Samoa Is.* | — N pt., (Mataatu harb., W d., ⚓ ⁑, w, r, b) ... | 13 28 | 172 21·2 |
| *Navigator's or Samoa Is.* | — South pt., Tanga ... | 13 48·6 | 172 32 |
| *Navigator's or Samoa Is.* | — West pt., Felialupo ... | 13 31 | 172 48 |
| | Curaçoa reef ... | 15 31 | 173 44 |
| | Cocos, or Keppel I., 350f., rks. 6m. ... ○ | 15 58 | 173 52 |

MARITIME POSITIONS

| (123) Places | Lat. | Lon. |
|---|---|---|
| *Islands and Banks west of Samoa Is.* | South | West |
| Verradors, or Boscawen, (*Niua-tabóu-tabóu*). [& rks., ab. 6m.], ab. 2000f., r | 15° 52′ | 173° 50 |
| Good Hope I. (*Niu-afu*), 550f., P, [3½m.], NW end, vill. | 15 34 | 175 41 |
| Zephyr reef | 16 0·3 | 177 6 |
| Wallis Is., 197f. (*Uea*). 9 ✝, ⊞ S, ⚓, b, r, Mua Mission | 13 20·7 | 176 10 |
| Horne Is., 2, Alofa, ⚓, Pk. 1200f. | 14 21·4 | 177 56·2 |
| — Fotuna, Mt. Schouten, 2500f., Sigave B. | 14 16 | 178 10 |
| Bayonnaise bk., ĩĩ | 12 8 | 179 43 |
| Field Bank | 12 17 | 174 44 |
| Robbie Bank | 11 3 | 176 53 |
| Isabella Bank | 12 27 | 177 17 |
| Tuscarora Bank | 11 49 | 178 14 |
| **Ellice Islands.** | | East |
| Sophia I. (*Nurakita*), vis. 16m. | 10 46 | 179 31 |
| Rose Bank | 11 3 | 179 50 |
| Mitchell grp., *Nukulailai*, Fangawa I. | 9 22 | 179 50 |
| Ellice, 2 Is., (*Fanafuti*), NS 14m., ✝ ✝, lag. ⚓′, b, ⚓, N pass ⊖ | 8 25·3 | 179 7·5 |
| De Peyster Is., (*Nukufetau*), ⚓ 9m., ✝, lag. entr. NW, 15 inside, S pt. | 8 4 | 178 29 |
| Tracy I., (*Oaitupu*), [3m.], ✝, S pt. | 7 30 | 178 41 |
| Netherland I., (*Nui*), NS 4m., vis. 4 l., P, South I. Fantapu | 7 15·7 | 177 10 |
| Lynx, or Speiden I. (*Nuitao*), small, no lagoon, Church | 6 6 | 177 20 |
| Hudson I., (*Nanomana*), NS 1½m., 50f., ✝, no lagoon | 6 18 | 176 20 |
| St. Augustine I., (*Nanumea*), 2 Is., ⚓ 2 l., ✝ ✝, Lakina I. | 5 39 | 176 6 |
| **Gilbert Islands.** | | |
| Arorai, or Hurd I., (*Tamoa*) | 2 39 | 176 52 |
| Rotcher I., (*Tamana*) ○ | 2 33 | 175 55 |
| Clerk I., (*Onoatou*), N pt. | 1 52 | 175 30 |
| Peru I., Francis Is., South pt. | 1 27 | 175 59 |
| Nukunau, Byron Is., S pt. | 1 24 | 176 31 |
| Taputeuea I., ⚓ 10 l., Peacock anchorage, ✝ ✝, (*Utiroa*), $w_o$, $b_o$, P | 1 12 | 174 43 |
| Sydenham, (*Nonoti*), ⚓ 7 l., lag. ‖o, S pt. village | 0 48·5 | 174 28 |
| Hopper I., (*Apamama*), ⚓ 10m., ⚓′ W, ⚓, $b_o$, $r_o$, Sth. pass | North 0 21 | 173 51·2 |
| Henderville I. (*Aranuka*), EW 7m., S pt. | 0 8 | 173 37·5 |
| Woodle I., (*Kuria*), ⚓ 8m., ✝ ✝, (rf. ⚓ 3m.), $r_o$ $w_o$ $b_o$, N pt. of reef | 0 19 | 173 22 |

| (124) Places | Lat. | Lon. |
|---|---|---|
| *Gilbert Archipelago* | North | East |
| Hall I., (*Maiana*), ⚓ 9m., ⚓ W, ⊓, $w_o$, $r_o$, $b_o$, House on N pt. | 1° 0′5 | 173° 1′ |
| Cook I., (*Tarawa*), ⚓ 7 l., ✝, SW pt., Bititu | 1 20·5 | 172 55·5 |
| Charlotte I. (*Apaiang*), ⚓ 6 l., lag. entr. SE, T, ✝ ✝, Lone Tree I. (*Iku*) | 1 46·3 | 172 57 |
| Mathews' I., (*Maraki*), NS 5m., lag., ‖o, N pt. | 2 1·5 | 173 17 |
| Pitt I., 3 Is., ⚓, (*Makin*), N pt. | 3 20 | 172 58 |
| Touching I., ✝, lag., ‖ W, ⚓, (*Taraturi*), South entr. | 3 4·5 | 172 44·7 |
| Ocean I., (*Paanopa*), [4m.], vis. 8 l., ✝, T, ⚓o, P ⊖ | South 0 52 | 169 35 |
| Pleasant I., (*Nauru*), 100f. [5m.], ✝, T, ⚓o, r, P | 0 33 | 166 55 |
| **Kermadec Islands, &c.** | | West |
| Raoul, or Sunday Is., 1627f. mid | 29 15 5 | 177 55 |
| Havre rk. | 31 18 | 178 59 |
| Espérance rk., small, 577f. ⊖ | 31 26 | 178 55 |
| Macaulay I. ⊖ | 30 15 | 178 32 |
| Curtis Is., 2, ab. 500f. | 30 35 | 178 36 |
| N Minerva rf, N elbow | 23 37 | 178 50 |
| S Minerva rf., mid. | 23 56 | 179 5 |
| Wolverine shoal ○ | 25 30 | 179 4 |
| Pylstaart I., [1m.], 700f., T, ✝ ✝, P | 22 20 | 176 12·5 |
| Pelorus reef 11 8 | 22 51 | 176 25 |
| **Friendly Islands.** | | |
| Cattow I., small | 21 30·5 | 174 53 |
| Eoa I., NS 4 l., ab. 600f., ‖ N, mid. | 21 24 | 174 51 |
| Tongatábou I., ⚓ 7 l., *l*, w., r, b, P, Van Dieman pt. | 21 4 | 175 22 |
| — N side, Niukalofa. lt. F | 21 8·0 | 175 11·7 |
| Reef, (H.M.S. North Star) | 20 50 | 174 30 |
| Honga Hapai, (S & Wst. of 2 Is.), [1m.], 200f., ✝, ~, ‖o | 20 36 | 175 21 |
| Annamuka I., (*Namuka*), [1 l.], lag., *l*, ✝, β ⊖ | 20 15 | 174 46 |
| Hapai Is., EW 16 l., S, or Fonua-ika | 20 8 | 174 42 |
| Falcon I. volcano (now a shoal) | 20 18·7 | 175 25 |
| Lefouka I., ⚓ 5m., Mission Stat. NW side, ✝ | 19 48·2 | 174 20 |
| Haano I., ⚓ 4m., E pt., Moui-tea | 19 41 | 174 14 |
| N Id., or Ofo-langa, [1m.] | 19 36 | 174 26 |
| Kao I., [1 l.], pyr., 3030f., ⊥ | 19 42 | 175 0 |
| Tofoa I., [5m.], ab. 1890f., ⊥ | 19 45 | 175 3 |
| Coral rf., (Sir E. Home) | 19 2 | 174 44 |
| Latte I., [1 l. ?]. ab. 1790f. | 18 49 | 174 37 |
| Vavu I., (*Hafuluhu*), ⚓ 4 l., 600f., W pt., (Port Refuge to SE d., ⊞, ≋, r, $w_o$) | 18 39·0 | 174 3·7 |
| — Port Valdez, Sandy pt. | 18 38·3 | 174 1 |
| Toku I., [2m.], 82f. | 18 10 | 174 14 |
| Amargura I., (*Fanualei*), ⊥, ✝o, 1230f. | 18 0 | 174 24 |

## MARITIME POSITIONS

**(125) Fiji Is., Eastern Archipelago**

| Places | Lat. S | Lon. W |
|---|---|---|
| **Fiji Islands.** | | |
| Ono Is., peak 370f. | 20°40′ | 178°42′ |
| — Simonoff (*Tuvana-i-tholo*), 95f. | 21 2 | 178 48 |
| Beregis reef (*Vuata Ono*) | 20 44 | 178 51 |
| Vatoa, or Turtle I., [?m.] 209f. ✱ ✝, rf. SE, w, t ⊖ | 19 49·4 | 178 13 |
| Nuku Singea rf., [2m.], 3f. rock | 19 14·2 | 178 20·? |
| Ongea I., (2 Is. & rf., ⚓ 4m.) | 19 12·5 | 178 25 |
| Fulanga I., (*Ongea Ndriki*), 300f., ✱ 5m., ✝, 260f. passage | 19 7·5 | 178 32 |
| Namuka I., E pt., 260f. | 18 51 | 178 35 |
| Mothe I., 590f., peak | 18 39 | 178 30 |
| Kambara I., 470f., NS 3m., S pt. | 18 9·5 | 178 56·5 |
| Tavunasithi, 200f., small | 18 43·5 | 179 5 |
| Vanua Vatu I. [2m.], ⚓, ✱, P, 310f. peak | 18 22 | 179 16 |
| Tova rf., *Na Vatu*, [3m.], N pass | 18 38 | 179 31·5 |
| Totoya I., [6m.], 1184f., peak | 18 57 | 179 48 |
| Olorua I., 250f., peak | 18 36·3 | 178 45 |
| Thakau I., *Lakuleku* reef, [2m.], NE pt. | 18 32·5 | 178 27·5 |
| (Oneata Passage.) | | |
| Oneata, 160f., I., [& rfs. EW 8m.], E islet | 18 26·5 | 178 20·5 |
| Lakemba I., ✱ 3m., ab. 720f., ✱, peak | 18 12·3 | 178 42·? |
| Bukatatanoa or Argo reefs, SE extreme | 18 21·3 | 178 13·7 |
| — North extreme | 17 58 | 178 25·5 |
| Reid reef, Reid haven | 17 55 | 178 21 |
| (Lakemba Passage, N-d. of do.) | | |
| Naiau I., ✱ 5m., 580f., sum. | 17 58 | 179 2 |
| Hawkins rf., *Thakau Lasemarawa*, rks. 3f. | 17 47 | 178 40 |
| Gordon rf., [2m.], *Thakau Tambu*, N pt. | 17 38 | 178 32 |
| Thithia, 540f., NE pass., NS 4m., ✱ ✝, SW pt., (rf. W 3m.) | 17 43 | 179 16·5 |
| Tavutha I., ✱ 4m., S pt., (rfs. ⚓), 800f. | 17 42·5 | 178 48 |
| Katafanga I., 180f., small, rfs., pk. | 17 31 | 178 42·7 |
| Mango I., 670f., [4m.], SW lt. | 17 28 | 179 10·5 |
| Vatu Vara I., 1030f., NS 4m., pk. | 17 25·5 | 179 31·5 |
| Ythata I., 840f., [& rf. EW 5m.], Boat pass | 17 14·3 | 179 30·7 |
| Exploring Is., & rfs. ⚓ 8 l., E reef, Nuku Thikombia Cairn, 6f. | 17 12·7 | 178 39 |
| — Munia, 950f. pk. | 17 22·3 | 178 52·5 |
| — Vanua Mbalavu, 930f., Black Swan pt. | 17 9·5 | 179 0·? |
| Naitamba I., ✱ 5m., sum. 610f. | 17 1 | 179 16 |
| Look-out rf., EW 6m., E pt. | 16 58 | 178 46·5 |
| Wailangilala I., 70f., small, Ship pass | 16 46 | 179 7 |

**(126) Fiji Is., Western Archipelago**

| Places | Lat. S | Lon. |
|---|---|---|
| | | West |
| Nanuku reef, *Nanuku Levu* at S extreme, 70f. | 16°43′ | 179°26′5 |
| Nuku-Mbasanga I., 70f., small | 16 18 | 179 14·? |
| Ngele Levu rf., EW 10m., Ngele I., 60f. | 16 5·3 | 179 8·7 |
| Va-tauúa I., small, 90f., mid. | 15 57 | 179 24 |
| Budd reef, Thombia I., 590f., pk. | 16 27·5 | 179 39·7 |
| Thikombia I., (Farewell), Nat. of the Is., ✱ 3m., rfs., ‖, *Naqilu Vatu*, 480f. | 15 45 | 179 53·5 |
| | | East |
| Tiviuni I., 4040f., ⚓ 8 l., ‖ South Cape | 17 1 | 179 56 |
| Rambe I., 1550f., C. Georgia | 16 32·5 | 179 59·? |
| Vanua Levu I., ⚓ 33 l., 2428f., E, or Undu Pt., *Na Potu* | 16 6 | 180 6·5 |
| — Savu Savu Pt. | 16 48·7 | 179 18 |
| — S extr., Vuya Pt. | 17 1 | 178 44·? |
| — Yendua I., pk., 641f. W extreme | 16 49 | 178 19 |
| — Dana's Peak, 2428f. | 16 42 | 178 55·5 |
| — N extr. of rf. lining N coast, 3m. off Kia I., 780f. | 16 10 | 179 5 |
| Moala I., [& rfs., ⚓ 4 l.], ab. 1535f., ✱ ✝, (rf. 3m.), N pt. of reef | 18 31 | 179 58·5 |
| Matuku I., 1256f., [& rf. NS 4m.], Matuku harb. | 19 10 | 179 45 |
| Goro I., (*Koro*), NS 9m., 1710f., ⚓ NW, N pt. | 17 14 | 179 26 |
| Horse-shoe rf., (*Thackaumomo*), [1m.], ⚓, N pt. | 17 38 | 179 17 |
| Nairai I., NS 4m., (rfs. 4m.), Needle Pk., 1078f. | 17 47·5 | 179 25 |
| Ngau I., pk., 2345f. EW 8m., (rfs. S, W) | 18 0 | 179 17·? |
| Mumbolithe rf., small, S pt. | 18 14·2 | 179 19 |
| Mbatiki I., (*Daveta Naka Suvu*), [1 l.], rf. | 17 46 | 179 9 |
| Wakaia I., NS 4m., 595f., E pt. | 17 36 | 179 1 |
| Mokongai I., NS 3m., rfs., S pt. | 17 28 | 178 58·5 |
| (Mokungai Passage.) | | |
| Vatu e thake, or Passage I., small, 304f. | 17 22·5 | 178 47 |
| Ovalau I., ⚓ 8m., 2089f., Levuka, Site of School-house, (lts. F 240 & 193f.) | 17 40·7 | 178 51·0 |
| Viti Levou, EW 29 l., 4000f., ✝, Rewa roads, Nukulau I. | 18 10·2 | 178 31·5 |
| — Nasalai reef, lt. Fl. 45f. | 18 8 | 178 42 |
| — Suva harb., ▦″, w, h, ⚓, Suva pier, (lts. F 3?0 & 125f.) | 18 8 | 178 26 |
| — West extr., Navula Pt. | 17 53 | 177 15 |
| — Muani Vatu Pk., 4000f. | 17 51 | 177 57·5 |
| Mananutha grp., Hudson's Is., Mana I. | 17 40·5 | 177 7 |
| — Waia I., ⚓ 5m., sum., 1874f. | 17 17 | 177 9 |
| Yasawa group, west extr. of the Is., Wiwa I., [2m.], (shl. S) | 17 9 | 176 54 |
| — Naviti, 740f., pk. | 17 5·5 | 177 16 |
| — Timboor I. | 16 43 | 177 31·5 |

## MARITIME POSITIONS

| | (127) Places | Lat. S | Lon. E |
|---|---|---|---|
| *Fiji Is.* | Round I., (*Lewa Kalou*), 500f., small, (‖ W-d.) ... | 16°40′ | 177°46′ |
| | Vatu Leile I., 110f., ⚓ 8m., *l*, ⚘, ⊥ N, W pt. ........... | 18 31 | 177 37 |
| | Thakau Lekleka or Flying Fish shl. ..................... | 18 36 | 177 48 |
| | Mbenga I., [5m.], ‖₀ W, pk. 1430f. ................ | 18 23 | 178 8·2 |
| | — S pt. of rf. round lagoon ... | 18 31·3 | 177 59 |
| | Ono I., [5m.], ‖₀, pk. 1110f.... | 18 53 | 178 29·7 |
| | Kandavu, Mt. Challenger, 2180f., ⚓ 9 l., ⚘ ⚘, (♁₀ ¼m.) .................. | 18 58·5 | 178 22 |
| | N. Astrolabe reef, Solo I., lt. Fl. 96f. .................. | 18 38 | 178 32·2 |
| | Great Astrolabe reef, N pt.... | 18 41·3 | 178 31·5 |
| | — N'galoa harb., N'galoa...... | 19 5 | 178 11·2 |
| | — Denham I., W extreme ... | 19 8 | 177 57 |
| *Islands and Reefs westward of Fiji Is.* | Hammond reef .................... | 15 32 | 175 20 |
| | Rotumah I., 900f., ⚓ 3 l., ⚘ ⚘, r′, P′, Oinafa......... | 12 29·3 | 177 7·5 |
| | Eagleston reef .................... | 12 21 | 177 50 |
| | Charlotte bk., ⚓ .................... | 11 47 | 173 13 |
| | Pandora rf. .......................... | 12 11 | 172 5 |
| | Mitre I., (*Futaka*), [1m.], vis. 4 l., ⚘. P₀ ............ | 11 55 | 170 10 |
| | Cherry I., (*Anuda*). [3m.] ... | 11 36 | 169 40 |
| | Tucopia, [3m.], 3000f., T, ⚘ ⚘, P, .................... | 12 21 | 168 43 |
| | Conway rf., [2c.], 6f., T ...... | 21 45 | 174 37·7 |
| | Mathew rk., [⅓m.], volcanic, 465f, ⌊₀, ~ .......... ... | 22 20 | 171 20 |
| | Hunter I., [½m.], 974f., ⌊₀ ... | 22 24 | 172 5 |
| | Brilliante shoal .................... | 23 14 | 170 5 |
| | Walpole I., [1½m.], 229f., ⚓₀, ⌊, P₀, S pt. ............ | 22 38 | 168 56·7 |
| | Durand rf., [⅔m.], ββ₀, T, ♁... | 22 2 | 168 39 |
| | NORFOLK I., 1039f., Sydney B., flag staff ................ | 29 3·7 | 167 58 |
| | **Loyalty Islands.** | | |
| *Loyalty Isles* | Maré or Britannia Is., S pt... | 21 40 | 168 1·2 |
| | — E pt., C. Coster............... | 21 24 | 168 7·5 |
| | — Tandine B., ⚓ .................. | 21 32 | 167 50 |
| | Boucher I., 90f. [4m.], ⚘, mid.......................... | 21 5·5 | 167 49 |
| | Chabrol I., E pt., C. Pine...... | 21 1 | 167 24 |
| | — Wreck Bay .................... | 20 45 | 167 8 |
| | — SE pt., C. de Flotte........ | 21 9·5 | 167 18·5 |
| | Uvea or Halgan I., [6 l.]...... | 20 43 | 166 36 |
| | — Oidiy I., Bishop Sd.......... | 20 28 | 166 30 |
| | Beaupré Is., [2 l.], *l*, ⚘, NE Id. .......................... | 20 22 | 166 14 |
| | Astrolabe rfs., 2, ⚓ 10 l., ‖₀, East reef ............ ○ | 19 50 | 165 56 |
| | Petrie reef, 20f., ⚓ ............ | 18 35 | 164 22 |
| | I of Pines, [3 l.]. lag., ⚓ W, ⚘ ⚘, P, Alcmene I....... | 22 42·5 | 167 28·5 |
| | SE elbow of rf ................... | 23 1 | 167 2 |

| | (128) Places | Lat. S | Lon. E |
|---|---|---|---|
| | **New Caledonia.** | | |
| *S. Pacific Ocean* — *New Caledonia* | New Caledonia, ⚓ 65 l., 5360f., E pt., Nau I. ...... | 22°15′5 | 167° 3′5 |
| | C. Coronation (Unia) ......... | 22 2 | 166 52·5 |
| | Balade harb., ⚓ ♁, (rfs 2 l.), Id. | 20 17·2 | 164 29·0 |
| | NW extr., Tia I., (shl.)......... | 19 18·5 | 163 57 |
| | Yandé I., peak 1000f. ......... | 20 22·5 | 163 49 |
| | C. Deverd, (shl. 3 l.)............ | 20 45 | 164 22 |
| | Port St. Vincent, ⊞, ♁₀, ⚘, ✝ 3½m., ⚘ f, Entr., (rfs. ✝ 4m.), Tenia I. ......... | 22 1 | 165 57 |
| | Port Noumea, lt. F red......... | 22 16·2 | 166 27·2 |
| | Amédée, lt. F 164f. ............ | 22 29 | 166 29 |
| | Delep Is., *l*, ⚘, rfs. Tgue I. ... | 19 31 | 163 35 |
| | D'Entrecasteaux rfs., SW pt., Boat pass ............... | 18 40 | 162 46 |
| | Huon Is., Bond reef, [⅓m.], *l*, ⚘, (rfs. 3 l.), N extreme, Three rocks 20f............ | 17 54 | 162 56 |
| | Fairway rf. ........................ | 21 0 | 161 46 |
| | **New Hebrides.** | | |
| *New Hebrides* | Aneityum I., EW 3 l. 2788f., ⚘ ⚘, w‴, b, P₀, P. Inyeu | 20 15·3 | 169 44·7 |
| | Erronan I., (*Futuna*), [1 l.?], 1931f., NW pt.... | 19 31 | 170 11 |
| | Tanna I., ⚓ 8 l., ⚘ ⚘, r, P, Port Resolution, ⊞ ...... | 19 31·3 | 169 27·5 |
| | — Volcano, 4m. inland, 980f. | 19 32·4 | 169 24·5 |
| | Immer I., small, *l*, P. 140f. ... | 19 16 | 169 37 |
| | Erromango, Dillon Bay, on W side, w .................. | 18 47·5 | 168 58 |
| | Sandwich I. (*Efate*), ⚓ 10 l., ⚘ ⚘, Havannah harbour........................ | 17 33·3 | 168 16·7 |
| | Three hill I., (*Mai*), 2171f. (rf. E pt., β) ............ ⊖ | 17 3·1 | 168 24·5 |
| | Monument rock, 397f., [1 l.], (Is W-d.) ................. | 17 16 | 168 28 |
| | Ap I., 2800f., [6 l.], Diamond B., (*Onamavit*) ⊖ | 16 47·5 | 168 10 |
| | Lopevi I., 4755f., pk.......... ⊖ | 16 30·5 | 168 21 |
| | Ambrym I., 4380f., EW 6 l., Dip Pt. ..................... | 16 14 | 167 54·7 |
| | Pentecost I., (*Arugh*), NS 11 l., 2000f., Steep Cliff B. | 15 40 | 168 8 |
| | Aurora I., (*Maiwo*), NS 11 l., 2000f., ⚘, w, b, Laka rere | 14 58 | 168 2 |
| | Lepers I., (*Aoba*), 4000f., Duin Dui ................... | 15 19 | 167 43 |
| | Mallicollo I., ⚓ 18 l., Port Sandwich, ⊞ ............ ⊖ | 16 25·5 | 167 47·5 |
| | — Espiègle B ...................... | 15 58·5 | 167 10·7 |
| | St. Bartholomew I., (*Malo*), EW 3 l., islet SE pt. ...... | 15 43 | 167 15 |
| | Espiritu Santo I., ⚓ 22 l., SW pt., or C. Lisburne ... | 15 38 | 166 46·5 |
| | — North pt., or C. Cumberland ...................... | 14 38 | 166 39 |
| | Port Olry .......................... | 15 1·3 | 167 5·5 |
| | Pic de l'Etoile, (Star I.), (*Meralaba*), 2900f., [1 m.], pk., ⚘, P₀ .................. | 14 29 | 167 59 |

## MARITIME POSITIONS

| | (129) Places | Lat. S | Lon. E |
|---|---|---|---|
| *Banks Is.* | Claire I., (*Merigi*), small, 200f. | 14° 17′ | 167° 48′ |
| | Vanua Lava, 3120f., P. Patteson. Nusa Pt. ............ | 13 48 | 167 30·5 |
| | Santa Maria, (*Gaua*), 2300f., Lakova B. .................. | 14 17 | 167 25 |
| | Bligh I., (*Ureparapara*), 2440f., peak ............... | 13 32 | 167 20 |
| | Torres Is., (*Ababa*). Tegua I., 600f., Hayter B. ...... | 13 15 | 166 33 |
| | **Santa Cruz Islands.** | | |
| *Santa Cruz Is.* | Vanikoro I., La Pérouse. ⚓ 14m., sum. 3031f. ......... | 11 37 | 166 51·5 |
| | — Ocili harb., on E side, ⊞... | 11 40·4 | 166 55·0 |
| | Toupoua I., (or Edgecumbe), Basilisk hr.................... | 11 20 | 166 30 |
| | Sta. Cruz I., (*Ndeni*), 1800f., ⚓ 8 l., E pt., C. Byron... | 10 41 | 166 8 |
| | — S pt., C. Mendaña............ | 10 53 | 165 52·5 |
| | Volcano I., (*Tinakula*)......... | 10 24·3 | 165 46·7 |
| | Swallow group (*Matéma Punavi*), 180f. ................. | 10 17·5 | 166 18·5 |
| | — Anologo, 120f. ............... | 10 6·2 | 165 41·7 |
| | Goldfinch shoal ................. | 10 14·5 | 166 54·5 |
| | Duff or Wilson group, NW extreme .................. ○ | 9 48 | 166 53 |
| | — Disappointment I., 1200f... | 9 57 | 167 0 |
| | — SE extr., Bass Is., 200f. ○ | 10 1 | 167 5 |
| | **Solomon Islands.** | | |
| *Ids. N.E. of Solomon Is.* | Stewart Is., 150f., 5 on a rf., [2 l.], *l*, ✱ †, r, P″, *Sikaiana* | 8 21·5 | 162 42·5 |
| | Roncador, or Candelaria rfs., rock, 10f. .................. | 6 13 | 159 13 |
| | Ontong Java, or Lord Howe's Is., (*Leueneuwa*), SW ext., Toukoua I.... ○ | 5 33 | 159 15 |
| | Frindsbury rf......................○ | 5 0 | 159 9 |
| | Tasman's Is., Niumanno S pt | 4 35 | 159 30 |
| | Mortlock, or Marqueen Is., EW 7 l., centre ... ○ | 4 45 | 157 0 |
| | Nine Is. of Carteret, 60f., ⚓ ab. 10 l., Green I. Trading station ......... ○ | 4 45 | 155 20 |
| *Solomon Is.* | Sta. Catalina I., 320f., (*Yoriki*), pk. ...................... | 10 54 | 162 26·5 |
| | St. Anna I., (*U-ah*). [4m.], 520f., ✱ †, Port Mary ... | 10 50·8 | 162 25·5 |
| | St. Christoval I., (*Robatu*), ⚓ 25 l., †, E pt., or C. Surville ..................... | 10 49 | 162 21 |
| | — Makira harbour ............ | 10 25·5 | 161 27 |
| | — NE pt., C. Recherché ...... | 10 10 | 161 19 |
| | Three Sisters, ⚓ 3 l., 250f., N one, (*Alita*) ........... | 10 8 | 161 54 |
| | Contrariété I., (*Ulaua*), NS 7m., 1200f., pk. ........... | 9 46 | 161 57 |
| | Ugi I., 676f., Selwyn B......... | 10 15·2 | 161 42 |
| | Maleita I., (*Mala*), ⚓ 34 l., S pt., or C. Zélé............ | 9 45 | 161 30 |
| | — Mt. Kolovrat, 4275f. ...... | 9 5·5 | 160 57 |
| | — Alit Bay ..................... | 8 59 | 160 45 |
| | — NW pt., C. Astrolabe, Mallu harbour ............ | 8 22 | 160 30 |

| | (130) Places | Lat. S | Lon. E |
|---|---|---|---|
| *Solomon Is.* | Gower I., [4 l.], *l*, ✱, S pt.......................... ○ | 7° 56′ | 160° 28′ |
| | Ramos Is. ........................○ | 8 19 | 160 9 |
| | Guadalcanar I., ⚓ 26 l., Marau sound, Ferguson I. | 9 50·5 | 160 48·7 |
| | — South pt., C. Henslow...... | 9 59 | 160 35 |
| | — Mt. Lammas, *h*, 8000f. ... | 9 45 | 160 0 |
| | — Wanderer B., Boyd Creek | 9 41·8 | 159 39·5 |
| | — South-west pt., C. Hunter | 9 49 | 159 47 |
| | — North extr., C. Espérance | 9 14 | 159 41 |
| | Florida I., 1500f., Mboli hr., Tree I ...................... | 9 3·5 | 160 17 |
| | Buena Vista I., 1050f., pk. ... | 8 53·5 | 160 1 |
| | Russell Is., 1600f., Pavúvu Pk. ...................... ... | 9 5 | 159 3 |
| | Murray I. (*Burakoi*) [1m.], 1000f. ......................... | 9 1 | 158 40 |
| | St. George I., ⚓ 4 l., ‖ N, Astrolabe Creek, ⊞, w, $r_o$, †, $P_o$, S cove ............ | 8 30·5 | 159 32 |
| | Isabel I., ⚓ 40 l., S pt., 2050f., C. Prieto (Vitora I.) .................. | 8 36 | 159 44·5 |
| | — Mt. Marescot, 3900f. ...... | 8 14 | 159 26 |
| | — Port Praslin ...............○ | 7 25·5 | 158 18·5 |
| | — C. Comfort, (rfs. 2 l) ...... | 7 19 | 158 6 |
| | New Georgia I., (*Marowo*), EW 14 l., Is. (W d.), S pt., or C. Pitt, *Garukai* | 8 48 | 158 15 |
| | Rendova I., 2500f., C. Pleasant ....................... | 8 45 | 157 24·5 |
| | — Rendova harbour......... ⊖ | 8 23·5 | 157 19 |
| | — Kolicara Inlet ............... | 8 10·3 | 157 17·5 |
| | Eddystone rk., (*Narova*), 1100f., $P_{\prime\prime}$, (shls. s, ✝ 3m.), harb. on W coast... | 8 16·1 | 156 29·5 |
| | Guizo I., ⚓ ....... .........⊖ | 8 5·7 | 156 50 |
| | Vella Lavella, C. Middleton, 3000f. ....................... | 7 38 | 156 30 |
| | Choiseul I., 1800f., ⚓ 33 l., E pt., C. Labée ........... | 7 29 | 157 49 |
| | — Bambatani.................. | 7 7 | 156 40 |
| | — Kangopassa ................. | 6 40 | 156 34 |
| | — Choiseul B., Redman I., (shl. 2 l.) ................. | 6 43·3 | 156 24·5 |
| | Shortland Is., 676f., [6 l.], SE pt., C. Stephens ..... . | 7 8 | 155 52·2 |
| | Treasury Is., (*Mono*), [3 l.], *l*, ✱, Blanche harb., Watson I. ........................ | 7 24 | 155 34 |
| | Bougainville I., ⚓ 44 l., C. Friendship, E end ......... | 6 42·5 | 155 58 |
| | — C. Le Cras. (Id., [2 l.?]) | 6 0 | 155 20 |
| | — Gazelle harbour ........... | 6 35 | 155 5 |
| | — Mt. Balbi, 10,171f., 5 l., inland ...................... | 5 56 | 154 54 |
| | — C. l'Averdi .................... | 5 30 | 155 1 |
| | — Buka I., ✱ †, N Cape ...... | 5 0 | 154 35 |
| | — Summit of Buka I., 1306f. | 5 16 | 154 33 |
| | — Queen Carola harbour ...... | 5 10 | 154 29 |
| | Indispensable rf., S pt. ......... | 13 2 | 160 31 |
| | — NW pt. .......................... | 12 15 | 159 59·7 |
| | Rennell I., 400f., ⚓ 12 l., SE pt. ....................... | 11 52 | 160 40 |
| | Bellona I., 400f., [3 l.], SE pt. ......................... | 11 23 | 159 47 |

## MARITIME POSITIONS

| | (131) Places | Lat. S | Lon. E |
|---|---|---|---|
| | **New Ireland and New Britain.** | | |
| *Islands NE. of New Ireland* | Sable reef ........................ | 3°33′ | 154°36′ |
| | Fead Is., or Abgarris, ✢ 9 l., *l*, ‖o, †, S, or Goodman I. | 3 24 | 154 43 |
| | Lyra shl., ✢ 4 l., ɪ or ʒ, centre ........................ O | 1 53 | 153 28 |
| | Sir Charles Hardy, or Vertes Is., 330f., [6 l.], E pt. ... | 4 30 | 154 13 |
| | St. John I., 450f., [3 l.], † †, ‡o, E pt. ........ O | 4 3 | 153 45 |
| | Kaan Is., [1 l.], (rky. Isl. 2 l.), centre.............. O | 3 32 | 153 30 |
| | Gerret Denys I., [5 l.], 1600f., (highest of these islands), † †, P, mid. ............... | 3 8 | 152 39 |
| | San Francisco I., 650f. ......... | 2 50 | 152 43 |
| | Gardner I., and Fisher's I., (3 Is. E-d., a shl. W-d ?) NS 10 l., ab. 1600f., N pt. Fisher I. ..................... | 2 36 | 152 1 |
| | Squally I., [3 l.], *l*, †, (small Id. S-d., ‖o)...... O | 1 40 | 150 30 |
| | Mathias' I., [8 l.], *h*, vis. 45m., (*Tombara*), sum. O | 1 40 | 149 40 |
| *New Ireland* | Cape Santa Maria ............ O | 4 2 | 153 14 |
| | — Holy Haven, S side ......... | 2 47·5 | 150 57·5 |
| | New Ireland, W pt., C. Teschke | 2 42 | 150 39 |
| | — Port Carteret, ⊞, Cocoa-nut I., 800f., NE pt., wo, w N, †, † ......... | 4 41·4 | 152 42·2 |
| | — Port Praslin, ⊞, SE corn., w | 4 49·8 | 152 48·5 |
| | — C. St. George ............... | 4 51 | 152 48·5 |
| | Sandwich I., [4 l.]. pk. 600f.... | 2 55 | 150 49 |
| | Mausoleum I., Byron Strait, 656f. ........................ | 2 42 | 150 33 |
| | New Hanover, 1640f., ✢ 13 l., N pt., or C. Salomon Sweert......................... | 2 20 | 150 14 |
| | — W pt., C. Queen Charlotte | 2 28 | 149 55 |
| | Portland Is., EW 7m., *l*, large I. ........................ | 2 37 | 149 39 |
| | Duke of York I., [3 l.], w′, †, Port Hunter, N side, Mitchell Pt. ................ | 4 5·5 | 152 28 |
| | Father and Son reefs, Father reef ........................... | 3 55 | 151 0 |
| *New Britain* | New Britain, ✢ 85 l., Blanche B., Matupi I. ... | 4 13·3 | 152 12·2 |
| | — Father Pk., vol., 4000f. ... | 5 1 | 151 31 |
| | — C. Palliser..................... | 4 37 | 152 20·5 |
| | — SE pt., C. Orford, ⊥, SE extr. | 5 20 | 152 10 |
| | — C. Quoy (pk. ✢ 3m.) ...... | 5 37 | 151 47 |
| | — Pt. Beechey .................. | 6 9 | 151 2 |
| | — Port Montague, ‡, w, r, Pt. Roebuck ......... O | 6 15 | 150 36 |
| | — South Cape, rky. islet ... O | 6 32 | 149 48 |
| | — C. Ann ........................ | 5 46 | 148 21 |
| | — C. Gloucester.................. | 5 28 | 148 23 |
| | Duportail Is., sum............. O | 4 54 | 151 21 |
| | Willaumez I., NS 5 l., S pt.... | 5 10 | 150 0 |
| | Whirlwind reef, centre ...... O | 4 51 | 148 14 |

| | (132) Places | Lat. S | Lon. E |
|---|---|---|---|
| *Bismarck Archipelago* | Rooke I., ✢ 7 l., *h*, †, Dampier Strait, Luther Anchorage, C. King ...... | 5°28·3′ | 147°46·7 |
| | — Tupinier I., [1 l.], *h*, ⩘ | 5 36 | 148 4 |
| | Lottin I., [4m.], upw. of 5000f. | 5 18 | 147 36 |
| | Long I., NS 5 l., Réaumur Pk. at N end, 2000f. ....... | 5 16 | 147 6 |
| | Mérite I., 2150f., EW 4m., mid. | 4 54 | 149 5 |
| | North I., small, hot spring, shoal, 5m. NW ............ | 4 32 | 149 4 |
| | Gipps I., hot springs ........... | 4 16 | 149 16 |
| | Victoria reef ..................... | 4 16 | 148 10 |
| | Albert reef ........................ | 3 57 | 147 58 |
| | Sherburne rf., EW 4 l., rks. 20f., SE part .............. | 3 15 | 148 16 |
| | Circular rf., [1 l.], T, (a lag. ‖ NW)................... | 3 18 | 147 40 |
| | Sydney shl., rks................. | 3 20 | 146 50 |
| | Elizabeth I., [2m.], *l*, †. [l.] NE, P ................. | 2 55 | 146 49 |
| | Purdy Is., †, 3 Is., Po, (Mole, Mouse, & Bat), Bat I. ... | 2 51 | 145 54 |
| | **Admiralty Islands.** | | |
| *Admiralty Is.* | Jesu Maria I., 700f., [& rfs. 3 l.], ʒ, P, SW pt., ‡ ... | 2 22 | 147 42 |
| | Vandola I., 600f., [1m.], †, P′ | 2 14 | 148 13 |
| | Los Reyes, 3, ✢ 3 l., NE one | 1 59 | 148 5 |
| | San Gabriel I., 12f., [2 l.], W end.......................... | 2 55 | 147 33 |
| | Admiralty I., 3000f., EW 16 l., NE pt., Negros Is. .. | 1 58 | 147 20 |
| | — Nares Hr, D'Entrecasteau rf., E ext. I........... | 1 55·2 | 146 41 |
| | Western Islet, [½m.], (bk. ✢ 1 l.) ........................ | 2 12 | 146 3 |
| | Sugar loaf, 800f.................. | 2 26 | 146 51 |
| *Hermit I., &c.* | Anchorites Is., 3, small, [3 l.], *l*, ‖o, † †, P...... | 0 54 | 145 30 |
| | Commerson I...................... | 0 45 | 145 17 |
| | Hermit Is., 500f., Alacrity Hr, Pémé I. ........... ⊖ | 1 28·8 | 145 5·7 |
| | Bouleuse I........................ | 1 26 | 144 34 |
| | L'Echiquier Is., 30 or more, *l*, rfs., ʒ, NE extr. ......... | 1 6 | 144 30 |
| | — SW extreme.................... | 1 40 | 144 3 |
| | Durour I., small, flat........... | 1 34 | 143 12 |
| | Matty I., small, flat ........... | 1 46 | 142 56 |
| | Tiger I., NS 7m., P ............ | 1 45 | 142 19 |
| | Two Is. (reported 1877) ...... | 0 0 | 146 0 |

## MARITIME POSITIONS

| (133) Places | Lat. | Lon. W |
|---|---|---|
| **NORTH PACIFIC OCEAN.** | | |
| **Galapagos, and Islands off West Coast of North America.** | | |
| *Galapagos Is.* | | |
| Hood I., ✣ 9m., 640f., T, Gard er B. on NE side, ✱, b, $w_o$ | South 1°23′4 | 89°40′ |
| Macgowen rf, [1m.], a rk. | 1 9 | 89 55·5 |
| Chatham I., ✣ 4m., T, 2490f. E pt., Mt. Pitt, b, 800f. | 0 44 | 89 16·5 |
| — Freshwater B., S side, watering place | 0 56·4 | 89 29·2 |
| Charles I., ✣ 9m., 1780f., w W. Post Office B., ⚓′, $w_o$, r, Daylight Pt. | 1 15·4 | 90 27·2 |
| Gardner I., [½m.], 760f., (rk. ✣ 3½m.) | 1 21 | 90 18·5 |
| Albemarle I., NS 75m., 4700f., w $w_o$, Iguana Cove | 0 59·0 | 91 28·5 |
| Narborough I., EW 17m., C. Douglas, 3720f. | 0 20 | 91 40·5 |
| Indefatigable I., EW 23m., Conway B., Eden I. | 0 33 | 90 33 |
| James I., ✣ 20m., James B., on W side, ⚓, ✱, E Cove | 0 12·1 | 90 51·2 |
| | North | |
| Redondo rk., 85f., T | 0 14 | 91 36·5 |
| Towers' I., ✣ 4m., 211f., E pt. | 0 21 | 89 55·5 |
| Abingdon I., ✣ 7m., ✱, ⚓′ S pt., $w_o$, $P_o$, mid. 1950f. | 0 34 | 90 44 |
| Wenman I., ✣ 2m., $✱_o$, 830f., ⚓ ✣ | 1 23 | 91 49 |
| Culpepper I., [1m.], 550f., ✱, T | 1 40 | 92 0 |
| *Is. off American Coast* | | |
| Malpelo I., sum. 1200f. | 4 0 | 81 32 |
| Cocos I., [4m.], r, Chatham B., N side, w ✣ | 5 33 | 87 2 |
| Clipperton rk., 40f., lag. I., NS 3m., *l*, 8 | 10 17 | 109 10 |
| Socorro I., ab. 3707f., $✱_o$, $w_o$, Braithwate B. | 18 43 | 110 57 |
| Clarion, or Cloud, EW 8m., ⚓′, $w_o$, r, $P_o$, Monument rk. | 18 22 | 114 46 |
| Benedicito I., ✣ 3m., 975f., ⚓, mid. | 19 18 | 110 50 |
| Roca Partida, 110f. ○ | 18 59 | 112 8 |
| Alijos, or Lobos, rks., 4, 112f. | 24 57 | 115 53 |
| Guadalupe I., NS 4 l., 4523f., S islet | 29 2 | 118 20 |
| **Islands in Central Pacific.** | | |
| *Central Pacific Is.* | | |
| Baker I. (Guano), 20f. | 0 13·5 | 176 29·5 |
| Howland I. (Guano), 20f. | 0 40·0 | 176 40 |
| Christmas I., NS 6 l., lag., ✱ r, $w_o$, ⚓ W, Cook Id. | 1 57·3 | 157 28 |
| Fanning I., [2m.], lag., r, w′, r, P, English Hr ○ | 3 51·3 | 159 22 |
| Washington, or New York I., [½m.], ✱ r, rf. ½m., ⚓ ⚓ $l_o$, village, W extreme | 4 43 | 160 24·5 |
| Palmyra I., EW 5 l., lag., $w_o$, $P_o$, Palm Point | 5 52·3 | 162 5 |

| (134) Places | Lat. N | Lon. W |
|---|---|---|
| Kingman shoal, S.E. extreme | 6°23 | 162°18·2′ |
| Johnston Is., [7m.], (rf. ✣ 7m., $ll_o$), mid. | 16 45 | 169 28 |
| **Sandwich (Hawaiian) Islands.** | | |
| *Sandwich (Hawaiian) Is.* | | |
| Owhyhee I. (*Hawaii*), NS 24 l., S pt., Ka Lae | 18 54 | 155 42 |
| — Mauna Loa, mt., 13,650f. | 19 29 | 155 38 |
| — Mauna Kea, 13,805f. | 19 50 | 155 32 |
| — East pt., C. Kumukahi | 19 30 | 154 51 |
| — Byron B., Hilo, lt. F 155f. | 19 43·9 | 155 7 |
| — N pt., Upolu Pt. | 20 16 | 155 53 |
| — Kawaihae B., lt. F 50f. | 20 3 | 155 51 |
| — Karakakoa B. (*Kealakekua*), Cook's Monument | 19 29 | 156 2·7 |
| Mowee I. (*Maui*), ✣ 14 l., E pt., Kauiki Hd., 392f. | 20 46 | 156 0·5 |
| — Kolakole Pk., 10,030f. | 20 42·7 | 156 17 |
| — Lahaina town, lt. F | 20 52·5 | 156 42 |
| Tahourowa I. (*Kalulaui*), ✣ 5 l., $✱_o$, W pt., (rf. 2m.) ○ | 20 28 | 156 45 |
| Ranai I., ✣ 7 l., $⚓_o$, Pulawai Pk., 3000f. | 20 49 | 156 54 |
| Morotoi I. (*Molokai*), EW 11 l., $⚓_o$, E pt., (Lanikaula) | 21 9 | 156 43 |
| — West pt. (Lae-o-ka Laau), lt. F 50f. | 21 6 | 157 19 |
| Woahoo I. (*Oahu*), ✣ 13 l., E pt. (Makapuu) | 21 18 | 157 39 |
| — S, or Diamond Pt., 761f. | 21 15 | 157 49 |
| — HONOLULU, King's cottage | 21 18 | 157 52 |
| — Konahuanui Pk., (*Pali*), 3175f. | 21 21 | 157 47 |
| — Pearl Locks (Honouliuli) | 21 21·5 | 158 1 |
| — Laeloa Pt., lt. F 43f. | 21 17 | 158 7 |
| — West pt. (Kaena) | 21 34 | 158 17 |
| — North pt. (Kahuku) | 21 43 | 157 59 |
| Atooi I. (*Kauai*), ✣ 11 l., Nawiliwili Hr., Sugar ho. | 21 58 | 159 2·2 |
| — Hanalae B., Charlton farm | 22 13 | 159 30 |
| — Waialeale Pk., 5000f. | 22 3 | 159 31 |
| — Waimea | 21 57 | 159 40 |
| Oneehow I. (*Niihau*), ✣ 7 l., Oku Pt. | 21 58 | 160 5·5 |
| — South pt., C. Kawaihoa | 21 46 | 160 18 |
| — Kaeo Pk., 1500f. | 21 53 | 160 10 |
| *Islands N.W. of Sandwich Is.* | | |
| Tahoora I., (*Kaula*), [1m.] | 21 39 | 160 32·5 |
| Bird I. (*Modu Manu*), [1m.], $✱_o$, $P_o$, 880f. | 23 3·2 | 161 55 |
| Necker I., [½m.], about 280f., $✱_o$, $l_o$, ⌒ | 23 35 | 164 39 |
| French Frigate shl., rf., ✣ 4 l., Id., 125f. | 23 46 | 166 16 |
| Gardner I., [½m.], 170f. | 25 0·7 | 167 59 |
| Maro rf., W pt., 8 *B*, vis. 5m. | 25 26 | 170 30 |
| Laysan I., 8, 25f. | 25 48 | 171 55 |
| Lisiansky I., [1m.], rf. 2m., *l*, sandy, $w_o$, (rf. ✣ 2 l.) | 26 0 | 174 0 |

## MARITIME POSITIONS

| | (135) Places | Lat. N | Lon. |
|---|---|---|---|
| | | | West |
| Islands South of Japan | Pearl & Hermes rf., SE I. .... | 27°47'8 | 175°51' |
| | Midway I., SW pt. of Sand I., 57f. .... | 28 12 | 177 22 |
| | Cure I., (Ocean, Stavers), l, Sand Island, 20f. .... | 28 25·7 | 178 29·7 |
| | **Bonin and Volcano Islands.** | | East |
| Bonin Is. | Bonin Is., NS 14 l., N, or Parry's grp., ✱ 3 l., N rk. | 27 45 | 142 7 |
| | Kater I., [& rks. 1½m], N rk. | 27 31 | 142 12 |
| | Peel I., NS 5m., SW islet ...... | 27 2 | 142 10 |
| | — Port Lloyd, ⊞, w', ⊅, r, ⚑, Kyosé .... | 27 5·6 | 142 11·5 |
| | Bailey Is., Ane Tima ........ | 28 33 | 142 9 |
| | Rock, I .............O | 29 37 | 141 58 |
| | Rosario (or Disappointment) I., 148f., [1m.], rky., ⊥, ✱o. β .... | 27 16 | 140 51 |
| | Volcano Is., S, Sulphur I., ⸸ 5m., 644f. .... | 24 48 | 141 20 |
| | —N Id., San Alessandro, 2534f. | 25 24 | 141 18 |
| | —S Id., San Augustino, 3039f. | 24 18 | 141 28 |
| | Forfana (late Arzobispo) I. . | 25 43 | 140 43·5 |
| | Rock, 7f. ..........O | 24 2 | 137 59 |
| | Rica de Oro rk., or Lot's Wife, 466f. .... | 29 45 | 140 22 |
| | Rasa I., ✱ 5m., ✱, 220f. ....O | 24 30 | 131 22 |
| | Borodino Is., 2, NS 4 l., l, Sandy, P, N one, 40f. .... | 26 2 | 131 20 |
| | Parece Vela (Bishop, Douglas, Nautilus), a rk 12f., in a lag., [1 l.], β .... | 20 28 | 136 13 |
| | **Ladrones.** | | |
| Mariana Is., or Ladrones | Santa Rosa shoal ..........O | 12 30 | 144 15 |
| | Guam, or Guahan I., ⸸ 9 l., Cocoa I. .... | 13 13 | 144 38 |
| | — San Luis de Apra, ⊞, w. r, fort .... | 13 25·8 | 144 39·5 |
| | — North pt., Pt. Ritidian..... | 13 39 | 144 51 |
| | Rota I., ⸸ 4 l., about 800f. ... | 14 7·5 | 145 13 |
| | Aguijan I., [1 l.], centre ...... | 14 51 | 145 31 |
| | Tinian I., NS 4 l., ‖o N, Anson's B. at SW part, ⚓, w, r, Anson Bay .... | 14 59·4 | 145 36·2 |
| | Saypan I., ⸸ 4 l., ab. 1200f., ✱, w, r, (rf. W-d.), N pt. | 15 17·5 | 145 46·5 |
| | Bird I., or Farallon de Medinilla, ⸸ 2m., ab. 50f. rks. | 16 0 | 146 0 |
| | Anataxan I., h, ⚓o, ⚑, E pt. | 16 20 | 145 41 |
| | Sariguan I. | 16 40·5 | 145 46 |
| | Zealancia bank (Piedras de Torres) ⸸ O | 16 52 | 145 49 |
| | Guguan I., NS 2m., E pt. ...... | 17 18·5 | 145 51·5 |
| | Alamagan I., 2316f., E part... | 17 35 | 145 52 |
| | Pagan I., W end. 1000f. ...... | 18 3·5 | 145 53 |
| | Agrigan I., P., W end ........ | 18 50 | 145 37 |
| | Assumption I., [3m.], 2848f. ⚑ W, w, ⌇ .... | 19 45 | 145 29·0 |
| | Urracas, 3 rks. | 20 0 | 145 21 |
| | Farallon de Pajaros, 1089f. ... | 20 32 | 144 54 |

| | (136) Places | Lat. N | Lon. E |
|---|---|---|---|
| Detached Is. and Reefs | Grampus Is. (Sebastian Lobos?). E.D. .... | 25° 10' | 146° 40' |
| | Marcus I., 60f. .... | 24 14 | 154 0 |
| | Wake, or Halcyon I., [3m.], l, lag., ✱, ⚑o, wo. ⚑, 8f. ... | 19 11 | 166 31 |
| | Gaspar Rico, or Cornwallis, (*Toangi*), vis. 5m., Scylla rks., NS 2 l. .... | 14 50 | 169 5 |
| | **Marshall Islands.** | | |
| East chain, Ratack Is. | Bikar, or Dawson Is., [4 l.], 9f. S I. .... | 12 14 | 170 15 |
| | Button, or Kutusov Is. (*Utirik*), N I. .... O | 11 18 | 169 54 |
| | — S grp., Taka Is., S pt. ...... | 11 3 | 169 46 |
| | Krusenstern, Tindle & Watts (*Ailuk*), Is., ✱ 5 l., Kapeniur I. .... | 10 27 | 170 0 |
| | Count Heiden, or Lekieb Is., ✱ 8 l., S pass. 14f. .... | 9 49 | 169 22 |
| | Jemo I., or Steep to ........O | 10 6 | 169 42 |
| | New Year I., (*Miadi*), NS 3m., l, ✱ .... | 10 18 | 170 55 |
| | Chatham Is., N grp., Romanzoff, (*Otdia*), Port Noel, E islet .... | 9 28 | 170 17 |
| | — S grp., Erikub, ✱ 8 l., S extr., (*Airik*) .... | 8 55 | 170 8 |
| | Calvert Is., ✱ 10 l., NW one, (*Kaven*) .... | 8 51 | 170 49 |
| | · South extreme .... | 8 30 | 171 10 |
| | Ibbetson Is., (*Aurh*), ✱ 4 l., NE pt. .... | 8 21 | 171 2 |
| | Arrowsmith Is., (*Majuro*), ✱ 6 l., Caroline I., W. pt. | 7 10 | 171 13 |
| | Arhno Atoll, Ine I. ...... | 6 53 | 171 43 |
| | Mulgrave Is., [6 l. ?], small, rfs., ‖o, Port Rhin .... | 6 14 | 171 46 |
| | Keats shoal, ⸸. .... | 5 55 | 173 38 |
| West chain, Ralick Is. | Boston, or Ebon Is., Jurij I. .... | 4 36·5 | 168 41·5 |
| | Bonham Is., (*Jalut*), ✱ 8 l., SE pass .... | 5 55·5 | 169 43 |
| | Hunter I., [2m.], (*Kili*)........ | 5 42 | 169 9 |
| | Baring Is., Namorik ........O | 5 35 | 168 5 |
| | Elmore, or Odia Is., ⸸ 7 l., South Pass .... | 7 15 | 168 48 |
| | Musquillo Is., ✱ 12 l., rfs., ‖o, W pt. Nama I. .... | 8 14 | 168 3 |
| | Lib I., 14f. .... | 8 19 | 167 28 |
| | Mentschikoff Is., ✱ 20 l., Ebadon I. .... | 9 22 | 166 53 |
| | Lae I., W pass .... | 8 58 | 166 27 |
| | Uja, or Catharina Is., NW I. | 9 21 | 165 36 |
| | Schanz Is., ✱ 5 l., Wottho I., 14f. .... | 10 10 | 166 6 |
| | Rongelab, or Pescadores Is., 14f., Po, South I. .... | 11 15 | 167 0 |
| | Rongerik Is., ⸸ 18 l., Bock I. .... | 11 24 | 167 35 |
| | Ailinginae Is., Knox I. .... | 11 4 | 166 36 |
| | Binkini or Eschholtz Is., ✱ 7 l., NW extr. .... | 11 42 | 165 25 |

## MARITIME POSITIONS

| (137) Places | Lat. N | Lon. E |
|---|---|---|
| Eniwetok, or Brown's group, [8 l.], ✝ ✝₀, lag., P₀, West Point | 11°31′ | 162° 5′ |
| — SE islet, or Parry | 11 21 | 162 25 |
| Arecifos, or Providence Is., rfs, ‖₀ ?, Uyelang I., 14f. | 9 42 | 161 1 |
| Greenwich Is., (*Kapinga-marangi*) | 1 4 | 154 45 |
| Indiana reef | 3 20 | 160 18 |
| Two Is. (reported 1877) | 0 0 | 146 0 |
| **Caroline Islands.** | | |
| Ualan I., (Strong I.), ✝ 8m., Coquille Harb. on NW side, ⊞, w, r. NE islet | 5 21·3 | 163 0·7 |
| — Mt Crozer, ab. 2155f. | 5 19 | 163 2·5 |
| Pingelap, or MacAskill Is., 3, [2m.], Tugula I. | 6 14·5 | 160 52 |
| Duperrey Is. & rf., ✝ 3m., or Mokil I., S pt. | 6 39 | 159 53 |
| Seniavina Is., 3 grps., ✝ 13 l., Punapi I., EW 5 l., ✝ ✝, P, Tolocolme Pk., 2861f. | 6 53 | 158 12 |
| Andema Is., ✝ 3 l., rfs., S pt. | 6 44 | 157 54 |
| Pakin, or Paguenema Is., Kapenuar I. | 7 6 | 157 43 |
| Ngatik Is., EW 3 l., *l*, ✝ ✝, ‖₀ P, E pt. | 5 48 | 157 31·5 |
| Bordelaise I., S. Augustin I., 107f., [½m.], ✝ (3 NW, rf. SE 3 l.) | 7 37 | 155 9 |
| Monteverde Is., Nukuor, E pt., ✝ 2 l., lag. | 3 52 | 155 0 |
| Mortlock Is., ✝ 6 l., ✝, Lukunor I., EW 7m., lag. Port Chamisso, ⊞, ✝ ✝, ww₀, Entr. | 5 20 | 153 58 |
| — Etal Is., NS 4m., N pt. | 5 37 | 153 42 |
| — Ta, or Sotoang grp., S pt. | 5 17 | 153 48 |
| Namoluk Is., 100f., (*Tainome*), 3, ✝ 8m., *l* | 5 55 | 153 16 |
| Losap I. | 6 53 | 152 43 |
| D'Urville I., 3 islets on a rf., *l*, ✝, ꞵ | 6 59 | 152 34 |
| Truk Is. (*Hogolu*), ✝ 15 l., P, S islet ⊖ | 6 57 | 151 58 |
| — Tsis I., [½m.], rfs., ✝ ✝, ▼ N, ⚓ NW, N pt. ⊖ | 7 18·5 | 151 48·5 |
| Mourileu grp., ✝ 7 l., E isle | 8 42 | 152 26 |
| Namolipifan grp., ✝ 5 l., lag. ‖ S, Namune islet | 8 25 | 151 49 |
| Lutke I., or East Faiu, [½m.], rfs., ✝ ✝, ww₀ | 8 33 | 151 26 |
| Namonuito grp., EW 15 l., E islet, Pisaras | 8 34 | 150 32 |
| — N extr., or Magur islet | 8 59·7 | 150 14·5 |
| — W extr., or Ulul islet | 8 36 | 149 47 |
| Martyrs' Is., NS 7m., ✝, P, N isld., Ollap ○ | 7 37 | 149 31 |
| — S Id. Tamatam, (W Id. Fanadik) ○ | 7 32 | 149 30 |
| Enderby Is. 2, ✝, ✝, (a bk. 7, ✝ 2 l.), (NW one, Alet; SE one, Pozoat) | 7 20 | 149 17 |

| (138) Places | Lat. N | Lon. E |
|---|---|---|
| *Caroline Islands* | | |
| Suk I., or Pulusuk I., NS. 2m., *l*, ✝ ○ | 6°40′ | 149°21′ |
| Ianthe and Nile Shoals, [½m.], sf., P.D. ○ | 5 53 / 5 32 | 145 39 / 145 42 |
| Pikelot Coquille, [½m.], on a rf, ✝ ✝. P₀ | 8 9 | 147 42 |
| Faiu I., West rf. ✝ 5m., islet in middle, ✝ | 8 3 | 146 50 |
| Satawal (Tucker) I., [1m.], P | 7 22 | 147 6 |
| Swede Is., (Lamotrek), 6, ✝ 2 l., S & E islet | 7 27 | 146 31 |
| — Elato Is., NS 2 l., N pt. | 7 30 | 146 19 |
| Olimarao Is., ✝ 2m., N islet | 7 43 | 145 56 |
| Faraulep Is., 3, [2m.], lag., S pt. ⊖ | 8 35 | 144 36 |
| Ifalik Is. (Wilson), [2m.], lag., SW extr. | 7 14 | 144 30 |
| Ulie Is. (Thirteen Is.), EW 6m., E, or Raur I. (⊞ ≡ E, ‖ SE), N pt | 7 21·5 | 143 57·5 |
| Iuripik (Kama), 2 Is., ✝ 2½m., E pt. | 6 40 | 143 11 |
| Sorol, Philip Is., S.E. I. | 8 6 | 140 24 |
| Feys, or Tromelin I., [1m.], *l*, ✝, no lag., ⚓₀. ‖, 30f. | 9 46 | 140 35 |
| Uluthi Is. (Mackenzie), ✝ 7 l., lag. *l*, ✝, N extr., Mogmog I. | 10 6 | 139 46 |
| — S extr., Pugelug I. | 9 46 | 139 41 |
| Yap I., 1150f., NS 3 l., ✝, (rf. S-d.), Tomil B., lt. F, 25f. | 9 25 | 138 6 |
| Hunter's reef | 9 58 | 138 23 |
| Matelotas Is. (Ngoli), ✝ 9 l., *l*, ✝ ✝, ‖₀, S I. | 8 15 | 137 35 |
| — North I., 150f. | 8 35 | 137 40 |
| **Pelew Islands, &c.** | | |
| *Pelew Is.* | | |
| Palao or Pelew Is., ✝ 29 l., ✝, P, (rfs. NW-d.), Korror H^r ⊖ | 7 19 | 134 32 |
| — Kajangle I., [2m.], (rf. ✝ 4 l.) | 8 3 | 134 38 |
| — Baobeltaob, N extr., reef | 7 47 | 134 33 |
| — Angaur I., 4m., w, ‖₀, S pt. | 6 50 | 134 10 |
| *Islands N.E. of Gillolo ⊖* | | |
| Pulo Marière, Warren Hastings I., NS 2m., vis. 4 l., ✝ ○ | 4 19 | 132 28 |
| Pulo Anna, or Current I., [½m.], *l*, ✝ (rf. W. 1m.), vis. 10m | 4 38 | 132 2 |
| Sonserol Is., or St. Andrew, 2, small, *l*, ✝, ‖₀, vis. 12m. | 5 20 | 132 16 |
| Nevil I., or Lord North, ✝ 1½m., *l*, ✝, (rf. E) | 3 2 | 131 5 |
| Helen, or Carteret shl., 3 ✝ 5 l., rks. 4f., N pt. islet, 2 ✝ | 3 0 | 131 52 |
| St. David's, or Freewill Is., 4, ✝ 5 l., *l*, ✝ ✝, P mid., vis. 18m. | 0 57 | 134 21 |

## MARITIME POSITIONS

| | (139) Places | Lat. N | Lon. |
|---|---|---|---|
| | **ARCTIC ARCHIPELAGO.** | | |
| | | | East |
| *Franz Joseph Land* | FRANZ JOSEPH LAND, Wilczek I., C. Hansa ......... | 80° 23′ | 59° 32′ |
| | C. Flora. Jackson wintered (1895–6) .................. | 79 55 | 49 40 |
| | C. Mary Harmsworth ..... ... | 80 28 | 42 0 |
| | Frederick Jackson I. Nansen wintered (1895–6) ...... | 81 13 | 55 45 |
| | C. Germania, 1200f ............ | 81 58 | 57 45 |
| | Hvidtland ..................... ... | 81 38 | 63 0 |
| | Nansen's farthest (1895) ...... | 86 5 | 96 30 |
| | *Fram's* farthest (1895) ......... | 85 57 | 66 0 |
| | Capt. Cagni's farthest (1900) | 86 34 | 64 30 |
| | C. Grant.............................. | 80 0 | 47 40 |
| | Gillis Land (1707) .........○ | 81 30 | 36 0 |
| | King Charles Is., East extr.○ | 79 0 | 32 40 |
| | — Swedish Foreland, N extr. | 78 50 | 26 40 |
| | **Spitzbergen.** | | |
| | Smeerenberg, ⚓′, 13 sd......... | 79 43 | 11 15 |
| | Hackluyt's Headland............ | 79 47 | 11 5 |
| | Cloven Cliff .................⊕ | 79 45 | 11 45 |
| | Moffen I., [2m.], *l*, N pt. ...... | 80 1 | 14 42 |
| | Vertegen Hook, *T* .........⊕ | 80 4 | 16 25 |
| | Treurenberg B., Hecla Cove, ⚓′ | 79 55 3 | 16 57 |
| | Hinlopen St. Hyperite I. ...⊕ | 79 42 | 19 0 |
| | North Cape.......................... | 80 32 | 20 14 |
| | Walden I., ♯ 1⅓m., b., NW pt. | 80 36 | 20 0 |
| | Little Table I., [⅓m.], 750f.... | 80 48 | 20 22 |
| | Charles XII. I. .................... | 80 43 | 25 12 |
| | Parry's farthest (July 1827)... | 82 40 | 19 0 |
| *Spitzbergen* | C. Leigh Smith ..................... | 80 11 | 28 7 |
| | C. Molen.............................. | 79 15 | 25 0 |
| | Ryk Yse Is., E. pt............○ | 77 50 | 26 0 |
| | Thousand Is., High rk. ...... | 77 2 | 21 20 |
| | Stor Fiord, Fox Ness.........⊕ | 78 3 | 19 2 |
| | Hope I., ♯ 9m., W pt.......... | 76 37 | 25 30 |
| | S. Cape, or Look-out............ | 76 27 | 16 50 |
| | Hornsunds Pk., 4560f ........ | 76 51 | 16 18 |
| | Bel Sd., Separation Pt. ......⊕ | 77 38 | 14 50 |
| | Ice Sound, pt. S side, entr...○ | 78 7 | 14 7 |
| | Charles I., S., or Saddle Pt.○ | 78 13 | 12 30 |
| | Fair Foreland..................○ | 78 58 | 10 35 |
| | Cape Mitra.......................... | 79 5 | 11 29 |
| | Bear, or Chérie I., 1200f., South Hr. .............○ | 74 22 | 29 18 |
| | | | West |
| | JAN MAYEN I., C. Northeast, or Young's Foreland...... | 71 8 | 7 50 |
| | — Mt. Beerenberg, 5836f. ... | 71 4 | 8 10 |
| | — C. South ........................ | 70 49 | 9 8 |
| | **Iceland.** | | |
| *Iceland* | Portland I............................ | 63 23 | 19 6 |
| | Hvalsbak rk. ....................... | 64 40 | 13 12 |
| | E. extreme, or Pt. Gepirhuk... | 65 5 | 13 26 |
| | C. Langanaes ...................... | 66 23 | 14 30 |
| | C. Revsnig .......................... | 66 33 | 16 9 |
| | Grimsey I., ♯ 4m., N pt....... | 66 34 | 18 1 |
| | Mevenklint........................... | 67 9 | 18 34 |
| | North C............................... | 66 28 | 22 26 |

| | (140) Places | Lat. N | Lon. W |
|---|---|---|---|
| | W. pt., or Staalburghuk ...... | 65 30′ | 24°30′ |
| | Sneefeldsyökel, 4696f. ......... | 64 48 | 23 43 |
| | Reikiavig, Holmenshaven...... | 64 8·6 | 21 53 |
| | C. Reikianes, lt. F 180f......... | 63 49 | 22 40 |
| | Mt. Heckla, 5364f. ............ | 63 58 | 19 38 |
| | Oster Yökel, 5964f................ | 63 36 | 19 33 |
| | Westmanoerne Is., S pt......... | 63 24 | 20 15 |
| | **Greenland.** | | |
| *Greenland, East Coast* | C. Bismarck ........................ | 76 47 | 18 30 |
| | Shannon I., ♯ 8 l., S pt., or C. Philip Broke......... | 74 55 | 17 33 |
| | Pendulum Is., 2, ♯ 5 l., 3000f | 74 38 | 18 30 |
| | C. Borlase Warren............... | 74 14 | 19 23 |
| | C. Hold with Hope of Hudson, 3000f. ................. | 73 26 | 20 29 |
| | Bontekoe, EW 3 l., SE pt. ... | 73 29 | 20 40 |
| | C. Parry .........................○ | 72 22 | 22 2 |
| | Traill I., C. Young .........○ | 72 16 | 21 52 |
| | Canning I., C. Wardlaw ...○ | 71 47 | 22 0 |
| | Liverpool I., NS 23 l., S pt. ... | 70 26 | 21 55 |
| | — Church Mt., 2967f. ......... | 71 4 | 21 37 |
| | Rathbone I., E pt. ............... | 70 40 | 21 15 |
| | C. Brewster, ⊥ ..................... | 70 11 | 22 0 |
| | C. Tupinier......................○ | 68 42 | 25 5 |
| | King Christian IX. Land, Leifs I., 2300f. ............ | 65 55 | 35 30 |
| | Hoidsadlen I. ....................... | 65 3 | 39 5 |
| | C. Moltke ........................... | 63 36 | 40 22 |
| | C. Adelaer ........................... | 61 49 | 42 0 |
| | C. Farewell, vis. 30 l. ......... | 59 49 | 43 54 |
| *Davis' Strait* | C. Desolation ........................ | 60 44 | 48 6 |
| | Frederickshaab Church......... | 61 59 | 49 44 |
| | Lichtenfels ........................... | 63 3 | 50 47 |
| | Godthaab ............................. | 64 10 | 51 46 |
| | Holsteinburg ......................... | 66 56 | 53 42 |
| | Whalefish Is., Kronprindsens I., ⚓, fl. st............ | 68 58·9 | 53 14·0 |
| | Disco I., ♯ Issungoak Pt....... | 69 39 | 51 55 |
| | — North pt., Iglorpait ......... | 70 19 | 54 36 |
| | — Godhavn .......................... | 69 13·9 | 53 42 |
| | Waygat, or Hare I., [5m.] ... | 70 27 | 54 45 |
| | Black Head........................... | 71 38 | 55 50 |
| | Sanderson's Hope ............... | 72 42 | 56 15 |
| | Upernivik ........................... | 72 46·9 | 56 2·7 |
| | C. Shackleton, 1400f............. | 73 44 | 56 40 |
| | Devil's Thumb, 1300f. ......... | 74 20 | 56 47 |
| *Baffin's Bay* | Red Head ............................ | 74 58 | 57 15 |
| | Sabine's Is., SW one .........○ | 75 25 | 58 50 |
| | C. York, Immagen.................. | 75 55 | 66 33 |
| | C. Dudley Digges, ⊥, 800f. ... | 76 8 | 68 43 |
| | North Star B., (Saunders wintered 1849) ............ | 76 32 | 68 45 |
| | Cary's Is., Southern ............ | 76 40 | 72 41 |
| | C. Parry ............................. | 77 26 | 71 8 |
| | Hackluyt I. (*Agpagsuak*), W pt. | 77 19 | 72 30 |
| *Smith's Sound* | C. Alexander ........................ | 78 11 | 73 21 |
| | Port Foulke ........................ | 78 18 | 73 0 |
| | Rensselaer B. (Kane wintered 1853–4–5) .................. | 78 37 | 70 53 |
| | M'Gary I. ........................... | 79 16 | 65 0 |
| | C. Calhoun........................... | 80 6 | 67 23 |
| | C. Constitution .................... | 80 33 | 66 30 |
| | Joe Island ........................... | 81 22 | 63 31 |

## MARITIME POSITIONS

| | (141) Places | Lat. N | Lon. W |
|---|---|---|---|
| *Arctic Sea* | Thank-God Hr., Hall's Rest. | 81°37′ | 61°37′ |
| | C. Bryant | 82 23 | 54 46 |
| | Mt. Hooker | 82 30 | 50 41 |
| | C. Britannia, 2050f. | 82 44 | 49 00 |
| | C. Beaumont | 82 48 | 50 30 |
| | Markham I., C. Neumayer | 83 1 | 48 0 |
| | Lockwood I., Lockwood's farthest (1882) | 83 25 | 40 45 |
| | C. Robert Lincoln ○ | 83 32 | 39 35 |
| | **Grant and Grinnell Land.** | | |
| | C. Alfred Ernest | 82 14 | 85 55 |
| | C. Columbia | 83 7 | 70 23 |
| | C. Joseph Henry | 82 49 | 63 36 |
| | Markham's farthest (1876) | 83 20·5 | 63 7 |
| | C. Sheridan (Sir G. Nares wintered 1875–6) | 82 26 | 61 21 |
| | C. Union | 82 15 | 61 8 |
| *Smith's Sound* | Discovery Harbour | 81 43 | 64 46 |
| | C. Baird | 81 32 | 64 32 |
| | C. M'Clintock | 79 58 | 70 50 |
| | C. Louis Napoleon | 79 38 | 72 19 |
| | C. Sabine | 78 43 | 74 15 |
| | C. Isabella | 78 16 | 75 33 |
| | Clarence Head | 76 41 | 77 48 |
| | Cobourg Is., East L., Princess Charlotte Monument | 75 39 | 77 45 |
| *Lancaster Sound* | **North Devon.** | | |
| | C. Horsburgh | 74 55 | 79 3 |
| | C. Osborn | 74 24 | 81 42 |
| | C. Warrender | 74 28 | 81 51 |
| | C. Bullen | 74 22 | 85 0 |
| | C. Hurd, ⊥ | 74 32 | 90 3 |
| | C. Riley | 74 40 | 91 48 |
| | Beechey I. (Franklin wintered 1845–6) | 74 43 | 91 45 |
| | Baring B. (Belcher wintered 1853-4) | 75 40 | 91 52 |
| | N. Cornwall, Mt. Greenwich | 77 36 | 94 41 |
| *Barrow Strait* | **Parry Islands.** | | |
| | Cornwallis I., C. Hotham | 74 38 | 93 34 |
| | — Assistance B. | 74 37 | 94 16 |
| | Griffith I., ⚓ 8 l., S pt. | 74 28 | 95 20 |
| | Lowther I., ⚓ 9 l., S pt. | 74 26 | 97 40 |
| | Bathurst I., C. Cockburn, Δ | 75 3 | 100 23 |
| | — Lyall Pt. | 76 39 | 104 58 |
| | — Sherard Osborn I., N pt. | 76 47 | 100 0 |
| | Byam Martin I., C. Gillman | 75 0 | 104 8 |
| | Melville I., ⚓ 44 l., Winter Harb. (Sir E. Parry wintered 1819-20) ⊕ | 74 47·2 | 110 48·2 |
| | — W extreme, C. Russell | 75 14 | 117 40 |
| | — N extreme, Markham I. | 77 00 | 109 43 |
| | Eglington I., C. Nares | 75 34 | 119 30 |
| | Prince Patrick I., Land's End | 76 16 | 124 6 |
| | Polynia Is., Ireland's Eye | 77 49 | 115 30 |

| | (142) Places | Lat. N | Lon. W |
|---|---|---|---|
| *Prince of Wales Strait* | **Banks Land.** | | |
| | C. M'Clure | 74°33′ | 120°50′ |
| | — Bay of Mercy (Investigator abandoned 1853) | 74 14 | 118 15 |
| | Prince Alfred, C. | 74 7 | 124 0 |
| | — C. Kellett | 71 55 | 125 28 |
| | — Nelson Head | 71 2 | 122 24 |
| | — Princess Royal Is. (M'Clure wintered 1850–1) | 72 45 | 117 44 |
| | **Prince Albert Land.** | | |
| | Prince of Wales Str., Peel Pt. | 73 20 | 113 54 |
| | Ramsay I. (Collinson wintered 1851–2) | 71 36 | 119 5 |
| | C. Wollaston | 71 3 | 118 9 |
| | C. Baring | 70 0 | 117 0 |
| | C. Back (Rae's farthest 1851) | 70 9 | 116 0 |
| *Dease Strait* | **Wollaston and Victoria Land.** | | |
| | C. Lady Franklin | 68 33 | 113 10 |
| | Cambridge B. (Collinson wintered 1852–3) | 69 5 | 105 10 |
| | Point Back | 68 55 | 103 16 |
| | Lind I., South pt. | 68 37 | 102 5 |
| | Gateshead I. | 70 25 | 100 38 |
| *Victoria Strait* | **King William Land.** | | |
| | Victoria Strait (Erebus and Terror abandoned 1848) | 69 49 | 98 49 |
| | C. Felix | 69 55 | 97 55 |
| | Pt. Franklin | 69 28 | 99 10 |
| | C. Crozier | 69 4 | 100 4 |
| | C. Herschel | 68 42 | 98 2 |
| | Mount Matheson | 68 45 | 95 7 |
| *McClintock Channel* | **Prince of Wales Land.** | | |
| | Cape Swinburne | 71 12 | 99 00 |
| | Pt. Allen Young | 72 10 | 101 55 |
| | Minto Head | 73 4 | 102 40 |
| | Parker I. | 74 14 | 100 35 |
| | Palmerston Pt., 600f. | 74 7 | 97 44 |
| | Cape McClure | 72 50 | 96 36 |
| *Prince Regent Inlet* | **North Somerset.** | | |
| | C. Rennel | 74 7 | 93 14 |
| | Leopold Is., N one, ⊥, E pt. | 74 3 | 89 53 |
| | Port Leopold (James Ross wintered 1848–9) | 73 50 | 90 12 |
| | Batty Bay | 73 13 | 91 8 |
| | Fury Pt. (H.M.S. Fury abandoned Aug. 1825; Sir J. Ross wintered 1832–3) | 72 40·5 | 91 53 |
| | C. Garry | 72 23 | 93 17 |
| | Bellot Strait, Pt. Kennedy (M'Clintock wintd. 1858–9) | 72 2 | 94 14 |
| | **Cockburn Island.** | | |
| | C. Kater | 71 54 | 89 59 |
| | Sherer's Mt. | 73 2 | 89 20 |

## MARITIME POSITIONS

| | (143) Places | Lat. N | Lon. W |
|---|---|---|---|
| *Lancaster Sound* | Port Bowen (Parry wintered 1824–5), Stony I. ⊕ | 73°13′6 | 88°54′7 |
| | C. York ⊖ | 73 50 | 86 40 |
| | C. Crawford ⊖ | 73 53 | 83 50 |
| | C. Charles York | 73 50 | 82 0 |
| | C. Hay | 73 52 | 79 50 |
| | Possession Mt, 2200f. | 73 22 | 77 35 |
| | C. Walter Bathurst | 73 28 | 76 36 |
| | C. Graham Moore ○ | 72 56 | 76 10 |
| | C. Bowen ○ | 72 21 | 74 45 |
| | C. Adair ○ | 71 32 | 71 29 |
| | Agnes' Monument, ⊥, 40f. ○ | 70 33 | 68 15 |
| | Cape Raper | 69 44 | 67 30 |
| | C. Kater ○ | 69 12 | 66 53 |
| | **Cumberland Island.** | | |
| *Davis' Strait* | C. Searle ○ | 67 13 | 62 22 |
| | Cape Dier of Davis ○ | 66 48 | 61 15 |
| | Mt. Raleigh, *h* ○ | 66 34 | 62 18 |
| | C. Walsingham ○ | 66 4 | 61 15 |
| | C. Mercy of Davis | 64 51 | 63 43 |
| | Cumberland Sd., Nijaduk Harbour | 65 7 | 64 25 |
| | — Kingaite Fiord, Union Hr. | 66 23 | 66 25 |
| | Kingawa Fiord ○ | 67 16 | 68 0 |
| | — Harrison Pt. | 64 57 | 66 5 |
| *Hudson Strait* | Hall I., Mt. Warwick ○ | 62 33 | 64 0 |
| | Frobisher B., Jordan R. | 63 45 | 68 55 |
| | Resolution I., ⚓ 13 l., E pt., or C. Warwick ○ | 61 40 | 64 30 |
| | — S pt., or Hatton's Headland, or C. Best | 61 21 | 65 0 |
| | Lower Savage I. | 61 35 | 66 7 |
| | Saddleback I. ○ | 62 11 | 67 43 |
| | Upper Savage I., ⚓ 3 l., E pt. ○ | 62 33 | 70 0 |
| | North Bluff | 62 32 | 70 25 |
| | **Fox Land.** | | |
| *Fox Channel* | King Charles Cape ○ | 64 22 | 77 50 |
| | Queen's C. ○ | 64 45 | 78 12 |
| | C. Weston ○ | 65 35 | 78 12 |
| | C. Dorchester ○ | 66 21 | 78 0 |
| | Pt. Peregrine (Fox's farthest, 1631) | 66 40 | 76 50 |
| | **Southampton Island.** | | |
| *Southampton I.* | Southampton Is., ⚓ 83 l., N pt., or C. Frigid ○ | 65 59 | 85 30 |
| | — E extr., or Seahorse Pt. ○ | 63 35 | 80 7 |
| | — C. Kendall | 63 42 | 87 15. |
| | Tom I., [4 l.], S pt. ○ | 63 10 | 87 0 |
| | Coats I., C. Pembroke ○ | 63 0 | 81 20 |
| | — S extr., or C. Southampton ○ | 62 10 | 83 45 |
| | **NORTH AMERICA.** | | |
| | Pt. Barrow, (Noowook) | 71 23 | 156 22 |
| | Port Moore (Maguire wintered 1852–4), MAGNETIC OBSERVATORY ⊕ | 71 21·4 | 156 16 |
| | Tangent Point | 71 10 | 154 46 |
| | C. Halket | 70 49 | 152 15 |
| | Pt. Beechey | 70 24 | 149 37 |

| | (144) Places | Lat. N | Lon. W |
|---|---|---|---|
| *Arctic Sea* | Return reef ○ | 70°25′ | 148°30′ |
| | Flaxman I., 50f., N side | 70 11 | 145 50 |
| | Camden B. (Collinson wintered 1853–4) | 70 8 | 145 29 |
| | Pt. Manning | 70 7 | 143 40 |
| | Herschel I., S pt. | 69 34 | 138 54 |
| | Mt. Cupola | 68 45 | 137 53 |
| | Mackenzie R., Shoalwater B. | 68 49 | 136 27 |
| | Pelly Is. [1 l.] | 69 32 | 135 33 |
| | Pullen I. | 69 45 | 134 20 |
| | Warren Pt. | 69 47 | 131 35 |
| | C. Dalhousie | 70 16 | 129 10 |
| | C. Bathurst | 70 36 | 127 30 |
| | C. Parry, NE pt. | 70 6 | 123 35 |
| | Keats Pt. | 60 49 | 122 0 |
| | Sir S. Clerk's I., SE pt. | 69 33 | 118 0 |
| | C. Bexley | 69 0 | 115 52 |
| *Coronation Gulf* | C. Krusenstern | 68 28 | 113 54 |
| | Coppermine R., mouth, E side | 67 48·5 | 115 31 |
| | C. Flinders | 68 14 | 109 14 |
| | Back's Western River | 66 28 | 107 49 |
| | Turnagain Pt. | 68 39 | 108 35 |
| | C. Alexander | 68 55 | 106 19 |
| | Melbourne I., EW 6 l., E pt. | 68 29 | 104 30 |
| | White Bear Pt. | 68 9 | 103 30 |
| | O'Reilly I., [4 l.], NW pt. | 68 12 | 99 24 |
| | Cape Gedde | 68 31 | 98 5 |
| | Pt. Ogle | 68 17 | 96 15 |
| | Cockburn B., mouth of Great Fish or Back River | 67 13 | 95 24 |
| *James Ross Strait* | Castor and Pollux R. (Dease and Simpson 1839, Rae 1854) | 68 32 | 94 0 |
| | Stanley Island | 68 44 | 94 50 |
| | Hull Bay | 69 20 | 93 42 |
| | Boothia Isthmus, Josephine B. | 69 39 | 94 40 |
| | MAGNETIC POLE (1831) | 70 5 | 96 47 |
| | C. Nikolas | 70 25 | 97 0 |
| | C. Hobson | 71 26 | 95 55 |
| | Murchison Promontory, Northern pt. of America. | 72 0 | 94 37 |
| *Boothia Gulf* | Elizabeth Harbour | 70 38 | 91 46 |
| | Victoria Harb. (Ross abandoned the Victoria 1831–2) | 70 9·3 | 91 25 |
| | Felix Harb., M'Diarmid I. (Ross wintered 1829–30) | 69 59·7 | 91 50 |
| | Pelly Bay, Parker Peak | 68 25 | 89 36 |
| | C. Chapman | 69 15 | 89 0 |
| | Rae Isthmus, C. Simpson | 67 20 | 87 2 |
| | Cape Richardson | 68 50 | 85 15 |
| *Melville Peninsula* | C. Englefield, Fury and Hecla Strait | 69 51 | 85 30 |
| | C. Halowell, (N head of do.) | 69 57·5 | 85 26 |
| | Igloolik I., EW 9m., (Parry wintered 1822–3), E pt. ⊕ | 69 21 | 81 31 |
| | Arlagnuk | 69 12 | 81 30 |
| | Ooglit Is. | 68 58 | 81 4 |
| | Ooglit I., [2m.], *l* | 68 24 | 81 38 |
| | C. Jermain | 67 47 | 82 0 |
| | C. Penrhyn | 67 25 | 81 25 |
| | Winter I., ⚓ 10m., *l*, S pt., or C. Fisher (Parry wintered 1821–2) ⊕ | 66 11·4 | 83 10·0 |

## MARITIME POSITIONS

| | (145) Places | Lat. N | Lon. W |
|---|---|---|---|
| *Rowe's Welcome* | Baffin I., * 7m., SE pt. ...... | 65°40′ | 83°29′ |
| | Repulse B., head Fort Hope... | 66 33 | 86 56 |
| | Wager R., S cape of entr. .... | 65 13 | 87 28 |
| | **HUDSON'S BAY.** | | |
| | Chesterfield Inlet, Wagg I... O | 63 21 | 91 14 |
| | — Head of inlet ............ | 64 0 | 95 50 |
| | Marble I., E part ............ O | 62 41 | 90 30 |
| | Whale Cove .................. O | 62 10 | 92 50 |
| | C. Esquimaux................. O | 61 8 | 94 0 |
| | Churchill. Battery Beacon... O | 58 46 | 94 10 |
| | C. Churchill .................. O | 58 52 | 93 14 |
| | York, factory, $r_o$, $\bar{r}$ ............ | 57 2 | 92 26 |
| | C. Tatnam ..................... O | 57 22 | 91 10 |
| | Severn Fort..................... O | 55 58 | 89 12 |
| | C. Lookout ...................... O | 55 23 | 85 13 |
| *James' Bay* | C. Henrietta Maria................ | 55 9 | 82 45 |
| | Albany Fort .................. O | 52 12 | 81 50 |
| | Moose Fort..................... | 51 13 | 80 40 |
| | Rupert's House .............. O | 51 23 | 78 29 |
| | East Main Fort .............. O | 52 10 | 78 32 |
| | North Bear I. ................. O | 54 27 | 81 6 |
| | Agoomska I., * 17 l., S pt. O | 52 49 | 81 0 |
| | South Cub ..................... O | 53 57 | 79 42 |
| | Long I., * 6 l., S pt......... O | 55 0 | 78 48 |
| | Richmond B., entr............ O | 56 14 | 77 15 |
| | South Belchers, centre ...... O | 55 55 | 89 48 |
| | King George's Is., centre ... O | 57 30 | 80 10 |
| | Sleepers, N part.............. O | 58 18 | 80 40 |
| | Brothers, East Bro. ......... O | 58 37 | 80 0 |
| | Ottawa Is., NE I. ............ O | 59 55 | 79 38 |
| | C. Dufferin ..................... O | 58 46 | 79 11 |
| | Smith I. ........................ O | 60 50 | 79 7 |
| *Hudson's Strait* | Mansfield I., * 19 l., South pt.................. O | 61 33 | 80 20 |
| | — North pt..................... O | 62 37 | 79 52 |
| | C. Wostenholme............... O | 62 37 | 77 26 |
| | Digges Is., W extreme ...... O | 62 34 | 78 5 |
| | Nottingham I., * 14 l., S pt., (8 shl. 7m.) ...... O | 63 6 | 77 50 |
| | Salisbury I., * 9 l., SE pt....... | 63 22 | 76 30 |
| | Mills I., N pt.................. O | 64 4 | 77 50 |
| | Charles I., C. Moses Oates O | 62 47 | 74 0 |
| | C. Weggs, Island ............ O | 62 31 | 74 0 |
| | Stupart Bay .................... | 61 33 | 71 33 |
| | C. Hope's Advance............... | 61 17 | 70 2 |
| | Green I. ........................ O | 60 8 | 67 52 |
| | Akpatok I., E end .............. | 60 10 | 66 36 |
| | Koksoak R., The Wort, 165f... | 58 29 | 68 7 |
| | Fort Chimo......................... | 58 8 | 68 18 |
| | **LABRADOR.** | | |
| *Labrador* | C. Chidleigh, 1500f. ............ | 60 33 | 64 15 |
| | Button Is., NS 3 l., vis. 7 l., NE pt........................ | 60 51 | 64 39 |
| | Eclipse Harb., Mt Bache, 2150f. | 59 50 | 64 2 |
| | Nachvak B., H. B. Co. Post ... | 59 3 | 63 52 |
| | Hebron Mission Station......... | 58 16 | 62 40 |
| | Mt. Thoresby, 2773f., Port Manvers, w, b............ O | 56 53 | 61 19 |
| | Nain ................................ | 56 32·9 | 61 40·7 |
| | Hopedale Harb. Obs......... ⊕ | 55 27 1 | 60 12 5 |

| | (146) Places | Lat. N | Lon. W |
|---|---|---|---|
| *Labrador* | Aillik Harb., C. Mokkovik ... | 55°13′5 | 59°18′2 |
| | Webeck Harb., Harbour rocks | 54 54·5 | 58 2·7 |
| | White Bear Is., Middle I., 190f. | 54 28 | 56 55 |
| | Hamilton Inlet, Rigoulette ... | 54 10 8 | 58 25·2 |
| | — Goose B., Rabbit I. ......... | 53 23 | 60 9 |
| | Cape Porcupine, 343f. ......... | 53 56 | 57 8 |
| | Outer Gannet I., 104f. ......... | 54 0·3 | 56 31·5 |
| | Cartwright Hb., Caribou Castle | 53 42·6 | 56 59 7 |
| | Gready Harb ...................... | 53 48 | 56 25·7 |
| | Indian Tickle, Indian Id., 360f. | 53 34·2 | 55 59·5 |
| | Roundhill I., 174f................ | 53 26 | 55 36 |
| | Occasional Harb. Obs. ......... | 52 40 | 55 44·2 |
| | C. St. Francis, 115f. ............ | 52 33 5 | 55 41·5 |
| | C. St. Lewis, St. Lewis rk. ... | 52 21·7 | 55 37 2 |
| | Battle Is., Double I., 130f....... | 52 15 | 55 33 |
| | Table Head........................ | 52 6 | 55 41 |
| | Belle Isle, * 9m., lt. F 470f. | 51 53 | 55 22·2 |
| *Strait of Belle Isle* | Chateau B., Castle I., S pt. ... | 51 58 | 55 50 |
| | Amour Pt., lt. F 155f. ......... | 51 27 5 | 56 51 |
| | Greenly I., lt. Rev. 100f. ...... | 51 22 7 | 57 10·5 |
| | Bradore hills, sum. 1264f. ...... | 51 34 | 57 12 |
| | Old Fort I., [1⅓m.] ........... | 51 22 | 57 47 |
| | Shag rks. .......................... | 51 10 | 58 18 |
| | Eagle Harb., E side, entr. ...... | 51 0 | 58 41 |
| | Grt. Mecatina I., * 3⅓m., *, SE pt. .................. | 50 44 | 58 53 |
| | Murr Is. and rks., [1 l.], E extr. ...................... | 50 42 | 58 50 |
| | Little Mecatina I., * 6m., S pt.......................... | 50 31 | 59 21 |
| | St Mary rks., [2m.], S pt. ... | 50 13 | 59 45 |
| | South Maker's ledge ............ | 50 9 | 59 57 |
| | C. Whittle, (rks. + 3m.) ...... | 50 11 | 60 8 |
| | **NEWFOUNDLAND.** | | |
| *Newfoundland, E. Coast* | Quirpon I., N pt., or C. Bauld, T, lt. Alt. 141f. ... | 51 38·8 | 55 25 |
| | Bell I., (S end) .................. | 50 42·2 | 55 35·5 |
| | C. St. John, Gull I., lt. Occ. 525f. ....................... | 50 0 | 55 21 |
| | Toulinguet Is., lt. Rev. 335f.... | 49 41·3 | 54 47·5 |
| | Seldom-come-by Harbour, Cann I., lt. F 85f. ......... | 49 35 | 54 10·7 |
| | Offer Wadham, lt. F 100f....... | 49 35·7 | 53 45·0 |
| | Funk I., 46f. ..................... | 49 45·5 | 53 10·7 |
| | C. Freels, Stinking I., lt. Occ. | 49 10·5 | 53 21·5 |
| | Greenspond I., 85f. ........... | 49 4·3 | 53 32 5 |
| | C. Bonavista, lt. Rev. 150f. ... | 48 42·0 | 53 4·5 |
| | Catalina Harb., Green I., lt. F 92f. ....................... | 48 30·2 | 53 2·2 |
| | Bonaventure Head ............... | 48 16·9 | 53 23·6 |
| | New Perlican, Bloody Pt ...... | 47 55·1 | 53 21·5 |
| | Baccalieu I., lt. Fl. 380f. ...... | 48 9 | 52 47·5 |
| | Harbour Grace, (lt. F 40f. on beach) ........................ | 47 41·4 | 53 12·5 |
| | C. St. Francis, lt. F 123f. ...... | 47 48·5 | 52 47·0 |
| | St. John's (Chainrock Battery) .................. | 47 34·0 | 52 40·7 |
| | C. Race, lt. Rev. 180f. ......... | 46 39·4 | 53 4 3 |
| | C. Pine, lt. F 314f. ............ | 46 37·1 | 53 31·7 |
| | Trepassy Harb., (Shingle neck) | 46 43·3 | 53 22·2 |
| | C. St. Mary, lt. Rev. 300f. ... | 46 49·5 | 54 11·5 |
| | Placentia Harb., lt. F 180f...... | 47 14 | 54 1 |
| | Burin Harb., lt. Rev. 430f...... | 47 0·4 | 55 8 7 |
| | Laun, Gt. Laun R. C. Church | 46 56·5 | 55 32·0 |

## MARITIME POSITIONS

| | (147) Places | Lat. N | Lon. W |
|---|---|---|---|
| *S. Coast* | St. Pierre I., Galantry lt. Fl. 210f. | 46°46'0 | 56°10'0 |
| | Great Miquelon I., C. Blanc, lt. Occ. 103f. | 47 6 | 56 24 |
| | Pass I., lts. F 281f. and 267f. | 47 29 | 56 12 |
| | Burgeo I., Boar I., lt. F 207f. | 47 36·5 | 57 35 |
| | La Poile Bay, Ireland I., lt. Fl. 67f. | 47 38 | 58 22 |
| | C. Ray, lt. Rev. 130f. | 47 37·0 | 59 18·2 |
| | Cod Roy I., S side of Boat Harb. | 47 52·5 | 59 23·7 |
| *W. Coast* | C. St. George, (Red I., SE pt.) | 48 33·8 | 59 13·2 |
| | C. St. Gregory | 49 23 | 58 14·5 |
| | Cow Head, (NW extr.) | 49 55·3 | 57 50 |
| | Port Saunders, (NE pt. of entry) | 50 38·5 | 57 18 |
| | Rich Pt., lt. Fl. 130f. | 50 41·6 | 57 24·2 |
| | Ferrolle Pt., (Cove Pt. NE extr.) | 51 2·2 | 57 2·7 |
| | Flower Cove, (Capstan Pt.) | 51 18·2 | 56 44·5 |
| | Green I., (150 fms. from NE end) | 51 24·2 | 56 33·7 |
| | C. Norman, lt. Rev. 138f. | 51 38·0 | 55 54·2 |
| | **GULF OF ST. LAWRENCE.** | | |
| | Natashquan Pt., S edge, (R. mo. ⚓ 4m.) | 50 6 | 61 44 |
| | Mingan Is., EW 15 l., Bowen rks., E extr. | 50 14 | 63 1 |
| *River St. Lawrence* ⊕ | Collins' shl., ⚓ 2m., ?, S pt. | 50 10 | 63 5 |
| | Clearwater Pt., SW extr. | 50 12·6 | 63 27 |
| | Perroquets, lt. Rev. 87f. | 50 14 | 64 11 |
| | Riv. St. John, entr. E pt. | 50 17 | 64 20 |
| | Seven Is., lt. F 200f. | 50 6 | 66 23 |
| | Grt. Cawee I., [¾m.], 250f. | 49 50·7 | 67 1 |
| | Egg I., lt. Rev. 70f. | 49 38 | 67 10 |
| | Pt. Monts, lt. F 100f. | 49 19·7 | 67 22 |
| | Quebec ⊞, NE bastion | 46 49·1 | 71 13·7 |
| | Quebec Observatory | 46 48·5 | 71 13·2 |
| | Wolfe & Montcalm's Monument | 46 48·6 | 71 13·5 |
| | Green I., lt. F 60f. | 48 3·4 | 69 25 |
| | C. Chatte, lt. Rev. 120f. | 49 6·0 | 66 46 |
| | St. Anne's Mounts, NE one, 3973f. | 48 52 | 66 49 |
| | C. Magdalen, lt. Alt. 147f. | 49 15·6 | 65 19 |
| | C. Gaspé, lt. F 350f. | 48 45·2 | 64 9 |
| | Douglas town, ⊞, w | 48 46 | 64 23 |
| *Anticosti* ⊕ | Anticosti I., ⚓ 41 l., E pt., or Heath Pt., lt. F 110f. | 49 5·4 | 61 42 |
| | Bagot Bluff, lt. Fl. 75f. | 49 4 | 62 15 |
| | Shallop Creek, ⊞, entr. | 49 9 | 62 35 |
| | South-west pt., l, lt. R 100f. | 49 23·8 | 63 36 |
| | Ellis Bay, ⊞, W entr., or C. Henry | 49 47·8 | 64 23·5 |
| | West point, lt. F 112f. | 49 52 | 64 32 |
| | Bonaventure I., [1½m.], ⊥, 250f., ‖ E | 48 29 | 64 10 |
| | Leander shl., [½m.], s | 48 25 | 64 18 |
| | Macquereau Pt. | 48 12 | 64 48 |
| | Chaleur B., Carlisle | 48 1 | 65 16 |
| | — Dalhousie I. lt. F 30f. | 48 4·4 | 66 22·2 |

| | (148) Places | Lat. N | Lon. W |
|---|---|---|---|
| | Miscow I., ⚓ 8m., NE pt., Pt. Birch, lt. F 79f. | 48° 1' | 64° 29' |
| | Miramichi B., Portage I., ⚓ 4m., S pt., lt. F 45f. | 47 10 | 65 3 |
| | Pt. Escumenac, lt. F 70f. | 47 5 | 64 48 |
| | Richibucto Harb., ⊞, mo. | 46 42 | 64 51 |
| | Fort Monckton | 46 3 | 64 4 |
| | Prince Edward's I., ⚓ 33 l., N Cape, lt. R 80f. | 47 4 | 63 59 |
| | — Richmond B., ⊞, Royalty Pt. | 46 34 | 63 43 |
| | — East pt., lt. R 100f. | 46 27 | 61 58 |
| | — Charlotte town, St. Peter I., lt. F 70f. | 46 7 | 63 10 |
| | Magdalen Is., ⚓ 19 l. | | |
| *Magdalen Is.* ⊕ | — Bird Is., 2, [7c.], E one 140f. | 47 51 | 61 9·7 |
| | — Bryon, or Cross I., ⚓ 4m., w, E pt. | 47 48 | 61 25·2 |
| | — East I., E extr. | 47 37·7 | 61 24·5 |
| | — Doyle rf., [3c.], s, δ | 47 35 | 61 15 |
| | — Entry I., [1½m.], 580f., ŧ | 47 17 | 61 42 |
| | — Amherst I., 550f., w, б, S pt., lt. Alt. 107f. | 47 13 | 61 57 |
| | — Deadman I., [3c.], T W, rf. E. | 47 16 | 62 14 |
| | St. Paul I., ⚓ 3m., 450f., w SW, lt. at N pt. F 140f. | 47 14·0 | 60 8 |
| | C. Breton I., ⚓ 33 l., C. North, lt. R 74f. | 47 2 | 60 23 |
| | St. Ann's Harb., ⊞, w. Beach Pt., lt. F 24f. | 46 17 | 60 32 |
| | Sydney Harb., ⊞, lt. at E side, entr., F 70f. | 46 16 | 60 7 |
| | Scatari I., EW 2 l., δ E, NE pt., lt. R 90f., δ 2m. | 46 2 | 59 40 |
| *C. Breton I.* | Louisburg, ⊞, w, б, lt. F 120f. | 45 53 | 59 57 |
| | C. Portland | 45 50 | 60 6 |
| | Madame I., EW 9m., S pt. | 45 28 | 61 3 |
| | Port Hood, ⊞, w, b, Juste-au-Corps I., at entr. | 46 0 | 61 36 |
| | C. St. Lawrence | 47 2 | 60 38 |
| | **NOVA SCOTIA.** | | |
| | Sable I., EW 7 m., E end, lt. F 12·f. | 43 58 | 59 46 |
| | NW bar, NW extr., s | 44 1 | 60 38 |
| | Pictou Harb., ⊞13, lts. 2 F... ⊕ | 45 41·5 | 62 40·2 |
| | C. St. George, lt. R 350f. | 45 53 | 61 55 |
| | Gut of Canso, NW entr., lt. F 110f. | 45 41·6 | 61 29·5 |
| | C. Canso, Cranberry I., 2 lts. F vert. 89f. and 54f. | 45 20 | 60 55 |
| | White Head I., S pt., lt. Fl. 55f. | 45 12 | 61 8 |
| | Country Harb., ⊞, Green I., lt F 51f. | 45 6 | 61 32 |
| | Wedge I., lt. F 81f. | 45 1 | 61 53 |
| | Liscomb Harb., ⊞. I. lt. Alt. 64f. | 44 59 | 61 58 |
| | Ship Harb., ⊞, Briers' I., w, b, Bear rk. 8f. | 44 44 | 62 45 |
| | Brig rk., sf., T | 44 38 | 62 57 |
| | Pollock rk., [½c.], sf. | 44 33 | 63 5 |
| | Halifax, ⊞, ⊞, Dkyd. tablet | 44 39·7 | 63 35·2 |
| | Sambro I., lt. F 115f., δ 2m. | 44 26·3 | 63 33 |
| | Pennant Pt. | 44 27 | 63 37 |

## MARITIME POSITIONS

| | (149) Places | Lat. N | Lon. W |
|---|---|---|---|
| Nova Scotia | Margaret's B., ⊞, Shut-in I. | 44° 34′ | 63° 54′ |
| | Tancook I. | 44 29 | 64 6 |
| | Malaguash Harb., ⊞. Cross I., [1½m.], lt., 2 lts. Vert. dist. 34f | 44 20 | 64 7 |
| | C. Le Have, ⊥, 107f., (Black rk. 1m.) | 44 12 | 64 18 |
| | Coffin I., lt. R 65f. | 44 2 | 64 38 |
| | Little Hope I., [2c.], 21f. | 43 49 | 64 45 |
| | Gull rk., lt. F 56f. | 43 39 | 65 6 |
| | Shelburne Harbour, ⊞, M'Nutt's I., SE pt., ⊥, r, w, 2 lts. F vert. 120f. and 65f. | 43 37·5 | 65 16 |
| | Brazil rk., [3 yds.], sf. | 43 22 | 65 25 |
| | C. Sable, (SE pt. of small I., l, ⚓. W end advancing 1m. in 4 years), ⊥, δ 3m., lt. R 53f. | 43 23 | 65 37 |
| | Blonde rk., small, δ | 43 20 | 65 57 |
| | Seal I., [2m.], S pt., δ 1½m., ⚓, lt. F 98f. | 43 24 | 66 1 |
| | Tusket Is. Pubnico Harb., ⊞ r, w, b, entr. | 43 37 | 65 52 |
| | C. Fourchu, k, ⚬, lt. R 117f. | 43 47 | 66 9 |
| | Lurcher rk., δ, small, 13f. | 43 52 | 66 25 |
| | C. St. Mary | 44 7 | 66 11 |
| New Brunswick, Bay of Fundy | Bryer's I., 4m., lt. F 92f. | 44 16 | 66 22 |
| | Annapolis Harb., ⊞, Pt. Prim, lt F 76f. | 44 42 | 65 47 |
| | Black rk., pt., lt. F 45f. | 45 10 | 64 46 |
| | Haute I., w, ⚓, lt Int. 365f. | 45 15·1 | 65 1 |
| | C. Chignecto, k, T | 45 19 | 64 57 |
| | C. Enragé, lt. F 120f. | 45 36 | 64 47 |
| | Quaco, lt. R 110f. | 45 19·5 | 65 32 |
| | Quaco Ldge, [1 l.] | 45 14 | 65 20 |
| | C. Spencer | 45 12 | 65 55 |
| | St. John's, ⊞, Partridge I., lt. F 119f. ⊕ | 45 14·1 | 66 3·5 |
| | C. Lepreau, lt. F 80f. | 45 3·7 | 66 28 |
| | Wolf Is., 3¾m., ⊥ T, 100f., Northst. | 44 59·5 | 66 41 |
| | Etang, harb., ⊞, tower S pt | 45 4 | 66 49 |
| | St. Andrew's, ⊞, N pt., lt. F. 42f. | 45 4·3 | 67 3 |
| | Campobello I., N pt., lt. F 64f. | 44 58 | 66 54 |
| | **UNITED STATES.** | | |
| Maine | Quoddy Hd., lt. F 133f. | 44 49 | 66 57 |
| | Old Proprietor shl., [⅓c.], rf | 44 30 | 66 37 |
| | Grand Manan, 14m., w, r, ‖ W, δ₀ NE pt. | 44 46 | 66 43 |
| | Gannet rk., lt. Fl. int. 66f. | 44 31 | 66 47 |
| | Libby I., off Machias B. | 44 32·5 | 67 22 |
| | Machias Seal Is., 2 lts. F 66f. and 54f. | 44 30 | 67 6 |
| | Nash's I., entr. Pleasant R., lt. F 47f. | 44 28 | 67 45 |
| | Petit Manan, S pt., lt. F, Fl. 125f. (δ 2 to 5m.) | 44 22 | 67 52 |
| | Baker's I., lt. Fl. 105f. | 44 13·5 | 68 12 |
| | Castine, lt. F 130f. | 44 23 | 68 49 |

| | (150) Places | Lat. N | Lon. W |
|---|---|---|---|
| Maine | Owl's Head, lt. F 105f. | 44° 6′ | 69° 3′ |
| | Mt. Desert rk. lt. F 75f. | 43 58 | 68 8 |
| | Cashe's Ledge, T T, [1m.] | 42 56 | 68 51 |
| | I Haute, 5m., Saddleback ledge, to E-d., lt. F 51f. | 44 1 | 68 44 |
| | Matinicus I. and rks., [4m.], lt. on rk., F 90f. | 43 47 | 68 51 |
| | White Head, ⊥, lt. F 79f. | 43 59 | 69 7 |
| | Monhegan I., [1m.], T, lt. R 175f. | 43 46 | 69 19 |
| | Pemaquid Pt., lt. F 75f. | 43 50 | 69 30 |
| | Burnt Island, lt. F 61f. | 43 49 | 69 38 |
| | Seguin I., lt. F 180f. | 43 41·6 | 69 46 |
| | Cashe's ledge, π, [¼m.] | 42 50 | 69 4 |
| | Portland, ⊞, City Hall | 43 39·2 | 70 15·2 |
| | — lt., W entr., F 101f. | 43 37 | 70 12 |
| | C. Elizabeth, 2 lts, [300 yds.], F, Fl. and F 143f. | 43 33·6 | 70 11·5 |
| | Wood I., entr. Saco Harb., lt. F, Fl. 63f. | 43 27 | 70 19 |
| | Agamenticus Hills | 43 13 | 70 41 |
| | C. Porpoise, Goat I., SW part. lt. F 38f. | 43 21 | 70 26 |
| | Bald Head | 43 13 | 70 34·5 |
| | Boon I., [¼m.], l, lt. F 133f. | 43 7 | 70 29 |
| | York Harb., ⊞ $^{21}_{12}$ | 43 9 | 70 39 |
| New Hampshire | Whale's Back, lt. F. Fl. 65f. | 43 4 | 70 42 |
| | Portsmouth, Fort Constitution, lt. F 70f. | 43 3·5 | 70 43 |
| | Is. of Shoals, [3 m.], S or White I., lt. R 87f. | 42 58 | 70 37 |
| | Newbury Port, ⊞, bar sf., 2 leading lts. F on N pt. of Plumb I., movable | 42 48·5 | 70 49·0 |
| | Ipswich Bay, lt. F, Fl. 50f. | 42 41 | 70 46 |
| | Annisquam Harb., ⊞, lt. F 50f. | 42 39·8 | 70 41 |
| | C. Ann, lts. NS, on Thatcher I., 2 lts. F 165f. (Salvages N-d., 2m.) | 42 38·4 | 70 34·7 |
| | C. Ann Harb., ⊞, lt. on Ten-Pound I., F 49f. | 42 36 | 70 40 |
| | Salem, ⊞, City Hall | 42 31·5 | 70 54·0 |
| | Baker's I., [⅓m.], 2 lts. F 87, 50f. | 42 32·2 | 70 47·5 |
| | Marblehead, lt. F 43f. | 42 30·2 | 70 50 |
| | St. George's shls., EW 7 l., SW, or shl. part, 5. | 41 43 | 67 47 |
| | Little George's, [5] | 41 15 | 68 0 |
| Massachusetts | Boston, ⊞, Cambridge Obs. | 42 22·8 | 71 7·7 |
| | — N side, main outer entr., lt. R 111f. | 42 19·7 | 70 53·7 |
| | Plymouth, ⊞, Gurnet lts., 2 F 93f. | 42 0·2 | 70 36·7 |
| | Barnstable, ⊞ $^{17}_{7}$, bar., lt. F 33f. | 41 43·2 | 70 16·5 |
| | Billingsgate I., lt. F 52f. | 41 51·6 | 70 4·5 |
| | Race Pt., lt. F, Fl. 51f. | 42 3·7 | 70 15 |
| | C. Cod, high, or Truro, lt. F 195f. | 42 2·4 | 70 4 |
| | Nausset, 3 lts. F 93f. | 41 51·6 | 69 57·7 |
| | Chatham Harb., 2 lts. F 80f., S one | 41 40·3 | 69 57·7 |
| | Monomy Pt., lt. F 41f. | 41 33·6 | 70 0·0 |

## MARITIME POSITIONS

| (151) | Places | Lat. N | Lon. W |
|---|---|---|---|
| *Massachusetts* | Nantucket I., EW 5 l., (shls. "Rips." E-d. 4 l.), N, or Sandy Pt., lt. F 70f. | 41° 23′ | 70° 3′ |
| | — Brant Pt., town, lt. F 43f. | 41 17·5 | 70 5·2 |
| | Nantucket, S shls., old do., ⚓ 2½m., N pt. | 41 5 | 69 50 |
| | — New do., EW 2½m., S pt. 3f. | 40 57 | 69 50 |
| | Martha's Vineyard, EW 6 l., NE pt., or C. Poge, lt. 55f. | 41 25·2 | 70 27·5 |
| | — Holmes Harb., ⊞, W Chop, lt. F 60f. | 41 28·8 | 70 36·2 |
| | — W pt., Gay Hd., lt. Fl. 10s 172f. | 41 20·9 | 70 50·5 |
| | Noman's Land, [1m.], stat. mid. | 41 15·2 | 70 49·0 |
| | Cuttehunk, lt. F 42f., at S and W pt. of Id. | 41 25 | 70 57 |
| | New Bedford, ⊞, Dumpling, or Round Hill, lt. F 43f. | 41 32·2 | 70 55·7 |
| *Rhode I.* | Sakonnet Pt., lt. F, Fl. 70f. | 41 26·5 | 71 12 |
| | Bristol, Episcopal Ch. | 41 40·0 | 71 17·2 |
| | Providence, College | 41 49·6 | 71 24·7 |
| | Newport, Court House | 41 29·5 | 71 19·2 |
| | Beaver-tail Pt., or Rhode I. lt., lt. F 68f. | 41 27 | 71 24 |
| | Pt. Judith, lt. R 67f. | 41 22 | 71 29 |
| | Block I., NS 5m., N pt., lt. F 61f. | 41 14 | 71 35 |
| *Connecticut* | Stonington, town, S pt., lt. F 50f. | 41 19·6 | 71 54·5 |
| | New London, lt. W entr. F 90f. | 41 18·9 | 72 5·7 |
| | Falkner I., lt. F, Fl. 98f. | 41 13 | 72 39 |
| | New Haven, ⊞, lt. F 57f. | 41 14·5 | 72 54·5 |
| | — Yale College | 41 18·5 | 72 56·5 |
| | Norwalk I., lt. F, Fl. 52f. | 41 2·8 | 73 25·5 |
| *New York* | Long I., ⚓ 34 l., E or Montauk Pt., lt. F, Fl. 169f. | 41 4·2 | 71 51·0 |
| | New York, ⊞, City Hall | 40 42·7 | 74 0 |
| | Fire Island, lt. Fl. 168f. | 40 37·9 | 73 12·7 |
| | Fort Tomkins, lt. F 89f. | 40 36·0 | 74 3·5 |
| | Princess Bay, lt. F, Fl. 107f. | 40 30·4 | 74 13·2 |
| | Sandy Hook, 3 lts. F 90f. and 2 beacon lts. F. | 40 27·6 | 74 0·7 |
| | Nevisink, 2 lts., F 248f. | 40 23·7 | 73 59·5 |
| *New Jersey* | Barnegat Inlet, S side, lt. Fl. (shl. 2m.) | 39 45·9 | 74 6·0 |
| | Little Egg Harb., ⊞, Tucker beach, lt. F, Fl. 52f. | 39 30 | 74 17·5 |
| | Grt. Egg Harb. ⊞, bar, entr. | 39 19 | 74 35 |
| | C. May, (shls. SW), lt. R 167f. | 38 55·8 | 74 58·5 |
| *Delaware* | Egg I., lt. F 50f. | 39 11 | 75 8 |
| | Cohansey Creek, lt. F 46f. | 39 21 | 75 22 |
| | Philadelphia, State House ⊕ | 39 57·0 | 75 9·5 |
| | Reedy I., lt. Fl. 36f. | 39 30 | 75 34 |
| | Bombay Hook, lt. F 46f. | 39 21·7 | 75 31 |
| | Salem, City, Church | 39 34·5 | 75 36 |
| | Mahon's River, lt. F 57f. | 39 11 | 75 24 |
| | C. Henlopen, (⚓ 2 l. SW), lt. F 128f. ⊕ | 38 46·6 | 75 5 |
| | Delaware Breakwater, west end, lt. F, Fl. 47f. | 38 47·8 | 75 6·7 |

| (152) | Places | Lat. N | Lon. W |
|---|---|---|---|
| *Virginia* | Asseateague I., ⚓ 6 l., l, S end, lt. F 153f., shls. off. | 37° 55′ | 75° 21′ |
| | Smith's I., ⚓ 10m., C. Charles (shls. off), lt. Fl. 160f. | 37 7 | 75 54 |
| | Baltimore, Battle Monument | 39 17·4 | 76 37·5 |
| | Annapolis, State House | 38 58·7 | 76 29·7 |
| | Pt. Look-out, entrance to Potomac R., lt. F 43f. | 38 2 | 76 19 |
| | Washington, Capitol | 38 53·4 | 77 2·0 |
| | Washington Naval Observatory | 38 53·6 | 77 2·7 |
| | New Pt. Comfort, lt. F 60f. | 37 18 | 76 17 |
| | Back River Pt., lt. F, Fl. 35f. | 37 5 | 76 16 |
| | C. Henry, lt. F 160f. | 36 56 | 76 0 |
| *North Carolina* | Roanoke Marshes, lt. F 33f. | 35 49 | 75 42 |
| | C. Hatteras, l, sand, (shls. 3 l. SE), lt. Fl. 191f. | 35 15 | 75 31 |
| | Ocracoke Inlet, lt. N side, F 75f. | 35 6·5 | 75 59 |
| | C. Look-out, shl. ⚓ 3 l., l, lt. F 156f. | 34 37 | 76 31 |
| | C. Fear, shl. ⚓ 5 l., Bald Head, lt. F 30f. | 33 52 | 78 0 |
| *South Carolina* | Georgetown | 33 22 | 79 18 |
| | North I., S pt., ⊞, bar 3f., entr., lt. F 85f. | 33 13 | 79 11 |
| | C. Romain, l, lt. R 154f., (shl. SE d. 6m.) | 33 1 | 79 22 |
| | Charleston, ⊞, Fort Ripley, lt. F 49f. | 32 46·4 | 79 54 |
| | — Sullivan's I., lt. F 57f. | 32 46 | 79 51 |
| *Georgia* | N Edisto Inlet | 32 33 | 80 12 |
| | Beaufort, Arsenal | 32 26 | 80 41 |
| | Port Royal, ⊞, Paris I., Back lt. F 130f. | 32 18 | 80 40 |
| | Savannah Riv., ⊞, Tybee I., lt. F 150f. | 32 1 | 80 51 |
| | — Town, exchange | 32 4·9 | 81 7 |
| | Sapello I., north entr. to Doboy Sound, lt. F, Fl. 79f. | 31 23 | 81 17 |
| | Darien, town | 31 25 | 81 33 |
| | St. Simon's I., lt. on S pt., F, Fl. 108f. | 31 8 | 81 23 |
| | Little Cumberland I., ⚓ 5 l., N pt., (entr. St. Andrew's Sound), lt. F 78f. | 30 59 | 81 25 |
| *Florida* | Amelia I., ⚓ 13m., N pt., (S pt. of St. Mary Inlet), lt. R 112f. | 30 40 | 81 26 |
| | St. John's Riv., ⊞6, S entr., Jacksonville, lt. F 84f. | 30 24 | 81 25 |
| | St. Augustine (bar), ⊞, N pt. of Anastasia I., lt. F, Fl. 165f. | 29 53 | 81 17 |
| | Musquito Inlet, north side of ent., lt. F 157f. | 29 5 | 80 55 |
| | C. Canaveral, w, north-east pitch, lt. R 139f. | 28 28 | 80 32 |
| | Indian Riv. Inlet, entr. w′ | 27 33 | 80 23 |
| | Jupiter Inlet, entr., lt. F & Fl. 146f. | 26 57 | 80 5 |
| | New Riv. Inlet, fort | 26 9 | 80 3 |
| | C. Florida, Fowey rocks, lt. F 111f. | 25 35 | 80 6 |

## MARITIME POSITIONS

| Region | (153) Places | Lat. N | Lon. W |
|---|---|---|---|
| Florida | Carysfort rf., lt. R 106f. | 25° 13′ | 80° 12′7 |
| | Tavanier Cay, δ 1 l. | 25 0 | 80 30 |
| | Lower Matacumba I., ⚓ 3m., W pt. (w‴ N) | 24 49 | 80 44·5 |
| | Sombrero Cay, lt. F 144f | 24 37·5 | 81 6·7 |
| | Sand Cay, lt. F, Fl. 110f. | 24 27 | 81 52·7 |
| | Cay West, NW pass., lt. F 50f. | 24 37 | 81 54 |
| | — CAY WEST, U.S. NAVAL STOREHOUSE | 24 33 4 | 81 48·5 |
| | Tortugas, EW 9m., shls. W 4l., ✱; W pt., Fort Jefferson, lt. F 65f., (δ 6m.) ⊕ | 24 38 | 82 53 |
| | **BAHAMA ISLANDS.** | | |
| Bahama Is. | Matanilla, shl. [s], T | 27 22 | 79 4 |
| | Memory rk., [½c.], 14f.? T | 26 57 | 79 7 |
| | Bahama I., EW 22 l., W, or Seulement Pt., ♆ | 26 41 | 79 0 |
| | — "South-east" Pt. (so called), [⚓] ꝏ, w | 26 28 | 78 40 |
| | Grt. Abacou I., ⚓ 23 l., lt. near S pt., R 160f. | 25 51·5 | 77 11·2 |
| | — East Pt. | 26 20 | 76 59 |
| | Elbow Cays, ♆, lt. F 123f. | 26 31 | 76 58 |
| | Great Bahama Bk., ⚓ 110 l., Grt Isaac rk., [¾m.], 40f. | 26 2 | 79 5 |
| | Bemini Is., [7m.], l, ♆, SW pt., w | 25 41 | 79 20 |
| | Gun Cay, lt. R 80f. | 25 34·5 | 79 19 |
| | Orange Cays, Id., [¾m.], 13f., ✱o, r̄ | 24 56 | 79 9·0 |
| | Cay Guinchos | 22 45 | 78 8 |
| | Lobos Cay, T, lt. F 146f. | 22 22·8 | 77 35·5 |
| | Diamond Pt., ꝏ T | 22 10 | 77 20 |
| | St. Domingo Cay, 15f., 1 ♆ | 21 42 | 75 45 |
| | Cay Verde, 72f. | 22 1 | 75 11·5 |
| | Grt. Ragged I., beac. hill 115f. | 22 11·5 | 75 44·2 |
| | Water Cay, [1½m.] | 23 0 | 75 44 |
| Bahama Is. and Banks | Long I., ⚓ 19 l., l, ♆, T, N pt. | 23 41 | 75 19 |
| | — South pt. | 22 51 | 74 51 |
| | Cay Sal bank, N. Elbow, lt. F 96f. | 23 56·5 | 80 28 |
| | Exuma I., ⚓ 8 l., entr. harb. ⊡ | 23 33 | 75 48 |
| | Eleuthera I., ⚓ 22 l., ♆, T, S pt. | 24 38 | 76 9 |
| | — NE, or Palmetto Pt. | 25 9 | 76 9 |
| | — N pt., hill, (shls. E and W 3 l.) | 25 35 | 76 44 |
| | Egg and Royal Is., West I. | 25 30 | 76 55 |
| | New Providence I., EW 5 l., Nassau, ⊡ⁿ₁, lt. F 68f. | 25 5·6 | 77 22·2 |
| | — E pt., Goulding Cay, w SW | 25 7 | 77 36 |
| | Green Cay, [2m.], w′ | 24 3 | 77 11 |
| | Andros I., ⚓ 32 l., Mastic Pt. | 25 4 | 77 57 |
| | Berry Is., NS 9 l., T, w, r, E lim., or Frozen Cay | 25 32·5 | 77 42 |
| | Great Stirrup Cays, r, lt. F 81f. | 25 49 7 | 77 54 |
| | Little Salvador, ⚓ 5m., W pt. | 24 36 | 75 59 |
| | St. Salvador, ⚓ 14 l., NW pt. | 24 41 | 75 46 |
| | — East pt. (*Columbus's landfall*) | 24 8 | 75 17 |
| | Concepcion [and rks. 2 l.], δ, l, ♆, T, Id. W pt. | 23 50 | 75 8 |
| | Watling's I., ⚓ 5 l., Dixon Hill, lt. Fl. 165f. | 24 6 | 74 26 |
| | Rum Cay, EW 3 l., wwo, S pt. | 23 37 | 74 50 |
| | Mira por vos, ⚓ 3 l., δ, NE rk. | 22 6 | 74 28 |
| | Crooked I., ⚓ 14 l., ⚓ ♆, wwo, S pt., Castle I., lt. F 123f. | 22 6 | 74 20·5 |
| | — Bird Rock, lt. R 120f. | 22 50 5 | 74 23 |

| Region | (154) Places | Lat. N | Lon. W |
|---|---|---|---|
| Bahama Is. and Banks | Samana, or Attwood's Cay, ✱, T, W pt. | 23° 5′5 | 73° 49′ |
| | Plana Cays, EW 10m., l, ♆, T, hill, W pt., ⚓. L, w′ | 22 35 | 73 38 |
| | Mariguana I., rf. EW 10 l., l, ♆, T, β, Centre hill, 110f. | 22 23 | 72 55 |
| | Hogsty rf., EW 5m., T, δ, NW Cay | 21 40·5 | 73 50·7 |
| | Grt. Inagua, ⚓ 15 l., l, ♆, lt. R 120f | 20 56 | 73 41 |
| | — Man of War B., W side, well | 21 4 | 73 39 |
| | Little Inagua, EW 3 l., N pt. | 21 33 | 73 0 |
| | Caicos bk., ⚓ 22 l., S rk. | 21 3 | 71 45 |
| | — West Caicos, ⚓ 7m., S pt. | 21 37 | 72 30 |
| | — East Harbour, wat. pl. | 21 31 | 71 32 |
| | Turk's Is., ⚓ 6 l., N extr., lt. Fl. 108f. | 21 31 | 71 8 |
| | — Hawk's Nest, wwo ⚓ ⚓o ⊕ | 21 26 3 | 71 10·5 |
| | Endymion rk., 1 f. | 21 7 | 71 18 |
| | Square Handkerchief, EW 30m., NE breaker | 21 6·5 | 70 29 |
| | Silver bk., ⚓ 15 l., Cay, SW rk. | 20 18 | 69 58 |
| | — North rks. | 20 53 | 69 55 |
| | — Eastern edge, ꝏ, T | 20 35 | 69 22 |
| | Bajo Navidad, ⚓ 7 l., N pt. ꝏ, T | 20 13 | 68 52 |
| | **CUBA.** | | |
| North Coast ⊖ | Cuba, ⚓ 217 l., E pt., C. Maysi, lt. F 128f., l, rf. 1m. | 20 15·2 | 74 9 |
| | Barracoa, fort | 20 21 | 74 28·5 |
| | C. Moa, Cay, ⚓′ | 20 41 | 74 53 |
| | Pt. Lucrecia, lt. R 112f. | 21 5 | 75 36·5 |
| | Port Naranjo, ⊡, W pt., ⚓, ⊥ | 21 6 | 75 50 |
| | Port del Padre, ⊡ | 21 17 | 76 25 |
| | Pt. Maternillos, lt. R 176f. | 21 40 | 77 8·7 |
| | I. Guajaba, ⚓ 10m., W pt. | 21 55 | 77 36 |
| | Cay Confites | 22 12 | 77 39 |
| | Cayo Romano, 2 Is., ⚓ 16 l., NW pt. | 22 27 | 78 19 |
| | Minerva Cay, [1m.] | 22 19 | 77 48 |
| | Cay Sal, bk., ⚓ 20 l., ı, Cay Sal, [1m.], w, ♆, N pt. | 23 41·7 | 80 25·0 |
| | — Elbow Cay, lt. F 96f. | 23 56·5 | 80 28 |
| | — Dog rks., ⚓ 8m., E pt. | 24 2 | 79 51 |
| | — Anguilla Is., ⚓ 7m., wo, S pt. | 23 29 | 79 32 |
| | Nicolao rf., Medano I., S-d. | 23 12 | 80 21 |
| | Bahia de Cadiz, lt. R 175f. | 23 12 | 80 30 |
| | Piedras Cay, lt. F, Fl. | 23 14·2 | 81 8·7 |
| | Matanzas, Bay, ⚓, S. Severino Castle | 23 3 | 81 37 |
| | Pan de Matanzas, 1277f. | 23 1·9 | 81 45 |
| | HAVANA, ⊡, MORRO lt. R 144f. | 23 9·4 | 82 21·5 |
| | Managua Paps, 2, EW 2m., 732f., W one | 22 57 | 82 22 |
| | Port Mariel, ⊡, entr. | 23 3 | 82 44 |
| | Bahia Honda, ⊡ Cerro Morillo | 23 0 | 83 11·7 |
| | Pan de Guaijaibon, 2532f. | 22 48 | 83 24 |
| | Colorados rfs., rks., δ, T, W pt. | 22 9 | 84 48 |
| | W extr., C. St. Antonio, l, ♆, T, rky., (shl. ⚓ 7m., ꝏ), lt. R 128f. | 21 53 | 84 57 2 |
| | C. Corrientes, l, sand, ♆ | 21 45·5 | 84 31 |
| | Pt. Piedras | 22 2 | 83 50 5 |
| | Cays of San Felipe, SW part, T, 1½m. ○ | 21 55 | 83 32 |

MARITIME POSITIONS

| | (155) Places | Lat. N | Lon. W |
|---|---|---|---|
| *Cuba S. Coast* ○ | I. of Pines, EW 16 l., S pt. ... | 21° 24'·4 | 82° 56' |
| | Rosario Channel, ʒ, S ent. ...... | 21 37 | 81 55 |
| | Jardines, w''', E extr. .......... | 21 39 | 81 2 |
| | Cay de Piedras, lt. F 27f. ...... | 21 58 | 81 3 |
| | Placer de Xagua, [3m.], ʒ ... | 21 37 | 80 35 |
| | Batavano .............................. | 22 43 | 82 18 |
| | Xagua B., ⊞, lt. F, Fl. 82f. ... | 22 1 | 80 30 |
| | Trinidad, mole ................ | 21 42 | 79 59 |
| | Cayo Blanco, 20f. .............. | 21 36·6 | 79 53·5 |
| | Manzanillo ........................○ | 20 20 | 77 10 |
| | C. de Cruz, rf. 2m., T, lt. F, Fl. 114f. ...................... | 19 49·9 | 77 45·5 |
| | Tarquino Pk., 8,400f. .......... | 19 56 | 76 45 |
| | SANTIAGO DE CUBA, ⊞, r, w, lt. F, Fl. 228f., Morro Castle ........................ | 19 57·4 | 75 52·7 |
| | — BLANCA BATTERY .......... | 20 00·3 | 75 50·5 |
| | Guantanamo, or Cumberland Harb., ⊞, E head ......... | 19 55 | 75 11 |
| *Caymans* | Cayman Brack, 3 l., E pt. | 19 45·2 | 79 44 |
| | Litt. Cayman, 7m., l, 3 ✝, E end ............................ | 19 42 | 79 58 |
| | Grt. Cayman, EW 6 l., l, ✝, ✝, ⚓ ⚓ₒ, r, town, Fort George .............. ⊕ | 19 17·7 | 81 23·5 |
| | — East pt., ✝, β 1m. .......... | 19 19 | 81 7 |
| | **JAMAICA.** | | |
| *Jamaica* | Jamaica, 43 l., E pt., or Pt. Morant, lt. R 115f. .......... | 17 55·1 | 76 11·7 |
| | Port Antonio, 2 ⊞, w, fort, lt. F 54f. ....................... | 18 11·3 | 76 27 |
| | St. Ann's B., ⊞, Long wharf, w | 18 26·4 | 77 13·7 |
| | Falmouth Harb., ⊡[16], bar, fort | 18 30·6 | 77 40 |
| | Montego B., fort ................ | 18 29·4 | 77 56·5 |
| | Lucia Harb., ⚓, fort, E entr.... | 18 28 | 78 10·7 |
| | Pedro Pt. ............................ | 18 28 | 78 14 |
| | N. Negril, N pt. .................. | 18 21·4 | 78 22 |
| | Dolphin Hd., pk., 1820f. ...... | 18 23 | 78 11 |
| | S. Negril Pt. ..................... | 18 16·8 | 78 23·5 |
| | Savannah la Mar, fort, shl. 2m. | 18 12·3 | 78 8·7 |
| | Pedro Bluff, 220f. .............. | 17 51 | 77 45·7 |
| | Alligator rf. 3m., W pt. ... | 17 48·5 | 77 33·5 |
| | Portland Pt., SE pt. ............ | 17 43 | 77 10 |
| | Old Harbour, ⊞. Careening I. | 17 53·5 | 77 5·5 |
| | PORT ROYAL, ⊞, ⊡, F. CHARLES | 17 56·0 | 76 50·7 |
| | Yallah's Pt., (hill 2400f. 3m.) | 17 52 | 76 33·5 |
| | Port Morant, ⊞, Leith Hall... | 17 53 | 76 21 |
| *Pedro Bank and Is. S Westward* | Morant Cays, 1 l., ⁎, δₒ 2½m., ⚓ NW, NE Cay, ✝, 7f. | 17 25 | 75 59 |
| | Pedro Bk., EW 31 l., SW rock | 16 48 | 78 13 |
| | — NW edge, ≋ | 17 36 | 78 52 |
| | — Portland rk., E edge, 32f. [2c.], 15f, ⚓ ⚓ₒ ʒ E. ....... | 17 6 | 77 26 |
| | Raxo Nuevo, EW 5 l., NE pt. | 15 53 | 78 34 |
| | Swan Is., 2, 4½m., ‖ₒ, 60f., (W one, ✝, w', ✝), E pt., ⌒, Lₒ | 17 25 | 83 56 |
| | **ST. DOMINGO.** | | |
| | St. Domingo, EW 120 l., E pt., C. Engano, (shl. N 3m.)... | 18 33·8 | 68 18·7 |
| | C. Rafael, Mt. Redonda, 2m. inland ........................ | 19 1 | 68 55 |

| | (156) Places | Lat. N | Lon. W |
|---|---|---|---|
| *St. Domingo, N. Coast* | Town of Savana la Mar, fort | 19° 3' | 69° 22' |
| | C. Samaná, rugged, h, ⊥ ⌒ ... | 19 18 | 69 8 |
| | Port Plata, lt. R 137f. ........ | 19 47 | 70 38 |
| | Old C. Français, ⌒ ............ | 19 40 | 69 52 |
| | Pt. Isabelle ......................... | 19 57 | 71 1 |
| | Monte Christi B., ⚓, r, w ...... | 19 53 | 71 40 |
| | C. Haytien Harb., ⊞, w, r, turret d'Estaing ............ | 19 46·7 | 72 11·7 |
| | Acul, ⊞ ............................ | 19 45 | 72 22 |
| | Tortuga I., 7 l., E pt., l ... | 20 1 | 72 34 |
| | St. Nicolas' Mole, ⊞, w, Fort St. George .................. | 19 49·5 | 73 22·2 |
| | Cape Fou ........................... | 19 44 | 73 29 |
| | Gonaives, ⊞, Pt. Verrier ...... | 19 25·7 | 72 42·7 |
| | St. Marcos Pt., h, ⊥ ........... | 19 2 | 72 50 |
| | Gonaive I., 10 l., ✝, W pt. | 18 55·4 | 73 18·2 |
| | Port-au-Prince, r, w', Fort Alexander, lt. F 46f. ...... | 18 33·2 | 72 20 |
| | Rochelois shl., [1 l.], rks., 3f. | 18 39 | 73 13 |
| | Caymites, ⚓, δ ‖ S, 500f. NE pt. | 18 39 | 73 40 |
| | C. Dame Marie, W pt., (w SE 2m.) ........................ | 18 36 | 74 27 |
| | C. Tiberun, h, ⌒, T, w, b in bay) ............................ | 18 22 | 74 28 |
| | La Hotte mountains, 7400f. ... | 18 23 | 74 3 |
| | Navasa I., [2m.]. 300f., T, ⁎, ⌒, r, mid. N side ......... | 18 25 | 75 2 |
| | Formigas shl., 2 l., ʒ, N pt | 18 35 | 75 45 |
| | Pt. Gravois ........................ | 18 1 | 73 56 |
| | I. Vache, [3 l.], T S, NW pt. | 18 6 | 73 43 |
| | Aux Cayes ........................ | 18 12 | 73 46 |
| | C. Jaquemel, ⊞, Wharf ...... | 18 13·5 | 72 33 |
| | Mountain, 8900f. ................. | 18 21 | 72 0 |
| | C. False ........................... | 17 45 | 71 40 |
| *St. Domingo, S. Coast* ○ | Beata I., NS 4m., l, ✝, ⚓ NW, NW pt., 80f. ......... | 17 36·7 | 71 32 |
| | Frayle rk., 50f. ................... | 17 37 | 71 41 |
| | Alta Vela, h, T, 500f. .......... | 17 28 | 71 40 |
| | C. Mongon .......................... | 17 50 | 71 14 |
| | Pt. Avarena ....................... | 18 7 | 71 0 |
| | Pt. Caldera, or Salinas ......... | 18 12 | 70 36 |
| | Pt. Nisao ............................ | 18 13 | 70 0 |
| | St. Domingo, City, ⊡[13], Consulate, lt. R 111f. ...... | 18 28·2 | 69 52 |
| | I. Saona, EW 4 l., ✝, Cana Pt. | 18 4 | 68 32 |
| | Mona I., EW 6m., (⌒, w, W end, b, rfs. 2m.), 175f., C. San Juan .............. | 18 3 | 67 51 |
| | Desecho I., [1m.], T, ✝, vis. 12 l. | 18 22·7 | 67 29·2 |
| | **PORTO RICO.** | | |
| *Porto Rico* | Aguila Pt., lt. R 128f. .......... | 17 58 | 67 15 |
| | Shoals 2 l. off W coast, Bajo Gallardo, [ʒ] ............ | 18 0 | 67 21 |
| | B of Mayaguez, lt. F .......... | 18 13 | 67 10 |
| | Aguadilla B, lt. Fl., r, w''' ... | 18 28·5 | 67 11 |
| | PORTO RICO, ⊞. MORRO, lt. R 174f. .................. | 18 28·9 | 66 7·5 |
| | NE extr., or C. Juan, (rks.), lt. F, Fl. 266f. ............ | 18 23 | 65 36 |
| | Anvil, 3700f. ..................... | 18 19 | 65 47 |
| | SE pt., C. Mala Pasqua ......... | 17 59 | 65 49 |
| | Caxo de Muertos I., [1m.], (⚓ W ʒ), S rk., lt. F, Fl. 297f. ............................ | 17 53 | 66 34 |

## MARITIME POSITIONS

| | (157) Places | Lat. N | Lon. W |
|---|---|---|---|
| | Port Ponce, lt. Fl. 39f. | 17° 58′ | 66° 40′ |
| | Pt. Guanica | 17 56 | 66 57 |
| | **CARIBBEE ISLANDS.** | | |
| Virgin Islands | Culebra, or Passage I., 7m., (SE. w, r, b), Culebrita I., lt. F 305f. | 18 19 | 65 14 |
| Virgin Islands | St. Thomas I., 4 l., r, lt. F 95f., E entr., Fort Christian | 18 20·4 | 64 55·7 |
| Virgin Islands | Frenchman's Cap, 195f. | 18 14 | 64 51 |
| Virgin Islands | St. John's I., EW 3 l., Ram Hd | 18 18·1 | 64 42 |
| Virgin Islands | Norman I., 440f., Man of War B., on W side. N pt. | 18 20 | 64 37 |
| Virgin Islands | Tortola, 10m., ab. 1780f. Town, r, Fort Burt Pt. | 18 25·1 | 64 36·5 |
| Virgin Islands | Ginger I., [1m.] 500f., | 18 24 | 64 28 |
| Virgin Islands | Virgin Gorda, 3 l., pk. 1370f., East pt. | 18 31 | 64 18·5 |
| Virgin Islands | Anegada, 3 l., l, (rf. SE 3 l.), W pt., w, 30f. | 18 45 | 64 24·7 |
| St. Croix | Sta. Cruz, 7 l., 1184f. E pt. | 17 45 | 64 34 |
| St. Croix | — Christiansted, Lang's Observatory, Transit pier, lt. F | 17 44·7 | 64 41·2 |
| Leeward Islands | Sombrero, [¾m.], l, T, w, 37f., lt. R 150f. ⊕ | 18 35·6 | 63 27·7 |
| Leeward Islands | Dog I., [& rks. 2½m.], W rk. ⊕ | 18 16·7 | 63 15·5 |
| Leeward Islands | Anguilla, 14m., 213f., w, Cust. ho. ⊕ | 18 13·2 | 63 4·2 |
| Leeward Islands | St. Martin I., EW 8m., w, r, b, sum. 1361f. | 18 5 | 63 3·2 |
| Leeward Islands | — Fort Marigot, lt. F 66f. ⊕ | 18 4·1 | 63 5·5 |
| Leeward Islands | S. Bartholomew, 5m., N pk. 992f. | 17 54·3 | 62 48·5 |
| Leeward Islands | Saba [3m.]. h, T, 2820f. | 17 38 | 63 14 |
| Leeward Islands | St. Eustatius, 4m., h, 1950f., Fort fl. st. | 17 29·2 | 62 59 |
| Leeward Islands | St. Christopher, 6 l., r, Mt. Misery. 4313f. | 17 22 | 62 48 |
| Leeward Islands | — St. George's Ch., lt. F 37f. | 17 18 | 62 43 |
| Leeward Islands | Nevis, [2l.], r, 3595f sum. | 17 12 | 62 33 |
| Leeward Islands | — Charleston, SW pt., | 17 8·8 | 62 36 |
| | Barbuda, 14m., vis. 6 l., r, SW pt.; S & E pt. 1 l., 200f. | 17 33 | 61 43 |
| | — River fort, SW side ⊕ | 17 35·8 | 61 49·5 |
| | Antigua, 12m. (N), 1330f. St. John's Cathedral T | 17 6·2 | 61 50·5 |
| | — English Harb., Dockyd., flagstaff | 17 00 | 61 45·7 |
| | — Boggy's Pk., 1339f. | 17 2 | 61 51 |
| | Redondo, 600f., W, T ⊕ | 16 55·5 | 62 18·7 |
| | Montserrat, 3 l., 3000f., w, T, N pt. | 16 49·3 | 62 11·7 |
| | — Plymouth, lt. F 56f. | 16 42·2 | 62 13 |
| | Guadeloupe, [12 l.], 4870f. N pt. | 16 21 | 61 26·8 |

| | (158) Places | Lat. N | Lon. W |
|---|---|---|---|
| Guadeloupe | Guadeloupe, Vieux Fort, pt. | 15° 57′ | 61° 42′ |
| Guadeloupe | — Basse Terre, Fort Irois ⊕ | 16 0·5 | 61 45·2 |
| Guadeloupe | — Souffrière, volc., 5500f. | 16 5 | 61 39 |
| Guadeloupe | Désirade, 7m., N pt. | 16 21·4 | 60 58·7 |
| Guadeloupe | Petite Terre, lt. F 108f. | 16 10·5 | 61 6 |
| Guadeloupe | Marie Galante, 10m., w W, Grand Bourg, lt. F. 46f. | 15 54 | 61 19 |
| | Dominica, 9 l., h, 1m., 4747f., N pt. | 15 38 | 61 26 |
| | — Roseau, town, lt. F. | 15 17·4 | 61 23 |
| | — South pt., h, fl. st. | 15 13 | 61 22 |
| | Aves I., [3c.], 10f., W | 15 42 | 63 37·7 |
| Martinique | Martinique, 11 L. Mt. Pelée, 4428f. | 14 48 | 61 10 |
| Martinique | — St. Pierre. St. Marthe, Battery. lts. 2 F. | 14 43·9 | 61 11·2 |
| Martinique | — Fort Royal. lt. F 131f. | 14 36 | 61 4·2 |
| Martinique | — South pt. islet | 14 24 | 60 52 |
| Martinique | — Caravel rk., 96f., | 14 48·5 | 60 53 |
| | St. Lucia, NS 10 l., 4000f., N pt. | 14 5 | 60 57 |
| | — Port Castries. Vigie, lt. F 300f. | 14 1·5 | 61 1 |
| | — W pt., 2 Sugarloaves, blk, vis. 16 l. | 13 47 | 61 5 |
| Windward Is. | St. Vincent I., NS 5 l., 3000f. | 13 23 | 61 11 |
| Windward Is. | — Kingston, Fort Charlotte, lt. F 640f. | 13 9 | 61 13·2 |
| Windward Is. | Bequia I., 2 l, W, Admiralty Bay, r, b, N pt. | 13 5 | 61 12 |
| Windward Is. | Grenada, 5 l., 2749f., (2m.), S pt. | 11 59 | 61 42 |
| Windward Is. | — St. George, fort, lt. F | 12 3 | 61 45 |
| | Barbados, 6 L. 1104f., E pt., lt., | 13 9·9 | 59 25·5 |
| | — Ricketts Battery | 13 5·7 | 59 37·2 |
| | — Bridgetown, Engr.'s Wharf | 13 5·2 | 59 36·7 |
| | **GULF OF MEXICO.** | | |
| | C. Sable, fort | 25 7 | 81 5 |
| | C. Romano, l, (bk. SW 9m., 5 f.) | 25 51 | 81 42 |
| | Saniabel I., r, w, b, lt. F, Fl., 98f. | 26 27 | 82 1 |
| | Tampa B., Egmont Cay at entr., lt. F 86f. ⊕ | 27 36·1 | 82 46 |
| | Anclote Cays. lt. Fl. 100f. | 28 10 | 82 52 |
| Florida | Cedar Cays, Dépot Cay, (shl. 7m.). lt. F, Fl. 75f. | 29 6 | 83 4 |
| Florida | St. Mark's, lt. E entr. F 83f. | 30 4·4 | 84 10·5 |
| Florida | Dog I., [6m.]. 3 E, W. | 29 46·3 | 84 38·2 |
| Florida | St. George I., (Harb. ), C. St. George, lt. F 73f. ⊕ | 29 35·3 | 85 3 |
| Florida | C. St. Blas, l, (shl. 4m.), lt. Fl. 198f. | 29 40 | 85 21 |
| | Pensacola B., Fort Barrancas, lt. Fl. 210f. | 30 20·8 | 87 19 |
| | Mobile, lt. E entr., R 33f. | 30 13·6 | 88 07 |
| | — Choctaw Pt., lt. F 47f. | 30 40 | 88 0 |

## MARITIME POSITIONS

| Region | (159) Places | | Lat. N | Lon. W |
|---|---|---|---|---|
| Mississippi | Ship I., 7m., ; w N, mid.; W pt., lt. F 54f. | ⊕ | 30°12′6 | 88°58′ |
| Mississippi | Cat I., EW 5m., , W pt., lt. F. | | 30 13·7 | 89 10 |
| Mississippi | Chandeleur Is., , *l*, , b, , SW, lt. N pt., F 58f. | | 30 3 | 88 53 |
| Mississippi | Mississippi Riv., NE pass., Frank's I. | | 29 11·5 | 89 0 |
| Mississippi | — South Pass, lt. Fl. 108f. | | 29 1 | 89 10 |
| Mississippi | — SW Pass, lt. F 128f. | | 28 58·5 | 89 23·5 |
| Louisiana | New Orleans, City Hall | | 29 57·7 | 90 6·7 |
| Louisiana | Timbalier I., 7m, lt. F, Fl. 111f. | | 29 3 | 90 21 |
| Louisiana | Ship I., shoal, lt. R 115f. | | 28 55 | 91 5 |
| Louisiana | South west reef, lt. F 56f. | | 29 23 | 91 30 |
| Texas | Sabine Pass, Texas Pt., bar 8f., mound, lt. Fl. 85f. | | 29 43 | 93 51 |
| Texas | Bolivar Pt., lt. F 117f. | | 29 22 | 94 45·7 |
| Texas | Galveston I., 7 L, *l*, 3 mid., NE pt. | | 29 21 | 94 45·7 |
| Texas | San Luis Harb., bar 12f., town | | 29 4 | 95 6 |
| Texas | Matagorda Bay, bar 8f., lt. F 91f. | | 28 20·2 | 96 25 |
| Texas | Aransas Pass, 8f., lt. F 59f. | | 27 51·5 | 97 3 |
| Texas | Santiago, Barra de, 7f., lt. F 60f. | | 26 6 | 97 10 |
| Texas | Rio Grande, or Bravo del Norte, U.S. Observatory | | 25 57·4 | 97 7·2 |
| | **MEXICO.** | | | |
| | Rio Fernando, or Tigre | O | 25 23 | 97 20 |
| | Barra de Santander, 8f. | O | 23 48 | 98 43 |
| | Barra del Ciega | O | 22 38 | 97 52 |
| | Cerro del Mecate, 10m. inland | O | 22 47 | 98 3 |
| | Tampico, bar 16f., 8, fl. st., lt. Fl. 141f. | O | 22 16 | 97 49 |
| | C. Roxo | O | 21 35 | 97 22 |
| | Lobos I., [⅔m.], 35f., , w, r, (rf. N 2m.) | O | 21 28 | 97 13 |
| | Tuspam shl., islets, | | 21 1 | 97 10 |
| Vera Cruz | Mexico, city, St. Augustine | | 19 25·7 | 99 5 |
| Vera Cruz | Vera Cruz, w, rr, San Juan de Ulloa, lt. R 79f. | | 19 12·5 | 96 8 |
| Vera Cruz | Sacrificios I., [and rf. ½m.] | | 19 10·2 | 96 5·5 |
| Vera Cruz | Orizaba, mount, 17,895f. | | 19 5 | 97 15 |
| Vera Cruz | Cofre del Perote, Pk., 13,995f. | | 19 29 | 97 7 |
| Vera Cruz | Alvarado, bar 8f. 8, lt. F 246f. | | 18 51 | 95 48 |
| Vera Cruz | Tuxtla, volcano | | 18 30 | 95 9 |
| Vera Cruz | Roca Partida, w, r | | 18 44 | 95 3 |
| Vera Cruz | Pt. Zapotitlan, 1 , w‴ | O | 18 35 | 94 48 |
| Vera Cruz | Goazacoalcos Bar, lt. F 126f. | | 18 10 | 94 26 |
| Vera Cruz | R. Tabasco, W mo., bar 8f. lt. F, Fl. 77f. | | 18 38 | 92 44 |
| Vera Cruz | I. Carmen, 9 L, W end, Port Laguna, entr. of Terminos Lag., , w, r, b, Brit. Cons., (lt. R 100f.) | | 18 38·4 | 91 53 |
| Vera Cruz | Champoton, w, b | | 19 21 | 90 44 |
| Vera Cruz | Lerma, Ch. in square, . w′ | | 19 48·4 | 90 36·7 |
| Vera Cruz | Campeche, ′, w, r, Fort San Jose, lt. F 95f. | | 19 50 | 90 33 |

| Region | (160) Places | | Lat. N | Lon. W |
|---|---|---|---|---|
| Yucatan | Celestun, lt. F 95f. | | 20° 53′ | 90° 24′ |
| Yucatan | Pt. Palmas, | | 21 2 | 90 15 |
| Yucatan | Sisal, , w, b, fort, lt. F 60f. | ⊕ | 21 10·1 | 90 2·7 |
| Yucatan | Sisal rk., [¾m.], 8f., (Snake and Madagascar shls. NW-d 7 l.) | ⊕ | 21 21 | 90 10 |
| Yucatan | Progresso, lt. F 57f. | | 21 16 | 89 36 |
| Yucatan | Lagartos, R. San Felipe | | 21 34 | 88 18 |
| Yucatan | C. Catoche, *l*, , (N pt. of Jolbos I., 6 l.) | ⊕ | 21 36 | 87 6 |
| Yucatan | Contoy I., 4m., *l*, , N pt. | | 21 32 | 86 49 |
| Yucatan | Mugeres I., 5m., 80f., , w, b, S pt., Stone turret | | 21 12·7 | 86 40·5 |
| Yucatan | Cozumel I., 8 l., 70f., , N pt. | | 20 35·5 | 86 44·7 |
| Yucatan | Ascension B., Noja spit | | 19 37 | 87 27 |
| Is. &c. in Gulf of Mexico | Arcas, [2m.], rks., , W Cay | ⊕ | 20 12·6 | 91 59·7 |
| Is. &c. in Gulf of Mexico | Obispo, shls., 2, 5m., s, , N one, beac. buoy | | 20 28·5 | 92 13 |
| Is. &c. in Gulf of Mexico | Triangles, 3 Is., 7m., *l*, rk., , , b, E one | ⊕ | 20 54·9 | 92 13 |
| Is. &c. in Gulf of Mexico | English bank, [s] | ⊕ | 21 47 | 91 56 |
| Is. &c. in Gulf of Mexico | Baxo Nuevo, [2c.], rf., *l*, 8, beac. 35f. | ⊕ | 21 50·5 | 92 5 |
| Is. &c. in Gulf of Mexico | Cay Arenas, Sandy I., [3m.], *l*, , beac. 20f., N pt. | | 22 8 | 91 23 |
| Is. &c. in Gulf of Mexico | Alacranes, 5 l., rks., 8, Whale rock | | 22 35 | 89 49 |
| Is. &c. in Gulf of Mexico | — Port, , Perez I., [4c.], huts | ⊕ | 22 23·6 | 89 42·2 |
| | **HONDURAS.** | | | |
| | Chinchorro bk., or Northern Triangles, 8 l., Great Cay, N pt. | | 18 37 | 87 20 |
| | Ambergris I., or Cay, E or Reef Pt., 8 2m. | | 18 6 | 87 50 |
| | — S pt. | | 18 23 | 87 23 |
| | Lt. ho. reef, 10 l., SE pt., Half Moon Cay, , lt. F 88f. | | 17 12 | 87 33 |
| | Turneffe, rfs., 10 l., Mauger Cay, 3 lts. F 53f., 49f. | | 17 36 | 87 46 |
| British Honduras | Glover rf., 5 l., S pt. | | 16 41 | 87 53 |
| British Honduras | Belize, , Fort St. George, , lt. F 43f. | | 17 29·3 | 88 12 |
| British Honduras | Dolphin Hd., 5m. inland | | 17 17 | 88 24 |
| British Honduras | Cockscomb Mt., 4000f. | ⊖ | 16 48 | 88 38 |
| British Honduras | Pt. Icacos. (w N ¾m.) | ⊕ | 16 14·3 | 88 36 |
| British Honduras | R. Dulce, entr., W pt. | | 15 49 | 88 47 |
| British Honduras | C. Three Pts., *l*, , (shls. 4 or 5 l.), NW pt., w, | | 15 58 | 88 39·5 |
| | Omoa, St. Fernando, fort | ⊕ | 15 47·2 | 88 3·7 |
| | Saddle hill, 1760f. | ⊕ | 15 45·0 | 87 58 |
| | Sal rocks, pt. | | 15 55 | 87 38 |
| | Cangrejo Pk., 8040f. | | 15 38 | 86 53 |
| | Truxillo, fort | | 15 55·7 | 85 59·5 |
| | C. Honduras, or Castilla, *l* | | 16 2 | 86 4 |
| | Utilla I., 7m., 8, NE pk. | ⊕ | 16 7·5 | 86 52·7 |
| | Salmadina shl., [1m.] | ⊕ | 15 54 | 87 4 |
| | Hog Is., [1 l.], highest hill on W. I. | ⊕ | 15 58 | 86 32·7 |
| | Rattan I., 9 l., , Coxen bay, lt. F. | | 16 18 | 86 35 |

## MARITIME POSITIONS

| | (161) Places | Lat. N | Lon. W |
|---|---|---|---|
| Honduras | Rattan Is., Port Royal Harb., ⊞, w', ł, George Cay, N W pt. | 16° 24'3 | 86° 19'2 |
| Honduras | Barburet I., δ 1 l. E | 16 26 | 86 9 |
| Honduras | Bonacca I., ⚓ 3 l., ⊞ NW and SE, *h*, ⚓, r̄, sum. 1200f. | 16 28 | 85 55 |
| Honduras | Misteriosa bk., ⚓ 8 l. π, S pt. π | 18 44 | 84 2 |
| Honduras | Swan Is., 2, EW 4m., W one, ⚓, w r r̄, E pt. ⊕ | 17 25 | 83 53 |
| Honduras | Poyas Pk., 3700f., 12m. inland | 15 44 | 84 56 |
| Honduras | C. Camaron, projecting, *l* | 16 0 | 85 3 |
| Honduras | Black R., bar δ, w', b | 15 57 | 84 56 |
| Honduras | Patook R. | 15 49 | 84 18 |
| Honduras | Caratasca lag., entr. 8f., E pt | 15 23·7 | 83 43 |
| Honduras | False Cape, *h*, δ shl | 15 13 | 83 22 |
| Honduras | C. Gracias à Dios, *l*, ⚓, $w_o$, b | 14 59 | 83 11 |
| Off-lying Islands and Cays | Bank off C. Gracias, N part | 16 48 | 82 10 |
| Off-lying Islands and Cays | — East extr., π | 15 32 | 80 56 |
| Off-lying Islands and Cays | Caxones, or Hobbies, ⚓ 4l., E pt. | 16 3 | 83 6 |
| Off-lying Islands and Cays | Cay Gorda, [2m.], ⚓$_o$, (SE-d. 2 l) | 15 52 | 82 24 |
| Off-lying Islands and Cays | Alargate rf., ⚓ 10m., E pt. | 15 7 | 82 20 |
| Off-lying Islands and Cays | Mosquito Cays, ⚓ 60f., (w W 5m., ⚓ S 1), SE part | 14 20 | 82 44 |
| Off-lying Islands and Cays | Rosalind bk., SE shl. part, 1, [5m.] | 16 8 | 80 17 |
| Off-lying Islands and Cays | Serranilla bk., Cays, EW 25m. S, beacon Cay, 8f. | 15 48 | 79 51 |
| Off-lying Islands and Cays | Serrana bk., ⚓ 6 l., δ, SW Cay, 32f. | 14 16 | 80 24 |
| Off-lying Islands and Cays | Quita Sueño bk., rf., NS 8 l., S pt. | 14 8 | 81 9 |
| Off-lying Islands and Cays | Roncador Cay, ⚓ 6m., 7f., ⚓, w, S pt. T | 13 31 | 80 2 |
| Off-lying Islands and Cays | Old Providence and Catalina Is., [rfs. 5 l.], w' W, b, r, ⚓ ⚓$_o$ W, sum. 1190f. | 13 21 | 81 23 |
| Off-lying Islands and Cays | St. Andrew's I., ⚓ 8m., 50f., w''', r', SW cove | 12 31·7 | 81 44 |
| Off-lying Islands and Cays | Courtown bk., ⚓ 7m., SW Cay, ⚓$_o$, w | 12 24 | 81 29 |
| Off-lying Islands and Cays | Albuquerque Cays, [4m.], ⚓ W | 12 10 | 81 54 |
| Mosquito Coast | Bragman's Bluff, ⚓ 1 S, w, *l* | 14 3 | 83 22 |
| Mosquito Coast | Rio Grande, bar 8f. | 12 54 | 83 32 |
| Mosquito Coast | Pearl Lagoon, entr., N pt., (shl.) | 12 21 | 83 38 |
| Mosquito Coast | Blewfields, ⊞ $^{15}_{12}$, (shifting bar), r, W pt. of bluff | 11 59·3 | 83 41 |
| Mosquito Coast | Little Corn I., *l*, ⚓, [1½m.], W pk. | 12 17·0 | 82 36 |
| Mosquito Coast | Great Corn I, ⚓ 2½m., *h*, ⚓, $w_{,,}$ b, r, ⚓ ⚓$_o$ SW pt., sum. | 12 9·2 | 82 59·7 |
| Mosquito Coast | Pajaro I., small, 155f. | 11 31 | 83 43 |
| Costa Rica | San Juan de Nicaragua, (called Grey-town, 1848), [⚓], w''' up riv., b, r | 10 55 | 83 43 |
| Costa Rica | Pt. Arenas ⊕ | 10 56·7 | 83 43·2 |
| Costa Rica | Mt. Cartago, 11,100f. ⊕ | 10 2 | 83 48 |
| Costa Rica | Pt. Blanco, Grape Cay, E of do., (w W 1m.), lt. F 60f. ⊕ | 10 0·0 | 83 2·5 |
| Costa Rica | Carreta Pt., w W 2m. | 9 38 | 82 40 |
| Costa Rica | Boca del Toro, ⊞, fort, w' ⚓ 1m., $r_o$, b ⊕ | 9 20·5 | 82 15·2 |
| Costa Rica | Blanco Pk., 11,740f. | 9 17 | 83 4 |
| Costa Rica | Shepherd's Harb., ⊞, Cay, ⚓ 2½m., White hut ⊕ | 9 14·4 | 82 20·7 |
| Costa Rica | Zapadilla Cays, ⚓ 3m., E pt. | 9 15 | 82 2 |

| | (162) Places | Lat. N | Lon. W |
|---|---|---|---|
| Chiriqui | Chiriqui, lag., ⊞, Chica Mola riv. ⊕ | 8° 59'0 | 81° 55'7 |
| Chiriqui | Valiente Pk., 722f. ⊕ | 9 10·5 | 81 55 |
| Chiriqui | Escudo I., ⚓ 2½m., *l*, ⚓, w W pt. ⊕ | 9 6·4 | 81 34·5 |
| Chiriqui | High pk., 5251f., (⚓ 6m. of Buppan bluff) ⊕ | 8 42·7 | 81 30·0 |
| Chiriqui | Castle Choco, 6342f., 5 l. inland ⊕ | 8 37 | 80 52 |
| | **ISTHMUS OF PANAMA.** | | |
| Isthmus of Panama. | Chagre, w riv., $rr_o$, San Lorenzo, fort ⊕ | 9 19·7 | 79 59·5 |
| Isthmus of Panama. | ASPINWALL, or COLON, lt. F 60f. | 9 22·2 | 79 54·7 |
| Isthmus of Panama. | Porto Bello, $rr_o$, ⊞, Fort St. Jeronymo ⊕ | 9 32·5 | 79 38·5 |
| Isthmus of Panama. | Farallon Sucio, rk | 9 39 | 79 37 |
| Isthmus of Panama. | Pt. Manzanilla, *h*, ⊥ ⊖ | 9 39 | 79 32 |
| Isthmus of Panama. | Pt. San Blas, *l*, (rf. 2m.) ⊖ | 9 35 | 78 58 |
| Isthmus of Panama. | Mandinga, ⚓' | 9 30 | 78 58 |
| Isthmus of Panama. | Muletas Archipelago, E pt. | 9 37 | 78 38 |
| Isthmus of Panama. | Pt. Musquitos | 9 8 | 77 56 |
| Isthmus of Panama. | Pinos I., [1m.], *h*, ⚓, NE pt. | 9 1·5 | 77 46 |
| Isthmus of Panama. | C. Tiburon, ⊥, *h*, rky., (⚓ 11 W) | 8 41 | 77 21·5 |
| New Grenada | Pt. Caribana, (shl. ⚓ 5m.) | 8 38 | 76 53 |
| New Grenada | I. Fuerte, [1½m.], ⚓, ⚓ ⚓, δ | 9 24 | 76 10·7 |
| New Grenada | Cispata Harb., ⊞, East pt. Zapote | 9 24 | 75 50 |
| New Grenada | Santiago de Tolu, E entr. | 9 31 | 75 38 |
| New Grenada | San Bernardo Is., [3 l.], *l*, ⚓, Nst. one | 9 48 | 75 53 |
| New Grenada | Tortuga shls., 2, outer, [1] | 10 3 | 75 57 |
| New Grenada | Rosario Is., [2 l.], Wst. one | 10 11 | 75 51 |
| New Grenada | Cartagena, ⊞, Dome ⊕ | 10 25·6 | 75 34·0 |
| New Grenada | — Entrance, fort, lt. F 60f. | 10 19 | 75 35 ? |
| New Grenada | Pt. Canoas, *l*, *h*, over, (rks. S W-d. 3m. 8f.) | 10 34 | 75 33 |
| New Grenada | Pt. Galera, *l* | 10 47 | 75 26 |
| New Grenada | Port Sabanilla, ⊞, lt. F, Fl. 98f. | 11 0 | 74 58 |
| New Grenada | Magdalena Riv., bar, $\|_o$, b, $w_{,,}$ C. Augusta | 11 6 | 74 51 |
| New Grenada | Sta. Marta, ⊞, Morro, lt. F 328f ⊕ | 11 15 | 74 14·7 |
| New Grenada | C. Aguja, ⊥, *h*, T, (rks. 3c.) | 11 20 | 74 12 |
| New Grenada | C. San Juan de Guia | 11 21 | 74 0 |
| New Grenada | Hacha, δ, lt. F 90f. | 11 33 | 72 55 |
| New Grenada | C. Vela, (islet 2c. off, δ$_o$), E pt. | 12 10 | 72 12 |
| New Grenada | Bahia Honda, ⚓', δ shl. in mid. entr., E pt. | 12 19 | 71 46 |
| New Grenada | Pt. Gallinas, (shl. 2m.) | 12 25 | 71 42 |
| New Grenada | Druid shl., [1], T E | 12 30 | 71 39 |
| New Grenada | Pt. Espada | 12 4 | 71 8 |
| New Grenada | Zapara Castle | 11 1 | 71 38 |
| New Grenada | Maracaybo, ⊞$_{1,,}$ bar, entr., (shifts) | 11 2 | 71 39 |
| New Grenada | — Town, 20m. up the lake, 10f. | 10 41 | 71 42 |
| New Grenada | Pt. Arenas | 11 7 | 70 55 |
| New Grenada | Coro | 11 24 | 69 44 |
| New Grenada | Pt. Cardon, *l* | 11 36 | 70 18 |
| New Grenada | C. San Roman | 12 11 | 70 5 |
| New Grenada | Pt. Manzanilla | 11 31 | 69 20 |
| | **VENEZUELA.** | | |
| | Monjes, δ$_o$, N rks. | 12 29 | 70 57 |
| | Oruba I., ⚓ 5 l., Port Caballos, lt. F 40f. | 12 29 | 70 7 |
| | Curaçao I., ⚓ 12 l., Mount S. Christoffel, 1200f. | 12 19 | 69 9 |

## MARITIME POSITIONS

| (163) | Places | Lat. N | Lon. W |
|---|---|---|---|
| *Coast of Venezuela* | Curaçao, Rif fort, St. Ann, ⊞ | 12° 6'3 | 68° 57' |
| | Little Curaçao, (2m.], *l*, lt. F 75f. | 11 59 | 68 35 |
| | Buen Ayre I., ⚓ 6 l., Lacre pt., lt. F 85f. | 12 2 | 68 17 |
| | Aves Is., 2 grps., EW 5 l., W one, [2 l.], ~, S Id. | 11 59 | 67 40 |
| | Los Roques, EW 8 l., Port El Roque, N side, ⚓', w, b, N pt., lt. R 208f. | 11 58 | 66 38·5 |
| | Orchila, [7m.], W pt., rk. 10f. | 11 49 | 66 14 |
| | St. Juan B., Cay St. Juan ... ⊖ | 11 10 | 68 23 |
| | Tucacas, ⊞, Ore house | 10 47 | 68 20 |
| | Porto Cabello, ⊞, lt. Fl. 82f. | 10 29·4 | 68 2·7 |
| | La Guayra, ⚓, w, r', Trinchera Bastion, lt. F 300f. ⊕ | 10 36·9 | 66 56·5 |
| | Caraccas, 3000f., 7m. inland | 10 30 | 66 57 |
| *Caraccas* | Peak, or Silla de Caraccas, 5m. inland, 8500f. | 10 32 | 66 52 |
| | Pt. Maspa, (rks. off) | 10 40 | 66 19 |
| | Centinella, 70f. | 10 49 | 66 9 |
| | C. Codera, *l*, T, (⚓' W ?, Corsair B.), W pt. | 10 36 | 66 7·5 |
| | Morro of Barcelona, (City ⊹ 2¼m.) | 10 13·5 | 64 43 |
| | Cumana, Fort Antonio, w', lt. F 44f. | 10 27·6 | 64 12 |
| | Pt. Escarseo | 10 40 | 64 16 |
| | Tortuga I., EW 4 l., Oriental Pt. | 10 55 | 65 12·5 |
| | Blanquilla I., NS 2 l., (*l*, ✱ o, $\delta_o$, w W, ⚓ NW), N pt. | 11 55 | 64 37 |
| | Hermanos, ⚓ 10m., T, $\delta_o$. S rk. | 11 42 | 64 29 |
| *Cumana* | Margarita I., EW 12 l., (N Coast $\delta_o$), N pt., C. Isla | 11 10 | 63 54 |
| | — Pampatar, Castle | 10 59 | 63 49 |
| | — West extr. | 10 58·5 | 64 25 |
| | Sola I., rk. δ | 11 19 | 63 36 |
| | Testigos Is., ⚓ 2¼m., $\delta_o$, ⚓ SW s, w, vis. 5 l., Grt. I. | 11 23 | 63 8 |
| | Carupano B., lt. F 130f. | 10 41·2 | 63 14·7 |
| | C. Three Points, $\delta_o$ ½m. | 10 45 | 62 41 |
| | Peñas Pt., (W pt. of Dragon's Mouth) | 10 44 | 61 51 |
| | Pt. Foleto, mouths of Orinoco R. | 10 0 | 62 18 |
| | **Trinidad and Tobago.** | | |
| *Trinidad* | Trinidad, ⚓ 26 l., E pt., Pt. Galera, *l*, rky. | 10 50 | 60 54 |
| | — Guayguarare Bay | 10 9·2 | 61 1 |
| | — Chacachacare I., [2m.], 830f., E side of Dragon's Mouth), sum. | 10 41·7 | 61 45 |
| | — Port Spain, ⊞, fort lt. F 50f. | 10 38·7 | 61 30·7 |
| | — West pt., Pt. Icacos, T, lt. F 39f. | 10 3·8 | 61 55·7 |
| | — SE pt., Pt. Galeota, vis. 6 l. | 10 8·2 | 60 59·2 |
| | Tobago, ⚓ 8 l., N pt., Marble I. | 11 21·8 | 60 31 |
| | — SW pt., shoal, 6m. SW | 11 8·6 | 60 50 |
| | — Rockly Bay, lt. F on E pt. | 11 10·1 | 60 42·4 |
| | **GUIANA.** | | |
| | Orinoco, E mo., (shls.), Crab I., [3 l.], N pt. | 8 42 | 60 55 |

| (164) | Places | Lat. | Lon. W |
|---|---|---|---|
| | | North | |
| | Pt. Barima, lt. v. F, s, 50f. | 8° 36' | 60° 23' |
| | Mocomoco Pt. | 8 39 | 60 10 |
| | R. Guayama entr. (bk. N 6 l., hills to SW-d. inland) | 8 25 | 59 57 |
| | Coco Pt., *h*, ⚓ ... ○ | 8 0 | 59 25 |
| | C. Nassau, E pt. of Pauroma R., (shl.) | 7 36 | 58 56 |
| | R. Essequibo, beacon E of Leguwan I. | 7 0 | 58 18 |
| *British Guiana* | — Fort Zealand | 6 47 | 58 32 |
| | R. Demerara, ⊞ $^{4}_{7}$, bar, beac., (5 or 6 ⚓ 9m. E-d. in 1834) | 6 58 | 58 14 |
| | Georgetown, lt. R 103f. | 6 49·4 | 58 11·5 |
| | Berbice R., shl., ⊞, bar 7f., Crab I., [1m.], *l*, ⚓ | 6 21 | 57 30 |
| | — Fort York | 6 19 | 57 32 |
| | Corentyn R., (shls. 3 l.), Nickerie Fort | 5 57·5 | 57 0 |
| *French and Dutch Guiana* | Coppename R., E pt., entr. ⊖ | 5 54 | 55 56 |
| | R. Surinam, Fort Amsterdam | 5 53 | 55 5·5 |
| | — Paramaribo, Church | 5 49 | 55 9 |
| | Post Orange | 5 57 | 54 34 |
| | R. Maroni, W pt., lt. F 76f. | 5 44 | 54 0·5 |
| | Mana R., Establ. on W bk. | 5 37 | 53 50 |
| | Salut, or Devil's Is., 3, [¾m.], ⚓ ⊹, S one, w, lt. F 197f. | 5 17 | 52 35 |
| | Cayenne, ⊞, fort, lt. F 130f. | 4 56·5 | 52 20 |
| | Mother rk., [¾m.], pilot sign | 4 53 | 52 10 |
| | Gunner's Is., ⚓ 2m., E, or grt. one | 4 50 | 51 54 |
| | Pt. Behague, *l*, ⚓, at E entr. of Aprouak Riv. | 4 35 | 51 53 |
| | Argent Mount | 4 22 | 51 39 |
| | C. Orange, *l*, ⚓ | 4 20 | 51 27 |
| | C. Cachipour, *l*, ⚓, NE part | 3 50 | 51 3 |
| | Mt. Mayé | 2 47 | 50 54 |
| | Maraca I., [3 l.], *l*, Old Cape North | 2 15 | 50 18 |
| *R. Amazon* | Cabo do Norte ○ | 1 40 | 49 57 |
| | Bailique I., [7m.], N pt. | 1 4 | 49 56 |
| | Macapá, fort | 0 0·8 | 51 2 |
| | Mexiana I., ⚓ 11 l., 8 W, E pt. | 0 0 | 49 19 |
| | **BRAZIL.** | | |
| | | South | |
| | Chaves | 0 18 | 49 55 |
| | Frescas I., [2m.] | 0 3 | 48 59 |
| | C. Magoari, NE pt. | 0 13 | 48 26 |
| | PARA, CUSTOM HOUSE | 1 27 | 48 30 |
| | Braganza shl. and bks., ⚓ 7 l., lt. F 30f. | 0 25 | 47 58 |
| | Salinas, vill., δ | 0 36 | 47 24 |
| | Cajetuba I., N pt. | 0 31 | 47 42 |
| | Aialaia Pt., lt. Rev | 0 36 | 47 22 |
| | Caite Is., NE part | 0 43 | 46 57 |
| | C. Gurupi, N pt. | 0 54 | 46 14 |
| | Pt. Tamandua | 1 16 | 45 23 |
| | I. St. Joao, ⚓ 4 l., *l*, w, lt. F 78f. | 1 17 | 44 55 |
| | Itacolomi Pt., ⚓, lt. R 147f. | 2 10 | 44 24·7 |
| | Maranham, ⊞ $^{27}_{11}$, w', r, Cathedral ⊕ | 2 31·7 | 44 16·7 |
| | Coroa Grande shl., rks., centre | 2 14 | 43 59 |
| | Fort St. Marcos, lt. F 119f. | 2 29 | 44 17 |

## MARITIME POSITIONS

| | (165) Places | Lat. S | Lon. W |
|---|---|---|---|
| | Manoel Luiz shl., [1 l.], T, $\beta\beta_o$, W rk. | 0° 51′ | 44° 17′ |
| | Silva shl. | 0 32 | 44 19 |
| | I. St. Anna, [7m.], (rfs. 4 l.), lt. R 190 f. | 2 16 | 43 38 |
| | Lançoes Grandes, W pt. | 2 21 | 43 22 |
| | Barra Velha, B. Paranahyba, lt. F | 2 50 | 41 44 |
| N. Coast | Jericoácoará w̄, r, E sand hill | 2 47 | 40 28 |
| | Almufedas, vill., Steeple in | 2 56 | 39 48 |
| | Mt. Melancias, isolated sand hill | 3 12 | 39 18 |
| | Ceara, Church tower | 3 43 | 38 32·5 |
| | Pt. Macoripe, lt. F 85f. | 3 42 | 38 27 |
| | Jaguaribe R., bar, $\beta\beta_o$, w, N pt., lt. F | 4 25 | 37 45 |
| | Aracati, town | 4 31 | 37 48 |
| | Morro Tibaõ, red sand hill | 4 49 | 37 18 |
| | Pt. do Mel, ? (shls.), N pt. | 4 55 | 36 53 |
| | Pt. Tubaraõ, N sand hill | 5 2 | 36 28 |
| | Urcas, shls., $\beta$, T N, N edge | 4 50 | 36 16 |
| | C. St. Roque, l, ⊥ | 5 30 | 35 16 |
| | Rio Grande do Norte, Circular Fort on ledge, (w ½m.), lt. F 43f. | 5 45 | 35 11 |
| | Parahyba do Norte Riv., 12/7, Pedra Secca, lt. R 52f. | 6 56 | 34 49 |
| | Fort Cabedello | 6 57·8 | 34 50 |
| | C. Branco. sand, ⊥, (2 at pt ?) | 7 8 | 34 48 |
| Brazil | Pt. de Guia, E extr. of S. Amer. | 7 26 | 34 47 |
| | Olinda Pt., lt. Occ. | 8 1 | 34 50 |
| | PERNAMBUCO, 15/81, bar, w′, r, b, Fort Picao, lt. R | 8 3·4 | 34 52 |
| | C. St. Agostinho, Ch. sum. | 8 20 | 34 56 |
| | Mt. Sellada, S pk. | 8 25 | 35 11 |
| | St. Aleixo I., [2c.], w | 8 36 | 35 0 |
| | Tamandaré, fort | 8 43 4 | 35 5 |
| | Maceio, w, fort, (lt. R 208f.) | 9 39 | 35 39 |
| | R. St. Francisco, S, or Samoco Pt., l, $\beta$ 1½m., lt. F 59f. | 10 29 | 36 24 |
| | Itabayana Mts., sum. | 10 47 | 37 23 |
| | Tres Irmaos, 3 mts., 2 l. inland, SE hill | 11 16 | 37 17 |
| | Mt. Masarandupio, 10m. inland | 12 24 | 38 4 |
| | BAHIA, [b], C. ST. ANTONIO, lt. R 140f. ⊕ | 13 0·7 | 38 32 |
| | Morro St. Paulo, lt. R 27ef. | 13 23 | 38 52 |
| | Quamannu B., Pt. de Muta | 13 52 | 38 56 |
| | Os Ilheos, rks., large one | 14 47 | 39 0 |
| | St. George, town, fort | 14 49 4 | 39 1 |
| E. Coast | Porto Seguro, r, Cathedral | 16 26·8 | 39 0 |
| | Abrolhos Is., [1½m.], W 8m., St. Barbara, lt. Rev. 189f. | 17 58 | 38 41 |
| | Sta. Cruz, Ch. | 16 17·3 | 39 0·2 |
| | Rio Doce, W pt., entr. | 19 37 | 39 46 |
| | Espiritu Santo B., w′, r, b, Sta. Luzia, lt. F 66f. | 20 19 | 40 16 |
| | Guarapari, Ch. | 20 43·9 | 40 27 |
| | Calvada Islet, 4m. out, W | 20 44 | 40 21 |
| | C. St. Thomé, l, (bks. 15m. off), lt. Fl. 157f. | 22 2 | 41 0 |
| | St. Ann Is., 3, 4m., w, b, sum. grt. | 22 25 | 41 41 |

| | (166) Places | Lat. S | Lon. W |
|---|---|---|---|
| | Anchoras Is., [1 l.]. E one | 22° 40′·5 | 41° 45′ |
| E. Coast | C. Frio, (I. 2½m.), S pt., lt. Fl. 300f. | 23 1·3 | 41 57 |
| | C. Negro, l, $\delta_o$ 3m., pt. | 22 57 | 42 39 |
| | Maricas Is., 1 l., $\delta_o$, Sst. | 23 1 | 42 54 |
| | Raza I., [¾m.]. lt. R 315f. | 23 3·7 | 43 8·7 |
| | RIO JANEIRO, fort Villagagnon, [b]. lt. F 59f. | 22 54·8 | 43 9·5 |
| | Rio Janeiro, OBSERVATORY | 22 54·4 | 43 10·2 |
| | Gabia Mt. | 22 59 | 43 17 |
| | Pt. Guaratiba, hill | 23 3·6 | 43 32 |
| | Marambaya I., EW 8 l., T S, W pt., (E entr. of Ilha Grande B., w, b), hill 2066f. | 23 4·4 | 43 59 |
| | Lage rk., 18f. | 23 6·6 | 43 49 7 |
| | I. Grande, EW 6 l., N, E. pt., or Pt. Castelhanos | 23 9·7 | 44 5·2 |
| | Ubatuba Ch. | 23 25·9 | 45 3·7 |
| | Pt. Cairoçu, E sum. of mt. | 23 18·2 | 44 35 |
| | Porcos Is., [rks. 4m.], ′, S hill | 23 32 9 | 45 3·2 |
| | Busios Is., [2m.], SE one | 23 44·5 | 44 59 |
| | St. Sebastian, (w, r, b), town | 23 47 | 45 21 |
| | St. Sebastian I., 5 l., vis. 15 l., S pt. | 23 57 | 45 15 |
| | Mont de Trigo, h | 23 51 | 45 45 |
| | Moela, lt. F 334f. | 24 2 | 46 13 |
| | Santos Harb., r, w′ 7m. up river, b, Arsenal | 23 55 8 | 46 19 |
| Brazil | Pt. Taypu | 24 1 | 46 24 |
| | Alcatrasses Is., rks., 5m., sum. | 24 6 | 45 40 |
| | Lage de Santos, rk. 7f. | 24 18 | 46 11 |
| | Queimada, Is., 2, 10m., large or outer one | 24 28 | 46 40 |
| | Iguape R. | 24 37 | 47 22 |
| | Bom Abrigo, I., [1½m.], h, lt. Fl. 504f. (E, Cananea, bar s) | 25 7 | 47 52 |
| | Mt. Cardoz ⊕ | 24 59 | 48 6 |
| | Figueira I., [⅓m.?], 160f., T | 25 22 | 48 3 |
| S. E. Coast | Paranagua B., town | 25 31 | 48 28 |
| | I. do Mel, 3m., lt. F 262f. | 25 33 | 48 18 |
| | Coral I., [1m.?], 64f., $\delta_o$ 2m. | 25 47 | 48 22 |
| | R. Guaratuba, pt., hill | 25 33 | 48 36 |
| | St. Francisco I., 6 l., h, C. Joao Dias, lt. F 309f. | 26 10 | 48 33 |
| | Tamboretes Is., [1 l.], S one | 26 21 | 48 32 |
| | Itapacoroya Pt., N part | 26 47 | 48 47 |
| | Pt. Bombas | 27 8 | 48 29 |
| | Arvoredo I., 2m., lt. F, Fl. 292f. | 27 18 | 48 22 |
| | Anhatomirim, w N 2m., r, b, fort, fl. st., lt. F 125f. ⊕ | 27 25·5 | 48 34·5 |
| | St. Catherine I., 10 l., (NW-d.), N pt. | 27 22·5 | 48 25·7 |
| | — Nostra Senhora de Desterro | 27 35 4 | 48 32 |
| | Pt. dos Naufragados, lt. Rev. 149f. | 27 49 | 48 32 |
| | Pt. Pinheira | 27 54 | 48 35 |
| | Batuba Pt., lt. F 69f. | 28 16 | 48 40 |
| | Lagoa, (City 1m. W-d.) bar | 28 28·5 | 48 48 |
| | C. Sta. Marta | 28 39 | 48 50 |
| | Rio Grande do Sul, entr. s, w̄, r′, E pt. tower, lt. F, Fl. 104f. | 32 7 | 52 7 |

## MARITIME POSITIONS

| | (167) Places | Lat. S | Lon. W |
|---|---|---|---|
| | **URUGUAY.** | | |
| R. Plate | C. Polonio, lt. F 137f. | 34°25′ | 53°47′ |
| | Ranger rk., small. ßß₀ | 34 30 | 53 51 |
| | C. St. Mary, (⚓ N-d. ᴛ̅ᴅ), lt. Rev. 132f. | 34 40 | 54 9 |
| | I. Lobos, [1m.]. (rfs. E d. 3m.) | 35 1 | 54 52 |
| | Maldonado, tower, w ⊕ | 34 53·5 | 54 57·7 |
| | Flores I., [1m.], lt. R² 106f. | 34 57 | 55 55 |
| | Monte Video, Rat I. | 34 53·5 | 56 14 |
| | Colonia, lt. Rev. 110f. | 34 28 | 57 51·7 |
| | **ARGENTINA.** | | |
| Buenos Ayres | Buenos Ayres, Custom House, lt. F | 34 36·5 | 58 22·2 |
| | Santiago, pier head, lt. F | 34 48 | 57 53·5 |
| | C. St. Antonio, N pt., or Pt. Rasa | 36 19 | 56 45 |
| | Pt. Medano, (shl. 6m.), S sum. | 36 59 | 56 41 |
| | Mar Chiquito, (entr. impract.) | 37 47 | 57 22 |
| | C. Corrientes, h, ⊥, 120f., E sum. | 38 5 | 57 29 |
| | Pt. Mogotes, h, 104f., δ 2m. | 38 5·7 | 57 31·2 |
| | Gueguen R., ‖₀ | 38 36 | 58 40 |
| | Sierra Ventana, 3500f. | 38 11·7 | 61 56·5 |
| | Bahia Blanca, Mt. Hermoso, lt. F 168f. | 38 59 | 61 39 |
| | — Fort Argentino | 38 43·8 | 62 15 |
| | R. Colorados, bar 7f. | 39 52 | 62 4 |
| | Union B., 11f., Indian Hd., 45f., ⊥. ✱. w′, b | 39 57·5 | 62 7·2 |
| | San Blas Harb., ⊞. w′. b‴, r, r̄. Main Pt. 35f., W entr. | 40 30·4 | 62 8 |
| | R. Negro, bar 8f.? South Barranca, r, b, lt. F 143f. | 41 3 | 62 48 |
| | Port St. Antonio, ⊞. ✱, b. E hd., or Villariño Pt., (bk. 4m. S), hum 40f. | 40 49 | 64 54 |
| | Sierra de Sn. Antonio, 1700f. | 41 41 | 65 12 |
| | Port San Josef, w₀, b, W head, pt. | 42 14 | 64 25 |
| | Valdez Penins., Pt. Norte, δ 1m. | 42 3 | 63 48 |
| | Pt. Delgada, 200f., SE cliff | 42 46 | 63 37 |
| | Nuevo G., E, or Nuevo Hd., ⊥, 200f., T, (w′. b) | 42 53 | 64 8 |
| | — W hd., Ninfas Pt. 240f., rks. 2m., E cliff | 42 58 | 64 20 |
| Patagonia, E. Coast | Salaberria 11f., ⚓ 8m., N and E pt. | 44 25 | 65 8 |
| | Port St. Elena, w₀, b, S Head | 44 32 | 65 22 |
| | C. Two Bays | 44 55 | 65 31 |
| | Arcé I., [1m.], SE sum. | 45 1 | 65 29 |
| | The Oven, or Prince Regent haven, ⊞, entr. | 45 0 | 65 40 |
| | Medrano rks. | 45 10 | 65 53 |
| | Tova I., ⚓ 4m., (Cove ⚓, ⊥′, b″, w) | 45 6 | 65 56 |
| | C. Aristazabal. (rks. off) | 45 13 | 66 30 |
| | Salamanca Pk., 700f. | 45 34 | 67 20 |
| | C. Three Pts., ab. 2000f., δ₀ 1m., NE pitch | 47 6 | 65 51 |
| | C. Blanco, l, rugged, (shls. 2 l.), NE sum., (S Cove, w₀. b‴) | 47 12 | 65 44 |
| | Port Desire, w′, b′, ruins | 47 45 | 65 55·5 |
| | Sea Bear B., ⚓′, b₀, ✱ at pt., Penguin I. | 47 55 | 65 42 |
| | Sirius rk. | 48 7 | 65 37 |
| | Monte Video, ab. 300f. | 48 14 | 66 26 |

| | (168) Places | Lat. S | Lon. W |
|---|---|---|---|
| | Watchman C., l, (shl. 2 l., s) | 48°21′ | 66°20′ |
| | Bellaco rk., or Eddystone, 6f. | 48 29 | 66 12 |
| | C. Curioso, l, striped | 49 11 | 67 37 |
| | Wood's Mt., vis. 11 l. | 49 13·7 | 67 45 |
| | Port St. Julian, ⊞, Sholl Pt. | 49 15·3 | 67 41·2 |
| | C. Francisco de Paulo, ⊥ | 49 42 | 67 37 |
| | Port Sta. Cruz, bar 11f., Mt. Entrance, on S side, ⊥, 350f. | 50 9 | 68 22 |
| | Coy Inlet | 50 54 | 69 8 |
| | C. Fairweather, ab. 300f. | 51 32·1 | 68 55·5 |
| | Port Gallegos, ⊞, Obsn. mound | 51 33·3 | 68 59·2 |
| | Cape Virgins | 52 20·2 | 68 21·7 |
| | **FALKLAND ISLANDS.** | | |
| Falkland Is. | Jason Is., ⚓ 9 l., 8 ‖, W Cay | 50 58·5 | 61 27·7 |
| | Grand Jason, ⚓ 4m., 1210f. | 51 3·2 | 61 3 |
| | White rk. | 51 17 | 60 52 |
| | New I., NS 5m., ⊞ ⚓. NW pt. | 51 42 | 61 17 |
| | Bird I., EW 1¼m., 410f. | 52 11 | 60 54 |
| | West Falkland, ⚓ 25 l., Port Stephens, ⊞, entr. E pt. | 52 11 | 60 41·2 |
| | C. Meredith, S extr. 290f. | 52 15·2 | 60 38 |
| | Albemarle rk. 150f. | 52 13 | 60 21·7 |
| | Port Edgar, ⊞, S head. sum. | 52 0·7 | 60 13·2 |
| | C. Tamar, 150f., N cliff. sum. | 51 17 | 59 29 |
| | Port Egmont, Cove, ruins | 51 21 | 60 3 |
| | Wreck I., EW 3m., W extr. | 51 10 | 60 14 |
| | Port San Carlos, ⊞. w, b, Fanning Hd., SW sum. | 51 27·2 | 59 7·2 |
| | Eddystone rk., 200f. | 51 10 | 59 2·5 |
| | East Falkland, ⚓ 27 l., Port Salvador, ⊞. Shag I., entr. | 51 23·7 | 58 19 |
| | C. Carysfort, NE cliff | 51 25·2 | 57 50·5 |
| | Port Louis ⊞, Settlem., fl. st. ⊕ | 51 32 | 58 7 |
| | E extr.. C. Pembroke, lt. F 110f. | 51 40·7 | 57 42 |
| | Port William, Stanley ⊞, w′, r, r̄, b, Gov. Store ho. | 51 41·2 | 57 51 |
| | Lively I., NS 7m., SE pt., (rks.) | 52 4·7 | 58 25 |
| | Sea Lion Is. and rf., EW 11m., W extr. | 52 25 | 59 8·5 |
| | George I., ⚓ 7m., rks. W 2m., SW pt. | 52 22·3 | 59 47·7 |
| | Beauchene I., [1½m.], 200f., (rk. ⚓ 5m.?), S pt. | 52 55·7 | 59 12·7 |
| | **SOUTH ATLANTIC ISLANDS.** | | |
| | South Georgia, ⚓ 30 l., C. North, pt., or C. Buller | 53 59 | 37 28 |
| | Wallis I., EW 4m., W pt. | 54 4 | 38 14 |
| | Annenkov I., [2m.], pk. | 54 37 | 37 3 |
| | Green I. | 55 2 | 36 2 |
| | Moltke Harbour, Obsn. spot | 54 30·9 | 36 5·7 |
| | Clerks' rks., ⚓ 2 l., ⌒, S extr. | 55 4 | 34 38 |
| | Shag rks. ♀ | 53 48 | 42 45 |
| | Marquis de Traverse Is., h, N one, Zavodovski, [3m.] | 56 18 | 27 29 |
| Sandwich Is. | — W one, or Lieskov, [2m.] | 56 41 | 28 10 |
| | Candlemas Is., EW 6m., h, volc., E one | 57 10 | 26 45 |
| | Saunders' I., ⚓ 6m., sum. | 57 52 | 26 24 |
| | Montague I., [3 l.], Cape | 58 27 | 26 44 |
| | Bristol I., [3 l.], E pt. | 59 0 | 26 18 |
| | Southern Thule Is., [3 l.], E pt. | 59 26 | 27 13 |
| | E extreme of group, rk. | 60 49 | 44 20 |

## MARITIME POSITIONS

| | (169) Places | Lat. S | Lon. |
|---|---|---|---|
| | | | West |
| *New Orkneys* | Laurie I., EW 7 l., E pt., C. Dundas, 559f. | 60° 54′ | 44° 20′ |
| | Murry Is., 1410f. S one | 61 2 | 44 30 |
| | Saddle I., [4m.], W pk., 1643f. | 60 43 | 45 10 |
| | Coronation I., ⅛ 12 l., E sum. 5397f. | 60 46 | 45 53 |
| | — NW pt., or Pt. Penguin | 60 33 | 46 40 |
| | Despair rk. | 60 36 | 47 12 |
| | Inaccessible Is., [4m.], 337f. | 60 40 | 47 38 |
| | Cornwallis I., [2m.] | 61 4 | 54 28 |
| | Elephant I., ♯ 9 l., E sum. | 61 6 | 54 45 |
| | — Rocks, NW-d., outer | 61 0 | 55 40 |
| | O'Brien I., [1m.] | 61 32 | 55 52 |
| | Rocks ○ | 61 43 | 56 50 |
| | Bridgeman I., [2m.], 600f. volcano ○ | 62 10 | 56 40 |
| | King George I., ♯ 13 l., E pt., or C. Melville ♀ | 62 2 | 57 30 |
| | Ridley I., [2m.] | 61 48 | 58 0 |
| | Livingston I., ♯ 10 l., NW pt., C. Shirreff | 62 28 | 60 28 |
| | Deception I. NS 10m., Port Foster, ⊞, Mt. Pond ⊕ | 62 55·6 | 60 30 |
| *New S. Shetland* | Smith I., EW 7 l., Mt. Foster, 6600f. | 63 2 | 62 47 |
| | William rk. | 63 17 | 63 0 |
| | C. Possession | 63 45 | 61 50 |
| | Astrolabe I., EW 4m., mid. | 63 16 | 58 20 |
| | Joinville I., EW 15 l., S pt., or C. Purvis | 63 39 | 55 48 |
| | C. Seymour | 64 13 | 56 32 |
| | Mt. Haddington | 64 12 | 58 2 |
| | Biscoe Is., Pitt I., mid. | 65 20 | 65 38 |
| | — Adelaide I., *h*, mid. | 67 15 | 68 15 |
| | Alexander I., N pt. | 68 51 | 73 10 |
| | St. Peter I. | 68 57 | 90 46 |
| | **ANTARCTIC OCEAN.** | | East |
| *Antarctic Ocean* | Sir Jas. C. Ross' furthest | 78 4 | 161 0 |
| | Mt. Erebus, 12,400f. | 77 33 | 166 58 |
| | Mt. Sabine | 71 42 | 169 55 |
| | Balleny Is. | 66 44 | 163 11 |
| | Adelie Land, Geology Pt. | 66 35 | 140 10 |
| | **TIERRA DEL FUEGO.** | | West |
| *Tierra del Fuego* | Pt. Catherine, *l* | 52 33 | 68 46 |
| | C. St. Sebastian, ⊥, 190f., N sum. | 53 19 | 68 10 |
| | C. Peñas, SE cliff | 53 51·5 | 67 33 |
| | C. San Diego, *l*, ⊥, E pt. | 54 41 | 65 7 |
| | Staten I., C. St. John | 54 42·3 | 63 43·5 |
| | — Vancouver, C. Kendall | 54 49·8 | 64 6 |
| | — C. St. Bartholomew | 54 54 | 66 46 |
| | Good Success B., ‡′, w, b, S hd. | 54 49 | 65 13 |
| | C. Good Success *h*, ⊥, rks. close | 54 55 | 65 22 |
| | Ushuwia, Beagle Channel, Mission Station | 54 49·4 | 68 18·5 |
| | New I., ♯ 8m., 8₀. Pt. Waller | 55 11 | 66 33 |
| | Barneveldt Is., [2½m.], cent. | 55 49 | 66 48·5 |
| | C. Horn, ab. 1391f. | 55 59 | 67 16 |
| | Hermit I., EW 14m., West C. | 55 50 | 67 55 |
| | — St. Martin Cove, ⊞, b, w | 55 51 | 67 34 |
| | Orange B., ⊞, Pyramid I. | 55 31·4 | 68 5·5 |
| | False C. Horn | 55 43 | 68 3 |
| | Ildefonso Is., ⅛ 5m., 100f., mid. | 55 50 | 69 18 |

| | (170) Places | Lat. S | Lon. W |
|---|---|---|---|
| *Tierra del Fuego* | Diego Ramirez Is., NS 5m., 587f. | 56° 31′ | 68° 43′·2 |
| | York Minster | 55 25 | 70 3 |
| | C. Castlereagh, (Stewart Hr. NE-d) | 54 56·5 | 71 29 |
| | Townshend Harb., ‡′″, islet, N | 54 42·3 | 71 55·7 |
| | Tower rks., 2, [1⅓m.], S & Est. | 54 37 | 73 3 |
| | C. Noir, (8 2m.), 600f., S pt. | 54 30 | 73 6 |
| | C. Gloucester, W pt. | 54 5 | 73 30 |
| | C. Inman, (rk. ♯ 2m.) | 53 19 | 74 19·5 |
| | Dislocation Harb., ⊞, (w ♯) | 52 54 | 74 37 |
| | C. Deseado, *h*, (rky. I. 2m. off) | 52 44 | 74 45 |
| | C. Pillar, N cliff | 52 43 | 74 42 |
| | **SOUTH AMERICA.** | | |
| | **West Coast.** | | |
| | **CHILE.** | | |
| *Magellan Strait* | C. Virgins | 52 20·2 | 68 21·7 |
| | Dungeness Pt. | 52 24 | 68 25·7 |
| | C. Possession, Refuge Beacon | 52 18·3 | 68 56·7 |
| | Direction Hill Beacon, 224f. | 52 22 | 69 30 |
| | SANDY POINT, BOAT-HO. lt. F 26f. | 53 9·9 | 70 54 |
| | PORT FAMINE, TENT N SIDE BAY | 53 38·2 | 70 56·5 |
| | C. Froward, (S extr. of America) | 53 54·6 | 71 18·5 |
| | Port Gallant, Cross Id. | 53 42 | 71 59·7 |
| | Mt. Sarmiento, 7330f., 2 pks. | 54 28 | 70 52·5 |
| | Mt. Buckland, ab. 4000f. | 54 26 | 70 23·7 |
| | Port Angosto, Hoy Pt. | 53 13·5 | 73 22·5 |
| | Tuesday B., Cascade Pt. | 52 50·2 | 74 29·5 |
| | Port Churruca, Diaz I., 60f. | 53 1·4 | 73 56 |
| | Port Tamar, Mouatt Id. | 52 56·5 | 73 46·5 |
| *Patagonian Inner Channels* | Sholl B., Obs. spot | 52 44·5 | 73 53 |
| | Otter B., Obs. Pt. | 52 22·5 | 73 40 |
| | Fortune B., Low I. | 52 15·8 | 73 41 |
| | Isthmus B., Obs. Pt. | 52 9·6 | 73 36·5 |
| | Columbine Cove, islet | 51 53·3 | 73 41·5 |
| | Mayne Harb., head of Str. | 51 18·5 | 74 4 |
| | Puerto Bueno, Obs. Rock | 50 59·4 | 74 11·7 |
| | Port Grappler, Obs. Pt. | 49 25·3 | 74 17·5 |
| | Eden Harb., cove, (staff) | 49 7·5 | 74 25·2 |
| | Halt B., Obs. I. | 48 54·3 | 74 21 |
| | Island Harb., Obs. I. | 48 3·6 | 74 36·2 |
| | Guaianeco Is., S. Pedro I., 410f. | 47 44 | 74 52·5 |
| *W. Coast Patagonia* | Westminster Hall, [1m.], 1120f. | 52 38 | 74 22 |
| | Evangelists, Sug. loaf, 360f. | 52 24 | 75 4 |
| | C. Victory, or Narborough, pt. | 52 16 | 74 55 |
| | Diana Pk. | 52 8 | 74 48·5 |
| | C. Isabel, *h*, ⊥, (pk. 2m. E), pt. | 51 50 | 75 11 |
| | Cambridge I., C. St. Lucia | 51 30 | 75 22 |
| | Scout rks., 10f. | 50 49 | 75 40 |
| | Madre de Dios Archip., W cliff, ⊥ | 50 36 | 75 32 |
| | C. Three Pts., Rugged Hd., 2000f., (rks. 2m.) | 50 1·4 | 75 23 |
| | Port Henry, ⊞′, w, b, W head | 50 0 | 75 20·5 |
| | Mt. Corso I., SW sum., (shls. 5m.), 1420f. | 49 46·4 | 75 32·5 |
| | C. Montague, extr. of rocky spit | 49 11·5 | 75 50 |

## MARITIME POSITIONS

| (171) Places | Lat. S | Lon. W |
|---|---|---|
| *Coast of Chile* | | |
| **Parallel** Pk., 2m. inland, 2800f. | 48°46′ | 75°31′ |
| Dundee rk., 45f. | 48 5 5 | 75 37·5 |
| Port Sta. Barbara. ⊞, W head | 48 2 | 75 25 |
| Guaianeco Is., Byron I., W pt. | 47 46 | 75 20 |
| C. Machado, ⚓,, (rks. 2m.)○ | 47 26 5 | 74 29 |
| Purcell I., [2m.], ✱, SW rk.○ | 46 55 | 74 39 |
| Port Otway, ⊞, S entr., sum. | 46 49·5 | 75 16 |
| C. Tres Montes, ⊥, 1300f., pt. | 46 59 | 75 26 |
| C. Raper, rk. close | 46 49 | 75 37·5 |
| C. Gallegos, T | 46 35 | 75 35 |
| San Estevan, port, w, $\delta_o$, entr. | 46 18 | 75 9 |
| Hellyer rks., [1m.] | 46 4 | 75 11·5 |
| C. Taytao, 2850f., ⊥, δ 1m., W pt. | 45 53 | 75 5·5 |
| Huamblin I., 700f., NS 3 l., ✱, W hd. | 44 49 | 75 12 |
| Ypun, or Narborough I., 2/12 9m., (Scotchwell Harb., SE. b, w), S, or John Pt. | 44 40·7 | 74 45·7 |
| Port Low, ⊞, w″, b, r̄, Huacanec I., 2/12 2m., S pt. | 43 48·5 | 73 59·5 |
| Huafo I., 6/12 13m., ⌣, ✱, NW pt., 800f., (rks. 3m.). | 43 36 | 74 46 |
| Chiloe I., NS 32 l., W pt., C Quilan, ✱ | 43 17 | 74 23 |
| — Corona Hd., lt. F, Fl. 224f. | 41 47 | 73 52 |
| — C. Matalqui | 42 11 | 74 11 |
| Huechucucuy Hd. | 41 46 | 74 0 |
| Corcobado Volc., 7500f. | 43 11 3 | 72 45·7 |
| Chayapiren Volc., 8000f., sum. | 42 48 | 72 31·5 |
| C. Quedal, T | 41 3 | 73 57·7 |
| Pt. Galera, W pt., lt. F, Fl. 180f. | 40 2 | 73 43·7 |
| Gonzales Hd., N pitch | 39 51 | 73 26 7 |
| Fort Corral | 39 52·9 | 73 26 |
| Valdivia, ⊞, Niebla bluff, lt. F 121f. | 39 52 | 73 24 |
| Mocha I., 2/12 7m., (rks. 3m., ⚓, ⊹ and ⊹, l,,, $r_o$, b, w‴), sum., 1250f. | 38 23 | 73 55·7 |
| Tucapel Hd., (R. Leübu, E-d.) | 37 36 | 73 38·7 |
| Lota Point, lt. R 180f. | 37 5 | 73 11 |
| Sta. Maria I., NS 6m., l, δ, (rks. ⊹ 1 l., w′, b, r), lt. Fl. 258f. | 36 59 | 73 32 |
| Arauco, fort | 37 15 | 73 19 |
| Paps of Bio Bio, 800f., SW sum. | 36 48 | 73 11 7 |
| Concepcion, ⊞, City, mid. at river | 36 49·5 | 73 2·2 |
| Talcahuano, w, r, b,, Quiriquina I., lt. R 213f. | 36 36 | 73 3 |
| Pt. Carranza, rks. | 35 37 | 72 38 7 |
| Riv. Maule, Church rk., (bar ⊹ 1½m.), δ | 35 19·7 | 72 26·2 |
| Bucalemo Hd., (Rapel shl., ⊹ 2m.) | 33 52 | 71 49·7 |
| Algarroba Pt. | 33 26 | 71 42·7 |
| Caraumilla Pt., rk | 33 6 | 71 44·7 |
| Bell of Quillota, 6200f., 7 l. inland | 32 57·2 | 71 6·2 |
| Aconcagua, 23,080f., 25 l. inland | 32 38·5 | 69 57·7 |
| Valparaiso, ⊞, [b], Exchange Cupola | 33 2·1 | 71 38·5 |
| Fort St. Antonio, site of... | 33 1·9 | 71 38 5 |

| (172) Places | Lat. S | Lon. W |
|---|---|---|
| *Chile* | | |
| Horcon B., (⚓′, w′, r̄, b), Hd., (rks. 1½m.) | 32°42′5 | 71°30′7 |
| Papado B., Gobernador Mt. | 32 31 | 71 28·7 |
| Pichidanque B., ⚓ s, Locos I. | 32 7·9 | 71 32·7 |
| Mt. Talinay, 2300f. | 30 51 | 71 38 7 |
| Pt. Lengua de Vaca, (B. E-d. ⚓) | 30 14 | 71 38·7 |
| Herradura de Coquimbo, ⊞, $w_o$, $b_o$, SW corner | 29 58·7 | 71 22·7 |
| Coquimbo, [b], w,, b̄, r, (⌊ Signal-hill), Tortuga Pt., lt. F, Fl. 98f. | 29 57 | 71 21 |
| Pajaros Islets, 2, 2/12 3m., N & W one | 29 33 | 71 35 |
| Chaneral I., [2m.] | 29 1 | 71 37 |
| Huasco Port, ⚓,, w‴, pier lt. | 28 25 | 71 16 |
| Herradura Pt., ⚓, ⌊′, $w_o$ | 28 6 | 71 13 |
| Copiapo, ⚓,, ⌊,, $w_o$, $r_o$, $b_o$, land pl. | 27 19·5 | 70 59 |
| Morro Pt. | 27 7 | 70 59 |
| Port Caldera, W hd., lt. F, Fl. 121f. | 27 3 | 70 53 |
| Flamenco, port, S head | 26 34 | 70 45 |
| Ballena Pt., rks | 25 49 | 70 48 |
| Grande Pt., h, ⌣ E, W sum. 1572f. | 25 7 | 70 31 |
| Paposo vill., w, b, White Hd. | 25 2 | 70 30 |
| Jara Hd., ⊥, w N | 23 53 | 70 33 |
| Antofagasta, Custom ho., lt. F 30f. | 23 39 | 70 25 |
| Mt. Moreno, (Jorge, old), 4160f., ♠o | 23 28·5 | 70 35·2 |
| — Constitution Rd., [⚓′], $w_o$, $b_o$ | 23 26·7 | 70 37·5 |
| Leading bluff, islet off | 23 1 | 70 32 |
| Mt. Mexillones, 2560f., (3m. inland) | 23 65 | 70 32 |
| Cobija B., w′, r, fl. st., ⌊ | 22 34 | 70 18 |
| — Pk., 3330f. | 22 32 | 70 15 |
| C. St. Francisco, or Paquiqui. | 21 56 | 70 12 |
| Arena Pt., l, ⚓ 16 | 21 39 | 70 10 |
| R. Loa, $\|_o$, w,,, and Gulley | 21 28 | 70 3 |
| Chipana B., ⚓′, tail of pt., ⌊⌊o | 21 23·0 | 70 8 |
| Lobo, or Blanco Pt., h, ⊥, | 21 5 | 70 13 |
| Carrasco Mt., 5520f. | 20 58·5 | 70 7 |
| Grueso Pt., l, ⊥, ⌊, | 20 23 | 70 13 |
| Iquique, w, Id., lt. F, Fl. 96f. | 20 12·5 | 70 11·5 |
| Pichalo Pt., projecting | 19 37 | 70 16 |
| Pisagua, Gulley and R., $\|_o$ w, | 19 34 | 70 14 |
| C. Lobos | 18 45 | 70 24 |
| Arica, w‴, r, Iron Church (Inglesia Matrix) | 18 28·7 | 70 20 |
| **PERU.** | | |
| *Peru* | | |
| Mount Sahama, 22,350f. | 18 0 | 68 48 |
| Morro of Sama, 3890f. | 17 59 | 70 53 |
| Coles Pt., l, sandy, (shls. ½m.) | 17 42 | 71 23 |
| Ylo, w, b̄, rivul. mo. | 17 37 | 71 21 |
| Pt. Mexico, l, ✱ | 17 11 | 71 49 |
| Islay, port of Arequipa, Custom ho. | 17 0 | 72 7·2 |
| Arequipa | 16 29 | 71 32 |
| Mount Misti, 20,320f. | 16 20 | 71 22 |
| Cornejo Pt. | 16 52 | 72 10 |
| Quilca, ⌊,, b,, Cove, W hd. | 16 42·3 | 72 28 |
| Mt. Camana, (Mt. like a fort) | 16 37 | 72 42 |
| Pescadores Pt., ⚓o, (rk S 1m.) | 16 24 | 73 18 |
| Pt. Lomas, ⚓′ ⊹, $w_o$, $r_o$, fl. st. | 15 33·2 | 74 52 |

## MARITIME POSITIONS

| | (173) Places | Lat. S | Lon. W |
|---|---|---|---|
| | Mount Illimani, 21,200f. ...... | 16°38′ | 67°49′ |
| | Mount Sorata, 21,520f.......... | 15 50 | 68 30 |
| | Port San Juan, ⊞, w₀, b₀, P₀... | 15 20·9 | 75 23 |
| Peru | Beware Pt., ⅄, ⊥ ................ | 15 9 | 75 23 |
| Peru | Pt. Nasca, ⊥, 1020f. ............ | 14 57 | 75 32 |
| Peru | Mesa (Table) de Doña Maria.. | 14 41 | 75 51 |
| Peru | Infiernillo rk., 50f., δ₀ ........ | 14 40 | 75 54·7 |
| Peru | Mt. Quemado, 2070f., ⚓ ...... | 14 20 | 76 7·7 |
| Peru | Vieja I., ⅔ 3½m., ⚓ NE, ⌊′ E, N pt. ........................ | 14 15 | 76 13·7 |
| Peru | Carretas Hd., S pt............... | 14 11 | 76 16·7 |
| Peru | Sangallan I., ⅔ 2½m., ⅄, ⊥, N sum........................ | 13 50 | 76 28·7 |
| Peru | Pisco, (⌊′, w′, S 2m. of Paracca vill.), r, b, pier lt. F | 13 45 | 76 10 |
| Peru | Chincha Is., ⅟ 3m., N pt. ... | 13 38 | 76 24·7 |
| Peru | Cerro Azul ⌊⌊, ⅄, ⊥ ........ | 13 3 | 76 30·7 |
| Peru | Asia rk., [½ . ], rks., pk., ⌊′ E | 12 48 | 76 38·7 |
| Peru | Chilca Pt., ⊥, sum. 300f.... .. | 12 31 | 76 50 |
| Peru | — Port, ⚓′, ⊞, rock............ | 12 29·3 | 76 49·5 |
| Peru | Pachacamac Is., ⅔ 1 l., 400f., δ₀ W-d., N one ........... | 12 18 | 76 55·7 |
| Peru | Morro Solar (Bay, ⚓ δ), 860f.. | 12 11 | 77 3·7 |
| Peru | Callao, San Lorenzo I., ⅔ 4½m., 1284f., C. St. Lorenzo, lt. F 980f. ...... | 12 4 | 77 15·7 |
| Peru | — ⊞, ⊟, r, w, b, Arsenal, fl. st. | 12 4·0 | 77 10·5 |
| Peru | Lima Cathedral, South Tower ...................... | 12 3·1 | 77 0 |
| Peru | Hormigas rks., [1½m.], 25f., T, S one........................ | 11 58 | 77 46 |
| Peru | Pescador Is., T, δ₀, large...... | 11 47 | 77 16 |
| Peru | Salinas Hill, (Haura Is. SW-d.) | 11 15 | 77 36 |
| Peru | Pelado rk., small ............... | 11 28 | 77 49 |
| Peru | Huacho B., ⚓′ s, ⌊′, r, w, b, pt. | 11 9 | 77 37 |
| Peru | Supé B., ⚓′, r, ŵ, vill., W pt.. | 10 49·7 | 77 44 |
| Peru | Darwin Pk., 5800f............... | 10 30 | 77 46 |
| Peru | Guarmey B., ⚓′, ww₀, r, b′ ... | 10 6 | 78 9 |
| Peru | Legarto Hd., ⊥ ................. | 10 7 | 78 10 |
| Peru | Culebras Pt., ⚓ N............... | 9 58 | 78 12 |
| Peru | Mt. Mongon, ⅄, W sum. 3900f. | 9 38 | 78 18 |
| Peru | Casma B., ⌊,, w, r, b ............ | 9 28 | 78 22 |
| Peru | Samanco B., ⌊′, ŵ′, r, b, huts.. | 9 15·6 | 78 29 |
| Peru | Mt. Division, 3 pks., 1880f. ... | 9 11 | 78 34 |
| Peru | Ferrol B., w₀, N pt. ... ...... | 9 7 | 78 36 |
| Peru | Santa I., [1½m.], ⚓′ NE, ⌊′ w, r | 9 2 | 78 39 |
| Peru | Santa B., ⚓ s, wat. pl. ......... | 9 0 | 78 38 |
| Peru | Chao Is., large, [½m.], 120f... | 8 46 | 78 45 |
| Peru | Guañape Hill, ab. 700f., (Is. ⅟ 8m.) ....................... | 8 27 | 78 53 |
| Peru | Huanchaco Road, ⌊₀, r, ŵ, Ch. | 8 5 | 79 5 |
| Peru | Truxillo, (1½m. inland), w₀, r, Ch. ........................... | 8 7·5 | 79 0 |
| Peru | Pacasmayo Pt., ⚓, ⌊,, w, r, b, mole lt. F 65f................. | 7 24 | 79 33 |
| Peru | Mt. Sulivan, 5000f., 17m. inland | 7 17 | 79 17·7 |
| Peru | Eten Hill, 640f., mole lt. F 65f. | 6 56 5 | 79 52 |
| Peru | Lambayeque Rd., δ ⚓, ⌊₀, w₀, r, b₀ .................... ○ | 6 46 | 79 56 7 |
| Peru | Lobos de Afuera Is., NS 3m., ab. 100f., ⚓₀, w₀, b₀, δ₀, Chichal de Afuera ......... | 6 54 | 80 41·7 |
| Peru | Lobos de Tierra, NS 2 l., ⚓ ⅟, S pt.............................. | 6 28·3 | 80 50·2 |
| Peru | Aguja Pt., ⊥, 150f. ........... | 5 55 | 81 6 |
| Peru | Piura R., ⚓′, Sechura Church | 5 35 | 80 46·7 |
| Peru | Saddle of Payta, 1300f.......... | 5 12 | 81 5·7 |

| | (174) Places | Lat. | Lon. W |
|---|---|---|---|
| | | South | |
| | Payta, Cathedral Tower ... | 5° 5′ | 81° 7′·7 |
| | Pariña Pt., ⊥, 80f. ............ | 4 41 | 81 19 |
| | C. Blanco, ⅄, ⊥, δ₀ ............ | 4 18 | 81 14 |
| | Malpelo Pt., ⅄, ⚓ ............... | 3 31 | 80 28·2 |
| | **ECUADOR.** | | |
| Ecuador | Sta. Clara I., [1½m.], shls., lt. F, Fl. 256f.................... | 3 11 | 80 24·5 |
| Ecuador | Puná I., ⅟ 9 l., Pt. Española, Consulate, lt. F 131f....... | 2 47·5 | 79 54 |
| Ecuador | Guayaquil, ŵ, r, b, Arsenal ... | 2 12·4 | 79 51·4 |
| Ecuador | Mount Chimborazo, 20,493f.... | 1 30 | 78 47 |
| Ecuador | St. Elena Pt., lt. F, Fl. 470f.... | 2 11 | 80 59 |
| Ecuador | Salango I., [1m.], w. ∥₀ E....... | 1 36 | 80 32 |
| Ecuador | Plata I., ⅔ 3m., 790f., lt. F... | 1 17 | 81 3 |
| Ecuador | C. St. Lorenzo ... .............. | 1 3 | 80 55 |
| Ecuador | Manta, lt. F 88f. .............. | 0 56·8 | 80 42·7 |
| Ecuador | Mount Cotopaxi, 19,613f....... | 0 43 | 78 18 |
| Ecuador | Quito, 9,343f..................... | 0 14 | 78 22 |
| Ecuador | C. Passado ....................... | 0 21·5 | 80 29·7 |
| | | North | |
| Ecuador | Galera Pt. ...................... | 0 50 | 80 5 |
| Ecuador | Atacames, town, w, (shls.) ... | 0 53 | 79 53 |
| Ecuador | Esmeralda R., Coquito Pt., lt. F | 1 0 | 79 41·5 |
| Ecuador | Pt. Mangles........................ | 1 35 | 79 5 |
| Ecuador | Tumaco Rd., Morro Chico .. | 1 49·6 | 78 44·5 |
| | **COLOMBIA.** | | |
| | Pt. Guascama...................... | 2 37 | 78 24 |
| | I. Gorgona, ⅟ 5m., 1296f., N pt. | 3 0·0 | 78 10 |
| | Pt. Chirambirà .................. | 4 17 | 77 29 |
| | C. Corrientes ..................... | 5 29 | 77 32 |
| | C. Francisco de Solano......... | 6 17 | 77 27 |
| | Pt. Caracoles ..................... | 7 40 | 78 16 |
| Panama Bay | Pt. Guarachina, (S side, entr. G. St. Michael) ........... | 8 6 | 78 21·7 |
| Panama Bay | I. Rey, ⅔ 5 l., Pt. Cocos ...... | 8 13 | 78 54 |
| Panama Bay | I. St. Jose, [2 l.], S pt......... | 8 12 | 79 7 |
| Panama Bay | Panama, ⊞, NE bast. .......... | 8 57·2 | 79 32 |
| Panama Bay | Taboga I., [2m.], vill. ⅟, w... | 8 47·3 | 79 32 7 |
| Panama Bay | Otoque Is., ⅔ 2½m., pk.......... | 8 35·6 | 79 35 |
| Panama Bay | Pt. Chame ........................ | 8 39 | 79 41 |
| Panama Bay | Pt. Mala ........................... | 7 28 | 79 58 |
| Panama Bay | Point Puercos..................... | 7 14 | 80 26 |
| | **CENTRAL AMERICA.** | | |
| Costa Rica | Hicaron I., (Quicara), (and islet S), NS 5m., S islet | 7 12 | 81 47·7 |
| Costa Rica | Quibo I., ⅔ 7 l., Adelarda Pt. | 7 31 | 81 53 |
| Costa Rica | Montuosa I., [½m.] ........... | 7 28 | 82 15 |
| Costa Rica | Bahia Honda, ⊞, w, Sentinela I., at entr., (w ⅟ 2m.) | 7 43·5 | 81 32 |
| Costa Rica | Magnetic Is., (off Port Nuevo, ⊞), [4c.] ......⊕ | 8 5 | 81 49 |
| Costa Rica | Pt. Burica. Id. off .............. | 8 2·3 | 82 53·5 |
| Costa Rica | Vinda rock........................ | 8 6 | 82 10 |
| Nicaragua | Ladrones Is. ..................... | 7 52 | 82 26 |
| Nicaragua | G. of Dulce, C. Matapalo, (rks. off) ......................... | 8 23 | 83 17 |
| Nicaragua | Caño I., [1m.], 404f., (w‴ ⅟ 1½m.) .......................... | 8 43 | 83 53·2 |
| Nicaragua | Nicoya G., Puntas Arenas Harb., ⊞, w, r, Pan de Azucar.......................... | 9 55·8 | 84 52 |
| Nicaragua | C. Blanco, ⅄, ⚓, (islet S, 1½m., ∥), 193f............. ... | 9 32 | 85 7 |
| Nicaragua | Guinonos Point, (reef off) ... | 9 54 | 85 41 |

## MARITIME POSITIONS

| Region | (175) Places | Lat N | Lon. W |
|---|---|---|---|
| Nicaragua | C. Velas | 10°21′·5 | 85°53′ |
| Nicaragua | Culebra, ⊞, entr. S, Viradores Is. | 10 35 | 85 43·2 |
| Nicaragua | St. Elena Pt. | 10 53·5 | 85 58 |
| Nicaragua | Salinas B., Salinas Is., [3c.] | 11 2·8 | 85 43·5 |
| Nicaragua | Port St. Juan, S bluff, lt. F 490f. | 11 15·2 | 85 53·5 |
| San Salvador | C. Desolado | 11 59 | 86 42 |
| San Salvador | Realejo, ⊞, r, b, Cardon I., ¼ ¾m., N pt., (w 1m.), lt. F 64f. | 12 27·9 | 87 12·7 |
| San Salvador | Volcan Viejo, 5670f. | 12 41 | 87 1·5 |
| San Salvador | Pt. Consegüina, (Volcano, 2830f., 3 l.) | 12 58·5 | 87 35 |
| San Salvador | G. of Conchagua, or Fonseca, Port de la Union, ⊞, w′, r, Chicarene Pt. | 13 17·1 | 87 47 |
| San Salvador | S. Miguel, vol., 7134f. | 13 25·5 | 88 18 |
| San Salvador | LIBERTAD, ⌊,, r, PIER HD. lt. F | 13 28·8 | 89 19·2 |
| San Salvador | Pt. Remedios, ⌊, ✻, (rf. 3m.) | 13 30 | 89 48 |
| San Salvador | Acajutla, vill., ⚓′ II, ⌊,, lt. F. | 13 34·4 | 89 50·7 |
| Guatemala | San Jose de Guatemala, Custom ho., lt. F | 13 55·3 | 90 49·7 |
| Guatemala | Acatenango Volcano, 12,890f. | 14 29 | 90 53·5 |
| Guatemala | Mount Tacana, 14,000f. | 15 8·5 | 92 7 |
| | **NORTH AMERICA.** | | |
| | **MEXICO. West Coast.** | | |
| Mexico, W. Coast | Tonala Bar | 15 59 | 93 58 |
| Mexico, W. Coast | St. Franc. de Tehuantepec, bar | 16 13 | 94 45 |
| Mexico, W. Coast | Salina Cruz, Morro, 244f. | 16 9·8 | 95 12·5 |
| Mexico, W. Coast | Port Guatulco, rky. islets | 15 44·4 | 96 8·2 |
| Mexico, W. Coast | Galera Point | 15 57·6 | 97 41·5 |
| Mexico, W. Coast | Acapulco, ⊞, w′, r, Fort St. Diego. [b] ⊕ | 16 50·8 | 99 55·7 |
| Mexico, W. Coast | Pt. Tequepa | 17 16 | 101 4·5 |
| Mexico, W. Coast | Morro Petatlan, 640f. | 17 31·5 | 101 27 |
| Mexico, W. Coast | Port Sihuatenejo, NW bight | 17 38·0 | 101 3·3 |
| Mexico, W. Coast | Istapa, or Isla Grande B. | 17 40·3 | 101 40 |
| Mexico, W. Coast | Mangrove bluff, 35f. | 17 55·5 | 102 12 |
| Mexico, W. Coast | Tejupan Papa, 5660f. | 18 24 | 103 11 |
| Mexico, W. Coast | Colima Volcano, 12,000f. | 19 25 | 103 33 |
| Mexico, W. Coast | Manzanilla B., ⚓′, w,, village | 19 3·2 | 104 19·7 |
| Mexico, W. Coast | Port Navidad, S head, 705f. | 19 11 | 104 43 |
| Mexico, W. Coast | Pt. Farallones, (rks. off) | 19 23·5 | 105 3 |
| Mexico, W. Coast | C. Corrientes, flat, ✻, 506f. | 20 24 | 105 42·5 |
| Mexico, W. Coast | Corventa rk., 25f. | 20 45 | 105 51 |
| Mexico, W. Coast | Tres Marias Is., S Juanito, 150f. | 21 43 | 106 41 |
| Mexico, W. Coast | Mt. St. Juan, 7550f., 5 l. inland | 21 26 | 104 58·5 |
| Mexico, W. Coast | San Blas, w,, r, r, Arsenal | 21 32·5 | 105 19 |
| Mexico, W. Coast | Isabel I., w₀. b₀. pk. 280f. | 21 52 | 105 53·5 |
| Mexico, W. Coast | Chamatla R., W ent. pt. | 22 47·5 | 106 2 |
| Mexico, W. Coast | Mazatlan, w,, Cust. ho. | 23 11·7 | 106 27·2 |
| Gulf of California | Culiacan R., Altata Railway Station | 24 37·7 | 107 56 |
| Gulf of California | I. St. Ignacio, [1m.], ⊥, 465f. | 25 26 | 109 24·2 |
| Gulf of California | Esterro de Ajiabampo, bar | 26 16·3 | 109 17·2 |
| Gulf of California | Pt. Rosa | 26 40 | 109 40·7 |
| Gulf of California | Lobos I., [5 l.], 75f., SW pt. | 27 21 | 110 38 |
| Gulf of California | Guaymas, ⊞, w′ w₀, fort | 27 55·4 | 110 55 |
| Gulf of California | C. Haro, lt. F, Fl. 346f. | 27 50·5 | 110 54·7 |
| Gulf of California | Tetas de Cabra, 1633f. | 28 1 | 111 5 |
| Gulf of California | I. St. Pedro Nalasco, 1071f. | 27 58 | 111 24 |
| Gulf of California | Tiburon I., [9 l.], Willard Pt., 345f. | 28 51 | 112 36 |
| Gulf of California | C. Tepoca | 30 16 | 112 52 |

| Region | (176) Places | Lat. N | Lon. W |
|---|---|---|---|
| Gulf of California | Rocky Bluff, 408f. | 31°20′ | 113°40′ |
| Gulf of California | Colorado R., Port Isabel beacon | 31 46 | 114 42 |
| Gulf of California | San Felipe Pt., 940f. | 31 2 | 114 49·5 |
| Gulf of California | Guardia I., ¼ 13 l., Pt. Refugio | 29 33·1 | 113 35·2 |
| Gulf of California | Sta. Teresa B., N pt. | 28 25 | 112 51 |
| Gulf of California | I. Tortuga, [2m.], 1016f. | 27 26 | 111 53 |
| Gulf of California | Sta. Inez Pt. | 27 3 | 111 56 |
| Gulf of California | Mulege, ⚓ | 26 53·5 | 111 57·5 |
| Gulf of California | Ildefonso I., [1m.], 387f. | 26 37 | 111 26 |
| Gulf of California | La Giganta Pk., 5794f. | 26 6 | 111 35 |
| Gulf of California | Loreto | 26 0·5 | 111 20·5 |
| Gulf of California | Carmen I., 1572f., 4 l., Salinas B. | 25 59·5 | 111 7 |
| Gulf of California | Catalina I., [7m.], 1548f., pt. | 25 42 | 110 47 |
| Gulf of California | Sta. Cruz I., [3m.], pk., 1500f | 25 16 | 110 43 |
| Gulf of California | San José I., ¼ 6 l., 2077f., Amortajada B., N pt. | 24 54·5 | 110 38·7 |
| Gulf of California | Espiritu Santo I., ¼ 4 l., Lupona Pt. | 24 24·2 | 110 20·5 |
| Gulf of California | La Paz | 24 10 | 110 20 |
| Gulf of California | Cerralbo I., ¼ 5 l., 2477f., Montana rock | 24 8 | 109 47 |
| Gulf of California | Pt. Arenas | 24 4 | 109 49 |
| Gulf of California | San José, Mission, r, w′′′′ | 23 3·5 | 109 41·7 |
| Gulf of California | C. St. Lucas, rks., ⌊, ✻₀, (w, vill. ), 251f. | 22 53 | 109 53 |
| Lower California | Magdalena B., ⊞, Custom ho. lt. | 24 38·3 | 112 8·7 |
| Lower California | C. St. Lazaro, Mt. 1300f. | 24 47 | 112 17·5 |
| Lower California | San Juanico Pt. | 26 2 | 112 17·5 |
| Lower California | Pt. Abreojos | 26 42 | 113 33 |
| Lower California | I. Asuncion, 100f. | 27 6 | 114 17·7 |
| Lower California | Port St. Bartholomew, N hd. | 27 39·8 | 114 52 |
| Lower California | I. Cerros, 3955f., NS 8 l., Morro Redondo | 28 1·3 | 115 11 |
| Lower California | Is. San Benito, W one, 650f. | 28 18 | 115 36 |
| Lower California | Playa Maria B. | 28 55 | 114 32 |
| Lower California | I. San Geronimo, [1 l.], 172f. ⊕ | 29 48 | 115 47·7 |
| Lower California | St. Quintin, ⊞, Sextant Pt. | 30 22 | 115 59 |
| Lower California | C. Colnett, SW pt., 400f. | 30 57 | 116 19·5 |
| Lower California | Todos Santos Bay, Enseñada Pt., 370f. | 31 51 | 117 37·2 |
| Lower California | Coronados rks., ¼ 5m., S isl., 674f. | 32 23·9 | 117 14 |
| | **UNITED STATES.** | | |
| | **California.** | | |
| Upper California | Boundary Obelisk | 32 32 | 117 7·5 |
| Upper California | St. Diego, ⊞, w, Pt. Loma, lt. Fl. 462f. | 32 40·2 | 117 14·7 |
| Upper California | St. Juan B., ⚓, ⌊,, outer rk. | 33 26·9 | 117 46 |
| Upper California | St. Pedro B., ⊞, w, r, lt. Fl. 156f. | 33 43·2 | 118 17 |
| Upper California | Cortez Bank, | 32 26 | 119 6 |
| Upper California | St. Clemente I., ¼ [6 l.], SE ⚓ | 32 49 | 118 25·2 |
| Upper California | Sta. Catalina I., ¼ [6 l.], Raper B., Barracks | 33 26 | 118 29·7 |
| Upper California | St. Nicolas I., ¼ 6m., John Begg rk., [2c.], NW-d. | 33 21·7 | 119 41·7 |
| Upper California | Sta. Barbara I., [2m.] | 33 28·5 | 119 2·2 |
| Upper California | Sta. Cruz I., [7 l.], Anacapa B., Observ. Pt. | 34 1·6 | 119 32 |
| Upper California | Sta. Rosa I., [3 l.], Becher B. Observ. Pt. | 34 1 | 120 2·7 |
| Upper California | San Miguel I., Cuyler Hr., Prince I. | 34 3·3 | 120 20 |

## MARITIME POSITIONS

| | (177) Places | Lat. N | Lon. W |
|---|---|---|---|
| *Upper California* | St. Barbara, lt. F 180f. | 34° 23'·7 | 120° 43'·2 |
| | Pt. Conception, lt. R. 135f. | 34 26·8 | 120 28 |
| | Pt. Arguilla | 34 35 | 120 39 |
| | San Luis Obispo, Whaler I | 35 9·5 | 120 45 |
| | Pt. Pinos, T, lt. F 91f. | 36 37·9 | 121 56 |
| | Monterey. w, w, r, b, fort | 36 36·4 | 121 53 |
| | Pt. Ano Nuevo | 37 6·7 | 122 20 |
| | Farallones rks., [1m.], pk., lt. Fl. 360f. | 37 41·8 | 123 0 |
| | St. Francisco, Fort Pt., lt. F 124f., S side, entr. | 37 48·5 | 122 28·7 |
| | Mt. Bolbones, 3765f., 10 l. inl. | 37 52·9 | 121 54·5 |
| | Pt. de los Reyes, lt. Fl. 296f. | 37 59·6 | 123 1·2 |
| | C. Bodega, (Russ. Stor, w) | 38 17·7 | 123 4·5 |
| | Pt. Arena. lt. F 156f. | 38 57·5 | 123 44·2 |
| | C. Mendocino, lt. Fl. 423f. | 40 26·3 | 124 24·5 |
| *Oregon* | Humboldt B., lt. F 53f. | 40 46 | 124 13·2 |
| | Crescent City, Pt. St. George, lt. Fl. 80f. | 41 44·6 | 124 12 |
| | C. Orford, lt. F 256f. | 42 50·1 | 124 33·7 |
| | C. Gregory, Empire City, lt F, Fl. 75f. | 43 20·6 | 124 23·2 |
| | C. Perpetua | 44 18 | 124 6·7 |
| | Yaquina Hd., lt. F 61f. | 44 40·6 | 124 4·7 |
| | C. Look-out | 45 20 | 124 0·7 |
| | Columbia R., Fort Astoria | 46 11 | 123 50 |
| | — C. Disappointment, lt. F 232f. | 46 16·5 | 124 3·2 |
| *Washington* | Shoalwater B., Toke Pt., lt F. Fl. 85f. | 46 43 | 124 4·5 |
| | Gray's Harb., ☐, bar, Pt. Brown | 46 56·2 | 124 8 |
| | Pt. Grenville | 47 18·3 | 124 16·5 |
| | Destruction I., rf. W 2½m. | 47 40·5 | 124 28·5 |
| | Flattery rks. | 48 10·3 | 124 46 |
| | C. Flattery, Tatouch I., lt. F 162f. | 48 23·2 | 124 44·7 |
| | Neeah B., Wyadda I., SW pt. | 48 22·5 | 124 36·2 |
| | New Dungeness Pt., lt. F 100f. | 48 11 | 123 6 |
| | Port Discovery | 48 5·5 | 122 54·5 |
| | Whidbey I., Admiralty Hd., lt. F 119f. | 48 9·4 | 122 39·5 |
| | Admiralty Inlet, Foulweather Bluff | 47 56·3 | 122 37·2 |
| | — Seattle Town | 47 36 | 122 21 |
| | — Hood Canal, Union City | 47 21 | 123 7 |
| | Puget Sound, Nisqually | 47 7 | 122 40 |
| | — Olympia Town | 47 3 | 122 55 |
| | Smith, or Blunt I., lt. Fl. 90f. | 48 19 | 122 51·5 |
| | Mount Baker, 10,694f. | 48 49 | 121 46 |
| | Semiahmoo Bay | 49 0 | 122 45·5 |
| | **BRITISH COLUMBIA.** | | |
| *Strait of Georgia* | Roberts Pt., W side | 49 0 | 123 5·5 |
| | Fraser River, lt. F 52f. | 49 3·7 | 123 17·0 |
| | — Garry Pt. | 49 7·1 | 123 12·0 |
| | — New Westm., Milit. Barr. | 49 13 | 122 54·5 |
| | Burrard Inlet, Atkinson Pt., lt. Rev. 119f | 49 20 | 123 16 |
| | — City of Vancouver, Canadian and Pacific Railway Wharf | 49 17 | 123 6 |
| | Bowen I., Roger Curtis C. | 49 20·3 | 123 26·2 |
| | Howe Sound, Plumper Cove | 49 24·6 | 123 29·2 |
| | Texada I., Pt. Upwood | 49 29·7 | 124 8·7 |

| | (178) Places | Lat. N | Lon. W |
|---|---|---|---|
| *Queen Charlotte Sound* | Texada, Marshall Pt. | 49° 48'·0 | 124° 40' |
| | Jervis Inlet, Hardy I., SW end | 49 43·7 | 124 14·7 |
| | Mystery Rock | 49 54·8 | 124 46 |
| | Hernando I.. S pt. | 49 58 | 124 56·2 |
| | Mittlenatch I., 200f. | 49 57 | 125 1·5 |
| | Valdez I., C. Mudge | 50 0·7 | 125 10·4 |
| | Thurlow I., Knox B. | 50 24·2 | 125 39 |
| | Port Neville, Robber's Nob | 50 31·1 | 126 4·3 |
| | Port Harvey. tide pole islet | 50 34 | 126 16·7 |
| | Wells pass, Tracey Hb, Starrk | 50 51 | 126 53·2 |
| | Blunden Harb., Byrnes I. | 50 54·4 | 127 19 |
| | Slingsby Chan., Dalkeith Pt. | 51 4·7 | 127 40 |
| | C. Caution | 51 9·6 | 127 48 |
| *Vancouver I., N.E. Coast* | Port San Juan, pinnacle rk., N side of Bay | 48 33·5 | 124 27·5 |
| | Sooke Inlet, Secretary I. | 48 19·6 | 123 42·7 |
| | Race I., lt. Fl. 118f. | 48 17·7 | 123 32·2 |
| | Esquimalt H., ☐, w, r, ☐, Duntze Head | 48 25·8 | 123 26·7 |
| | Victoria Harb., Laurel Pt. | 48 25·4 | 123 23 |
| | Nanaimo Hb., Dr. Benson's ho. | 49 10·2 | 123 56·6 |
| | Nanoose Harb., entrance rk. | 49 15·7 | 124 8 |
| | Baynes Sd., Henry B., Beak Pt. | 49 36·5 | 124 51·2 |
| | Seymour Narrows, Plumper B., W pt. | 50 10·0 | 125 22·5 |
| | Albert B., Cormorant I., bluff | 50 35·0 | 126 57·5 |
| | Beaver Harb., shell islet | 50 42·6 | 127 25 |
| | P. Alexander, Goletas Chn., islet in centre of the port | 50 50·8 | 127 40 |
| | Bull Hb., Hope I., N pt. Ind. Is. | 50 54·8 | 127 56 |
| *Vancouver I., S.W. Coast* | C. Scott, 500f., sum. of cape | 50 46·7 | 128 26·7 |
| | Triangle I., 680f., Scott Is., W pt. | 50 51·9 | 129 6·5 |
| | C. Russell, δ | 50 41 | 128 23·5 |
| | C. Palmerston, δ | 50 36·5 | 128 19 |
| | Quatsino Sd., ent., mt. 1275f., δ | 50 27·5 | 128 3·7 |
| | — Observatory rk., N harb. | 50 29·4 | 128 3·7 |
| | — Observ. I., Koprino Harb. | 50 30 | 127 52·2 |
| | — Kitten I., Hecate Cove | 50 32·4 | 127 36·2 |
| | — Reef Pt. | 50 21·3 | 128 0 |
| | Clerke reefs, W extreme | 50 12·3 | 127 55 |
| | C. Cook, or Woody Pt., Solander I. | 50 6·5 | 127 57·2 |
| | Nasparti Inlet, Head beach | 50 11·3 | 127 38 |
| | Sulivan reefs | 50 4·5 | 127 41 |
| | Lookout I., δ, W extreme | 50 0·0 | 127 26·5 |
| | Ninety-eight-feet Island | 49 47·7 | 127 21·7 |
| | Kyuquot Sound, Shingle Pt., ent. of Narrowgut Creek. | 49 59·9 | 127 9·5 |
| | Thirty-feet Island | 49 55·2 | 127 16 |
| | Totchu Pt., δ | 49 51·2 | 127 9·5 |
| | Esperanza Inlet, Obser. rk., Queen's Cove | 49 52·7 | 127 0 |
| | Nuchatlitz In., Port Langford, Colwood I. | 49 47·3 | 126 57 |
| | Ferrer Pt. | 49 44·7 | 126 59·7 |
| | Bajo Pt., rf. 3m. | 49 37·5 | 126 50·7 |
| | Nootka Sound, Friendly Cove | 49 35·5 | 126 37·5 |
| | Estevan Pt., S extr., rf. 2m. | 40 22·1 | 126 32·5 |
| | Hesquiat Harb., Boat Cove, leading Mt. 2726f. | 49 27·5 | 126 25·5 |
| | Refuge Cove, vil. on W side | 49 20·8 | 126 16·7 |
| | Flores I., summit 3000f. | 49 18·2 | 126 9 |
| | Sea Otter rk., 6f. | 49 11·5 | 126 8·5 |
| | Clayoquot Sound, Obs. I., Hecate B. | 49 15·4 | 125 56·2 |

## MARITIME POSITIONS

| (179) | Places | Lat. N | Lon. W |
|---|---|---|---|
| | Gowlland rks, 10 to 15f. | 49° 3·6 | 125° 51·7 |
| | Barclay Sound, Obs. I., Alberni Can., Stamp Harb. | 49 13·8 | 124 50·0 |
| | — Observ. I., Island Harb. | 48 54·7 | 125 17 |
| | — Danger rk. | 48 49·2 | 125 18·5 |
| | — Cape Beale, lt. Fl. 164f. | 48 47·4 | 125 13 |
| *Hecate Strait* | Virgin rks., 50f. | 51 17 | 128 13 |
| | Pearl rks., 15f. | 51 22 | 128 2 |
| | Dalkeith Pt. ⊕ | 51 4·7 | 127 40 |
| | Safety Cove ⊕ | 51 31·7 | 127 56·5 |
| | Goldstream Harb. ⊕ | 51 43·3 | 128 0·5 |
| | Namu Harb. | 51 51·7 | 127 52·5 |
| | Loughlin Harb. | 52 8·6 | 128 10·2 |
| | Kynumpt Harb. | 51 12·3 | 128 11·5 |
| | C. Swaine ○ | 52 18 | 128 32 |
| | Carter Bay | 52 49·7 | 128 24·5 |
| | Holmes Bay | 53 16·4 | 129 5·2 |
| | Stewart Anchorage | 53 52·5 | 130 5·2 |
| | Alpha Bay | 53 52 | 130 17·5 |
| | C. Ibbetson ○ | 54 1 | 130 36 |
| | Duncan Bay, Observatory Pt. | 54 20·2 | 130 27·5 |
| | P. Simpson Fort | 54 33·5 | 130 26·2 |
| *Queen Charlotte Is.* | Queen Charlotte's Is., ‡ 55 l., S pt C. St. James, (rks. ‡ 1000f.) ○ | 51 55 | 131 2 |
| | — C. Henry ○ | 52 55·5 | 132 21 |
| | — Skidegate I., Anchor Cov. ⊕ | 53 12·5 | 132 14·2 |
| | — Hippa I., [1 l.], village ○ | 53 33 | 132 58 |
| | — Frederick I. ○ | 53 59 | 133 9 |
| | — Pt. North ○ | 54 15 | 132 56 |
| | **UNITED STATES.** | | |
| | **Alaska.** | | |
| *Sitka Archipelago* | Port Stewart, ⊞, Sst. islet | 55 38·3 | 131 47 |
| | C. Chacon | 54 41 | 132 1 |
| | C. Muzon | 54 40 | 132 41 |
| | Forrester's I., NS 4m., S pt. (rks.) | 54 48 | 133 35 |
| | C. Addington | 55 27 | 133 52 |
| | Port Protection, ⊞, Pt. Baker | 56 20·5 | 133 39 |
| | Coronation Is., [3 l.], S pt. | 55 50 | 134 12 |
| | Hazy Is. | 55 54 | 134 32 |
| | C. Ommanney | 56 10 | 134 37 |
| | Sitka, ⊞, Arsenal, lt. F | 57 2·9 | 135 19·7 |
| | C. Edgecumbe, 2855f. | 57 0 | 135 49 |
| | C. Cross, rks. | 57 56 | 136 31 |
| | C. Spencer, rks. | 58 13 | 136 35 |
| | C. Fairweather | 58 51 | 137 50 |
| | Mt. Fairweather, 15,500f. | 58 58 | 137 27 |
| | Port Mulgrave, ⊞, Pt. Turner | 59 33·0 | 139 43·0 |
| | Pt. Manby | 59 45 | 140 17 |
| *Alaska* | Mt. St. Elias, 19,500f. | 60 20 | 140 58 |
| | C. Suckling | 60 1 | 144 15 |
| | Kayes I., ‡ 5 l., S pt., C. Hamond ⊖ | 59 52 | 144 50 |
| | Port Etches, ⊞, Phipps Pt. | 60 21·2 | 146 50·2 |
| | Montague I., S pt. C. Clear | 59 46 | 148 0 |
| | C. Puget | 59 56 | 148 30 |
| | Pt. Gore | 59 11 | 150 52 |
| | C. Elizabeth, E pt. | 59 9 | 151 42 |
| | Anchor Pt., S hd. | 59 49 | 151 47 |
| | Iliamna Pk., 12,066f., vol. | 60 3 | 153 0 |
| | Pt. Campbell | 61 4 | 150 9 |
| | Mt. St. Augustine, (Id. [3 l.]), sum. | 59 22 | 153 30 |

| (180) | Places | Lat. N | Lon. |
|---|---|---|---|
| | | | West |
| *Alaska* | C. Douglas, E pt. | 58° 54′ | 153° 17′ |
| | Barren Is., [5 l.], *h*, E pt. | 58 58 | 151 50 |
| | Pt. Banks | 58 38 | 152 12 |
| | Kadiak I., ‡ 27 l., E pt., C. Greville, or Tolstoy, rks. | 57 37 | 152 0 |
| | — St. Paul Harb. | 57 47·5 | 152 19·7 |
| | — Trinity Is., SW pt. | 56 23 | 154 40 |
| | Chirikoff I., [3 l.], N pt. | 55 56 | 155 34 |
| | Shumagin Is., Nagai I., Sanborn Harb. | 55 8·1 | 159 58·2 |
| | Sannakh I., sum. 1850f. | 54 25·3 | 162 44 |
| *Aleutian Islands* | Unimak Pass, Ugamok I., S. pt | 54 12 | 164 57 |
| | Unalashka, ‡ 23 l., Iliuliuk Port, ⊞, church ⊕ | 53 50·2 | 166 30·7 |
| | Bogosloff I., [2 m.], ‖o pk., 344f. | 53 57·5 | 167 58 |
| | Umnak I., Vsevidoff, vol. 8000f | 53 15 | 168 29 |
| | Yunaska I., ‡ 5 l., sum. 2864f. | 52 36 | 170 47 |
| | Amukhta I., [2 l.], 3738f. | 52 28 | 171 17 |
| | Siguam I., ‡ 5m., 2098f. SW pt. | 52 17·5 | 172 36 |
| | Amlia I., EW 12 l., ⚲o (rk ‡ 5m.) Suchikoff B. | 52 2·2 | 173 22·5 |
| | Atka I., ‡ 20 l., vol., 4988f., Nazan B. ⊕ | 52 10·6 | 174 15 |
| | Sitchin I., [2 l.], *h*, vol., 5083f. | 52 5 | 176 8 |
| | Kanaga I., ‡ 9 l., N pt. | 51 56 | 177 5 |
| | Tanaga I., EW 11 l., (w in Bay, *W d.*), NW pk. 7108f. | 51 53 | 178 9 |
| | Gareloi, or Burning I., or Volcano, [2 l.], 5334f. | 51 47·5 | 178 52·5 |
| | Amatignak I., 1921f., West pt. | 51 18 | 179 12 |
| | | | East |
| | I. of Seven Mountains, Semisopochnoi, 3122f. [3 P] | 51 56 | 179 37·5 |
| | Amchitka I., ‡ 11 l., Constantine Harbour ⊕ | 51 23·6 | 179 10·2 |
| | Kyska I., NS 8 l., Kyska Harbour | 51 59·1 | 177 29·2 |
| | Bouldyr I., [1 l.], (rks. E 6 l.), mid. 1145f. | 52 34 | 175 45 |
| | Agattu, [4 l.], sum. ○ | 52 25 | 173 10 |
| | Semichi, 2 Is., ‡ 2 l., Alaid I., 818f | 52 45 | 173 52 |
| | Attu, EW 15 l., 3084f., W pt., C. Wrangel | 52 58 | 172 27 |
| | — Chichogoff Harb. | 52 55·7 | 173 11·5 |
| | | | West |
| | Pribeloff Is., St. Paul I., EW 8 l., NE pt., (rf. E 2 l.) | 57 15·2 | 170 7 |
| | — St. George I., ‡ 4 l., E pt. | 56 36·7 | 169 27·5 |
| *Behring Sea, Coast of Alaska* | I. Amak, [1 l.], rk. *NW-d.* | 55 27 | 163 3 |
| | Port Moller, ⊞, tongue, S pt. | 55 56 | 160 35 |
| | C. Strogonov, (I. off) | 56 52 | 158 42 |
| | Bristol B., C. Constantine, (bks. *S-d.* 4 l.) | 58 25 | 158 44 |
| | — Nagnek R., Suworoff vill. | 58 40 | 157 3 |
| | Hagenmeister I., ‡ 6 l., S pt. | 58 34 | 160 50 |
| | C. Newenham | 58 41 | 162 5 |
| | C. Avinoff, Anogogmute | 59 39 | 163 45 |
| | Nunivak I., EW 23 l., N pt., C. Etolin | 60 27 | 166 5 |
| | I. St. Mathew, ‡ 10 l., 1500f., SE pt., C. Upright | 60 18 | 172 4 |
| | — Hall I., 1500f., [2 l.], N pt. | 60 32 | 172 40 |

## MARITIME POSITIONS

| (181) | Places | Lat. N | Lon. W |
|---|---|---|---|
| *Behring's Strait* | I. St. Lawrence, ⚓ 30 l., NE pt. | 63°15' | 168°38' |
| | — West pt., C. Sanachno | 63 26 | 171 50 |
| | C. Romantsof, 70f. | 61 52 | 166 10 |
| | Mouth of Yukon R. | 62 20 | 164 20 |
| | I. Stuart, [3 l.] | 63 23 | 162 37 |
| | St. Michael, fort | 63 26 | 161 24 |
| | C. Darby | 64 17 | 162 45 |
| | Sledge I., [2m.], Aziak | 64 30 | 166 8 |
| | Pt. Rodney | 64 39 | 166 18 |
| | King I., [1 l.]. N pt., 700f. | 65 0 | 168 1 |
| | Port Clarence, ⊞. w, Pt. Spencer ⊕ | 65 16·7 | 166 48 |

| (182) | Places | Lat. N | Lon. W |
|---|---|---|---|
| *Arctic Ocean* | C. Prince of Wales (extreme W pt. of America) | 65°33' | 167°59' |
| | Fairway rock | 65 39 | 168 43 |
| | Diomede Is., 2, N one, or Ratmanoff I., [5m.], S pt. | 65 47 | 169 4 |
| | Kotzebue Sound, C. Espenberg, E pt. | 66 33 | 163 28 |
| | — Chamisso I., 231f., w E summit ⊕ | 66 13·2 | 161 46 |
| | C. Krusentern, *l*, sandy | 67 11 | 163 37 |
| | Pt. Hope, *l*. | 68 20 | 166 45 |
| | C. Lisburne, 849f. | 68 52 | 166 6 |
| | Icy Cape (shoals) | 70 20 | 161 46 |
| | Pt. Barrow, Noowook ⊕ | 71 23 | 156 22 |

# TABLE 11.

## PLACES AT WHICH DOCKS, WET OR DRY, OR SLIPS, MAY BE FOUND, REPAIRS MADE, COALS OBTAINED, &c.

London
Chatham
Sheerness
Deal
Dover
Shoreham ?
Portsmouth
Southampton
Topsham
Dartmouth
Devonport
Falmouth
Penzance
Bristol
Newport
Cardiff
Swansea
Hartlepool
Pembroke
Holyhead
Liverpool
Barrow
Whitehaven
Greenock
Glasgow
Stornoway
Lerwick ?
Inverness ?
Aberdeen
Grangemouth
Dundee
Leith
Berwick
Tynemouth
Sunderland
Hull
Great Grimsby
King's Lynn
Ipswich

Cork
Limerick
Sligo
Londonderry
Belfast
Larne
Drogheda
Dublin
Kingstown
Dundalk
Carrickfergus
Wexford

Ostend
Antwerp
Rotterdam
Flushing
Harlingen
Ghent
Delfzyl
Amsterdam

Williamshaven
Hamburg

Elsineur
Copenhagen
Kiel
Stettin
Dantzig
Memel
Riga
Oscarshamn
Kronstadt
Stockholm
Carlscrona
Malmo
Gottenburg

Christiansund
Christiania
Christiansand
Bergen
Trondheim
Archangel

Dunkerque
Calais
Dieppe
Havre
Trouville
Honfleur
Caen
Cherbourg
St. Pierre
St. Helier's
Granville
Morlaix ?
Brest
L'Orient
St. Nazaire
Port de Palais ?
Nantes
Rochelle
Rochefort
Bordeaux
Lormont
Bayonne

Bilbao
Rivadeo
Ferrol
Corunna
Vigo

Figueira
Oporto
Lisbon

Huelva
Cadiz
Gibraltar
Malaga
Cartagena
Valencia

Barcelona

Marseille
Port Ciotat
Toulon

Port Mahon
Cagliari
Caprera I.

Genoa
Spezia
Leghorn
Civita Vecchia
Naples
Messina
Catania
Syracuse
Marsala
Palermo
Taranto
Bari
Ancona
Venice

Trieste
Pola
Fiume

Corfu
Patras
Salamis
Piræus
Syra

Constantinople
Rostoff
Odessa
Nicolaieff
Sevastopol
Batoum

Smyrna
Suda Bay
Beirut
Alexandria
Port Said
Suez

Malta
Tunis
Algiers

Palmas
Teneriffe
Flores
St. Michael's
St. Vincent
Bermuda

Senegal
Goree
Bathurst
Sierra Leone
Quetta

Dix Cove
Elmira
C. Coast ?
Whydah
Princes I.
Lagos
Fernando Po
Congo
Loando
Ascension ?
St. Helena
Cape Town
Simon's B.

Port Elizabeth
East London
Natal
Comoro Is. ?
Mozambique
Reunion
Mauritius
Mahé
Zanzibar
Aden

Muscat
Basrah
Karachi
Bombay
Colombo
Trincomalee
Negapatam
Pondicherri
Madras
Calcutta
Chittagong
Akyab
Rangoon
Moulmein
Mergui
Port Blair

Acheen
Penang
Malacca
Singapore
Padang
Bangkok
Saigon

Canton
Whampoa
Hong Kong
Swatau
Amoy
Fu-chau
Shanghae
Tamoui
Ningpo
Taku
New-chang
Vladivostock

Nagasaki
Hiogo
Kobé
Osaka
Yedo
Hakodadi

Labuan
Manilla
Macassar
Batavia
Samarang
Sourabaya
Amboina
Ternate

Swan R.
King G.'s Sound
Adelaide
Port Phillip
Port Western
Hobart
Port Jackson
Newcastle
Brisbane
Maryborough
Townsville

Nelson
Wellington
Auckland
Otago
Lyttelton
Napier
Wangaroa

Noumea
Levuka
Tahiti
Honolulu

St. John's
Montreal
Toronto
Quebec
Picton
Sydney
Halifax
Gamden
St. John's, New Brk.

Portland
Bath
Portsmouth
Boston
New London
New York
Philadelphia
Baltimore
Norfolk
Charleston

Savannah
Pensacola
Mobile
New Orleans

Nassau
Havana
Santiago de Cuba
Cienfuegos
Port Royal
Port au Prince
Porto Rico
St. Thomas
Sta. Cruz
Antigua
Martinique
St. Lucia ?
Barbados
Grenada

Vera Cruz
Belize
Porto Bello
Curaçao
Caraccas
Port Spain
Demerara
Campeche
Surinam
Cayenne ?

Parà ?
Maranham ?
Pernambuco
Bahia
Rio Janeiro
Rio Grande do Sul
Monte Video
Buenos Ayres

Port Stanley, Falkland Is. ?

Coronel
Talcuhuano
Valparaiso
Coquimbo
Caldera
Antofagasta

Iquique
Callao
Payta
Guayaquil
Panama

Acapulco
Mazatlan
Guaymas
St. Francisco
Portland
Esquimault

# THE NAVIGABLE MERCATORIAL DISTANCES IN NAUTICAL MILES BETWEEN EUROPE AND THE PRINCIPAL PORTS OF NORTH AMERICA AND THE WEST INDIES.

## LIVERPOOL

| Ports | Liverpool | Plymouth | Queenstown | GIBRALTAR | Halifax | New York | Bermuda | St. Thomas | San Juan, Porto Rico | Port au Prince | Jamaica | Havana | Vera Cruz | New Orleans | Antigua | Guadeloupe | Dominica | Martinique | St. Vincent | Barbados | Grenada | Trinidad | Curaçao | La Guayra | Savanilla | Cartagena | Colon | Greytown | Belize | Demerara |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plymouth | 344 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Queenstown | 235 | 212 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| GIBRALTAR | 1280 | 1050 | 1090 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Halifax | 2485 | 2442 | 2237 | 2710 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| New York | 3022 | 2981 | 2830 | 3256 | 580 | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bermuda | 2982 | 2920 | 2754 | 2968 | 751 | 690 | | | | | | | | | | | | | | | | | | | | | | | | |
| St. Thomas | 3596 | 3506 | 3368 | 3336 | 1587 | 1432 | 840 | | | | | | | | | | | | | | | | | | | | | | | |
| S. Juan, Po. Rico | 3658 | 3568 | 3430 | 3416 | 1582 | 1400 | 829 | 81 | | | | | | | | | | | | | | | | | | | | | | |
| Port au Prince | 3864 | 3914 | 3756 | 3848 | 1685 | 1362 | 991 | 621 | 540 | | | | | | | | | | | | | | | | | | | | | |
| Jamaica | 4099 | 4037 | 3871 | 3963 | 1810 | 1484 | 1135 | 703 | 633 | 280 | | | | | | | | | | | | | | | | | | | | |
| Havana | 4132 | 4070 | 3904 | 4237 | 1650 | 1187 | 1150 | 1044 | 963 | 650 | 743 | | | | | | | | | | | | | | | | | | | |
| Vera Cruz | 4937 | 4875 | 4709 | 5044 | 2475 | 1994 | 1946 | 1890 | 1809 | 1883 | 1200 | 807 | | | | | | | | | | | | | | | | | | |
| New Orleans | 4651 | 4589 | 4423 | 4817 | 2148 | 1717 | 1669 | 1600 | 1519 | 1938 | 1105 | 590 | 800 | | | | | | | | | | | | | | | | | |
| Antigua | 3538 | 3438 | 3310 | 3218 | 1653 | 1547 | 932 | 181 | 262 | 802 | 882 | 1225 | 2018 | 1781 | | | | | | | | | | | | | | | | |
| Guadeloupe | 3541 | 3441 | 3313 | 3215 | 1723 | 1617 | 1002 | 256 | 322 | 877 | 900 | 1550 | 2076 | 2011 | 70 | | | | | | | | | | | | | | | |
| Dominica | 3581 | 3481 | 3353 | 3237 | 1743 | 1637 | 1022 | 271 | 337 | 922 | 911 | 1582 | 2050 | 1985 | 120 | 47 | | | | | | | | | | | | | | |
| Martinique | 3623 | 3523 | 3395 | 3240 | 1823 | 1717 | 1102 | 317 | 381 | 958 | 952 | 1608 | 2096 | 2031 | 170 | 100 | 55 | | | | | | | | | | | | | |
| St. Vincent | 3698 | 3508 | 3483 | 3265 | 1890 | 1783 | 1169 | 370 | 432 | 975 | 970 | 1628 | 2106 | 2041 | 245 | 194 | 133 | 93 | | | | | | | | | | | | |
| Barbados | 3660 | 3538 | 3473 | 3245 | 1910 | 1820 | 1185 | 433 | 499 | 1065 | 1055 | 1723 | 2201 | 2136 | 285 | 220 | 170 | 133 | 97 | | | | | | | | | | | |
| Grenada | 3776 | 3673 | 3558 | 3386 | 1954 | 1847 | 1232 | 419 | 473 | 980 | 960 | 1632 | 2100 | 2025 | 307 | 250 | 200 | 157 | 74 | 150 | | | | | | | | | | |
| Trinidad | 3837 | 3734 | 3619 | 3434 | 2055 | 1943 | 1333 | 511 | 569 | 1042 | 1008 | 1700 | 2168 | 2113 | 402 | 359 | 312 | 258 | 173 | 206 | 90 | | | | | | | | | |
| Curaçao | 4063 | 3963 | 3835 | 3720 | 1987 | 1763 | 1237 | 461 | 488 | 645 | 572 | 1249 | 1847 | 1872 | 525 | 510 | 488 | 491 | 460 | 556 | 425 | 456 | | | | | | | | |
| La Guayra | 4019 | 3919 | 3791 | 3701 | 2064 | 1818 | 1318 | 480 | 508 | 798 | 725 | 1402 | 2000 | 2025 | 488 | 460 | 438 | 419 | 368 | 456 | 315 | 318 | 153 | | | | | | | |
| Savanilla | 4319 | 4229 | 4091 | 4060 | 2200 | 1783 | 1447 | 723 | 754 | 585 | 431 | 1046 | 1485 | 1428 | 840 | 840 | 823 | 835 | 815 | 912 | 795 | 831 | 370 | 513 | | | | | | |
| Cartagena | 4381 | 4291 | 4153 | 4122 | 2262 | 1832 | 1509 | 785 | 816 | 634 | 468 | 1062 | 1501 | 1444 | 902 | 902 | 885 | 897 | 877 | 974 | 857 | 893 | 432 | 575 | 62 | | | | | |
| Colon | 4616 | 4526 | 4388 | 4263 | 2294 | 1980 | 1630 | 1020 | 970 | 768 | 547 | 979 | 1404 | 1369 | 1145 | 1150 | 1133 | 1145 | 1125 | 1222 | 1105 | 1141 | 680 | 823 | 310 | 363 | | | | |
| Greytown | 4761 | 4699 | 4533 | 4523 | 2360 | 2046 | 1679 | 1187 | 1112 | 839 | 577 | 841 | 1260 | 1232 | 1330 | 1337 | 1325 | 1337 | 1320 | 1417 | 1300 | 1336 | 875 | 1018 | 517 | 481 | 245 | | | |
| Belize | 4680 | 4618 | 4451 | 4558 | 2139 | 1708 | 1706 | 1363 | 1278 | 915 | 648 | 521 | 858 | 827 | 1533 | 1557 | 1551 | 1578 | 1581 | 1678 | 1563 | 1597 | 1153 | 1306 | 867 | 837 | 731 | 583 | | |
| Demerara | 3877 | 3779 | 3679 | 3397 | 2285 | 2206 | 1570 | 793 | 854 | 1346 | 1306 | 1998 | 2466 | 2401 | 656 | 586 | 563 | 493 | 423 | 390 | 380 | 341 | 782 | 653 | 1154 | 1216 | 1464 | 659 | 1943 | |
| PERNAMBUCO | 4094 | 3860 | 3874 | 3140 | 3545 | 3681 | 2932 | 2422 | 2467 | 3079 | 3008 | 3737 | 4205 | 4102 | 2247 | 2182 | 2157 | 2105 | 2082 | 2002 | 2072 | 2037 | 2493 | 2355 | 2868 | 2930 | 3178 | 3373 | 3634 | 1701 |

Liverpool to Holyhead 70
„ to Longships 273
Plymouth to Lizard 47
„ to Gravesend 294

St. Thomas and Lisbon 3161
Jamaica and Lisbon 3772
Havana and Lisbon 3979
Vera Cruz and Lisbon 4786
New Orleans and Lisbon 4532
Antigua and Lisbon 3056
Dominica and Lisbon 3100
Martinique & Bordeaux / St. Vincent [3640]
Barbados and Lisbon 3099
Grenada and Lisbon 3249
Curaçao and Lisbon 3588
Savanilla and Lisbon 3896
Cartagena and Lisbon 3958
Colon and Lisbon 4201
Belize and Lisbon 4390
Demerara and Lisbon 3287

## NORTH AMERICAN AND WEST INDIAN PORTS.

| Ports | St. Thomas | Havana | New Orleans | Vera Cruz | San Juan, Pto. Rico | Port au Prince | Jamaica | Colon | Barbados | Demerara |
|---|---|---|---|---|---|---|---|---|---|---|
| Quebec | 2240 | 2320 | 2854 | 3120 | 2245 | 2374 | 2505 | 2997 | 2547 | 2932 |
| Boston | 1500 | 1410 | 1944 | 2219 | 1485 | 1524 | 1655 | 2147 | 1867 | 2252 |
| Philadelphia | 1422 | 1144 | 1678 | 1944 | 1394 | 1333 | 1464 | 1958 | 1831 | 2216 |
| Baltimore | 1406 | 1105 | 1639 | 1905 | 1370 | 1290 | 1421 | 1913 | 1826 | 2211 |
| Washington | 1416 | 1115 | 1649 | 1915 | 1380 | 1300 | 1431 | 1923 | 1836 | 2221 |
| Charleston | 1187 | 646 | 1180 | 1446 | 1135 | 953 | 1084 | 1576 | 1620 | 1980 |

## BRITISH TO N. AMERICAN PORTS: NORTHERN ROUTE.

| Ports | Belle Isle | Quebec | Cape Race | Halifax | Boston | New York | Phila-d'phia | Balti-more | Wash-ingt'n |
|---|---|---|---|---|---|---|---|---|---|
| Glasgow | 1821 | 2561 | 1908 | 2368 | 2725 | 2918 | 3073 | 3240 | 3243 |
| Belfast | 1775 | 2515 | 1862 | 2322 | 2679 | 2872 | 3027 | 3194 | 3197 |
| Liverp'l | 1891 | 2631 | 1977 | 2437 | 2794 | 2987 | 3142 | 3309 | 3312 |
| Inistrh'l | 1689 | 2429 | 1775 | 2235 | 2592 | 2785 | 2940 | 3107 | 3110 |
| C. Wrath | 1800 | 2540 | 1843 | 2275 | 2632 | 2825 | 2980 | 3147 | 3150 |

Bermuda Narrows to Dockyard 11 m.
Port Royal to Kingston 6 m.

## LONDON

90 m. taken from London Distances give Distances to Dover (see p. 643A).

| Ports | London | Liverpool | Plymouth | Queenstown | Belle Isle | Quebec | Pr. Edward I. | St. John's | Cape Race | Halifax | Sable Island | Boston | New York | Philadelphia | Baltimore | Washington | Charleston | Bermuda | Nassau | Gibraltar | PERNAMBUCO | CAPE OF G. HOPE | Lisbon |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Liverpool | 650 | | | | | | | | | | | | | | | | | | | | | | |
| Plymouth | 317 | 346 | | | | | | | | | | | | | | | | | | | | | |
| Queenstown | 552 | 241 | 211 | | | | | | | | | | | | | | | | | | | | |
| Belle Isle | 2268 | 1953 | 1951 | 1763 | | | | | | | | | | | | | | | | | | | |
| Quebec | 3008 | 2693 | 2691 | 2506 | 740 | | | | | | | | | | | | | | | | | | |
| Pr. Edward I. | 2711 | 2452 | 2394 | 2224 | 509 | 559 | | | | | | | | | | | | | | | | | |
| St. John's | 2248 | 1986 | 1931 | 1758 | 299 | 869 | 503 | | | | | | | | | | | | | | | | |
| Cape Race | 2268 | 2009 | 1951 | 1781 | 359 | 809 | 443 | 60 | | | | | | | | | | | | | | | |
| Halifax | 2759 | 2469 | 2442 | 2257 | 600 | 748 | 260 | 530 | 460 | | | | | | | | | | | | | | |
| Sable Island | 2623 | 2356 | 2306 | 2128 | 528 | 705 | 217 | 377 | 317 | 170 | | | | | | | | | | | | | |
| Boston | 3133 | 2807 | 2816 | 2629 | 968 | 1117 | 629 | 867 | 817 | 379 | 510 | | | | | | | | | | | | |
| New York | 3298 | 3022 | 2981 | 2830 | 1086 | 1318 | 830 | 1070 | 1010 | 580 | 684 | 336 | | | | | | | | | | | |
| Philadelphia | 3508 | 3232 | 3191 | 3004 | 1155 | 1458 | 975 | 1225 | 1165 | 725 | 836 | 493 | 234 | | | | | | | | | | |
| Baltimore | 3680 | 3404 | 3363 | 3176 | 1470 | 1608 | 1120 | 1392 | 1332 | 886 | 1007 | 665 | 405 | 358 | | | | | | | | | |
| Washington | 3683 | 3407 | 3366 | 3179 | 1473 | 1611 | 1123 | 1395 | 1335 | 889 | 1010 | 663 | 410 | 364 | 182 | | | | | | | | |
| Charleston | 3850 | 3575 | 3533 | 3347 | 1642 | 1783 | 1295 | 1572 | 1512 | 1052 | 1175 | 832 | 603 | 573 | 532 | 537 | | | | | | | |
| Bermuda | 3237 | 2982 | 2920 | 2754 | 1207 | 1427 | 939 | 1095 | 1035 | 760 | 753 | 707 | 690 | 722 | 767 | 772 | 771 | | | | | | |
| Nassau | 4053 | 3792 | 3736 | 3564 | 1942 | 2081 | 1593 | 1801 | 1741 | 1351 | 1432 | 1150 | 966 | 914 | 877 | 881 | 501 | 787 | | | | | |
| Gibraltar | 1330 | 1287 | 1050 | 1090 | 2357 | 3221 | 2733 | 2245 | 2240 | 2710 | 2546 | 3084 | 3256 | 3357 | 3555 | 3558 | 3701 | 2968 | 3777 | | | | |
| PERNAMBUCO | 4130 | 4094 | 3860 | 3874 | 3511 | 4100 | 3735 | 3512 | 3452 | 3541 | 3397 | 3662 | 3681 | 3732 | 3736 | 3741 | 3602 | 2982 | 3228 | 3140 | | | |
| CAPE OF G. HOPE | 6156 | 6113 | 5882 | 5906 | 6490 | 6931 | 6565 | 6282 | 6222 | 6530 | 6385 | 6792 | 6817 | 6872 | 6967 | 6970 | 6861 | 6160 | 6589 | 5119 | 3346 | | |
| Lisbon | 1035 | 1000 | 764 | 810 | 1955 | 2803 | 2437 | 1977 | 1994 | 2463 | 2301 | 2825 | 3020 | 3173 | 3325 | 3330 | 3462 | 2745 | 3565 | 300 | 3358 | 5152 | |
| Bordeaux | 689 | 673 | 420 | 535 | 2219 | 3024 | 2658 | 2183 | 2215 | 2708 | 2556 | 3080 | 3279 | 3452 | 3623 | 3628 | 3784 | 3121 | 3554 | 1008 | 3822 | 3838 | 732 |

| | |
|---|---|
| New York to Sandy Hook .. | 15 |
| Philadelphia to C. Henlopen | 87 |
| Baltimore to C. Henry .. | 155 |
| Washington to C. Henry .. | 160 |
| Quebec to Canso I. .. .. | 610 |
| Bermuda to St. Michaels .. | 1960 |
| Quebec to Montreal .. .. | 135 |

## HALIFAX

| Ports | Halifax | New York | Bermuda | Jamaica | Barbados | Gibraltar | Fayal | Madeira | Teneriffe | St. Vincent, C. Verd I. | Sierra Leone | Fernando Po |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| New York | 580 | | | | | | | | | | | |
| Bermuda | 760 | 690 | | | | | | | | | | |
| Jamaica | 1810 | 1484 | 1135 | | | | | | | | | |
| Barbados | 1910 | 1820 | 1185 | 1055 | | | | | | | | |
| Gibraltar | 2710 | 3256 | 2968 | 3963 | 3245 | | | | | | | |
| Fayal | 1613 | 2136 | 1809 | 2831 | 2254 | 1121 | | | | | | |
| Madeira | 2300 | 2812 | 2428 | 3377 | 2625 | 610 | 676 | | | | | |
| Teneriffe | 2464 | 2939 | 2511 | 3471 | 2615 | 717 | 871 | 259 | | | | |
| St. Vincent | 2571 | 2955 | 2359 | 2960 | 2019 | 1565 | 1323 | 1042 | 843 | | | |
| Sierra Leone | 3409 | 3803 | 3208 | 3781 | 2751 | 1977 | 2032 | 1579 | 1300 | 855 | | |
| Fernando Po | 4845 | 5214 | 4619 | 5137 | 4096 | 3412 | 3455 | 3000 | 2741 | 2274 | 1465 | |
| Nassau | 1451 | 966 | 806 | 670 | 1299 | 3777 | 2602 | 3208 | 3284 | 2964 | 3800 | 5192 |

| | |
|---|---|
| Fayal and Pernambuco | 2812 |
| Nassau and St. Thomas's | 866 |
| „ and Havana | 390 |
| Sierra Leone and St Thomas's | 3070 |

## DISTANCES SOUTHWARD OF THE DRIFT ICE.

| | Quebec | Halifax | Boston | New York |
|---|---|---|---|---|
| Liverpool | 3171 | 2685 | 2997 | 3152 |
| Queenstown | 2904 | 2424 | 2762 | 2885 |
| Plymouth | 3070 | 2585 | 2929 | 3053 |
| Lisbon | 2958 | 2492 | | |
| Bordeaux | 3207 | 2801 | | |

# THE NAVIGABLE MERCATORIAL DISTANCES IN NAUTICAL MILES BETWEEN EUROPE AND THE PRINCIPAL PORTS ON THE SOUTH-EAST COAST OF SOUTH AMERICA.

| Ports | LONDON | Liverpool | Southampton | Plymouth | Lisbon | GIBRALTAR | Madeira | Tenerife | St. Vincent | Para | Maranham | Ceara | PERNAMBUCO |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Liverpool .. | 650 | | | | | | | | | | | | |
| Southampton .. | 207 | 463 | | | | | | | | | | | |
| Plymouth .. | 317 | 344 | 131 | | | | | | | | | | |
| Lisbon .. | 1034 | 1000 | 865 | 764 | | | | | | | | | |
| GIBRALTAR .. | 1320 | 1280 | 1140 | 1050 | 300 | | | | | | | | |
| Madeira .. | 1465 | 1417 | 1300 | 1210 | 525 | 603 | | | | | | | |
| Tenerife .. | 1690 | 1651 | 1525 | 1420 | 715 | 717 | 259 | | | | | | |
| St. Vincent .. | 2507 | 2459 | 2347 | 2250 | 1560 | 1565 | 1042 | 843 | | | | | |
| Para .. | 4170 | 4107 | 4009 | 3890 | 3260 | 3303 | 2735 | 2586 | 1779 | | | | |
| Maranham .. | 4080 | 4017 | 3919 | 3800 | 3175 | 3199 | 2650 | 2466 | 1634 | 357 | | | |
| Ceara .. | 3994 | 3931 | 3799 | 3680 | 3022 | 3197 | 2500 | 2335 | 1452 | 673 | 374 | | |
| PERNAMBUCO .. | 4130 | 4094 | 3956 | 3960 | 3158 | 3140 | 2651 | 2442 | 1609 | 1070 | 759 | 385 | |
| Maceio .. | 4254 | 4191 | 4093 | 3974 | 3268 | 3250 | 2761 | 2561 | 1719 | 1169 | 869 | 495 | 110 |
| Bahia .. | 4520 | 4457 | 4359 | 4240 | 3534 | 3516 | 3027 | 2827 | 1985 | 1435 | 1135 | 761 | 376 |
| Victoria .. | 4947 | 4884 | 4786 | 4667 | 3961 | 3943 | 3454 | 3254 | 2412 | 1802 | 1562 | 1188 | 803 |
| Cape Frio .. | 5125 | 5061 | 4952 | 4851 | 4164 | 4133 | 3657 | 3432 | 2615 | 2064 | 1764 | 1390 | 1006 |
| Rio de Janeiro .. | 5192 | 5128 | 5019 | 4918 | 4231 | 4200 | 3724 | 3499 | 2682 | 2131 | 1831 | 1457 | 1073 |
| Santos .. | 5397 | 5334 | 5207 | 5117 | 4409 | 4391 | 3902 | 3702 | 2860 | 2309 | 2009 | 1635 | 1251 |
| St. Catharina .. | 5609 | 5546 | 5419 | 5329 | 4621 | 4603 | 4114 | 3914 | 3072 | 2521 | 2221 | 1847 | 1463 |
| Rio Grande .. | 5912 | 5849 | 5722 | 5632 | 4924 | 4906 | 4417 | 4217 | 3375 | 2824 | 2524 | 2150 | 1765 |
| Maldonado .. | 6143 | 6080 | 5953 | 5863 | 5155 | 5137 | 4648 | 4448 | 3606 | 3055 | 2755 | 2381 | 1997 |
| Monte Video .. | 6179 | 6115 | 6006 | 5905 | 5218 | 5187 | 4711 | 4486 | 3669 | 3118 | 2818 | 2444 | 2060 |
| Buenos Ayres .. | 6289 | 6225 | 6116 | 6015 | 5328 | 5297 | 4821 | 4596 | 3778 | 3228 | 2918 | 2558 | 2169 |
| Nuevo Gulf .. | 6802 | 6739 | 6612 | 6522 | 5814 | 5796 | 5307 | 5107 | 4265 | 3714 | 3416 | 3040 | 2656 |
| Falklands .. | 7030 | 6951 | 6842 | 6723 | 6053 | 6030 | 5546 | 5346 | 4504 | 3953 | 3653 | 3279 | 2895 |
| Cape Virgins . | 7268 | 7204 | 7090 | 6994 | 6307 | 6280 | 5800 | 5575 | 4749 | 4198 | 3898 | 3524 | 3149 |
| Sierra Leone .. | 3020 | 2957 | 2830 | 2740 | 2010 | 1977 | 1579 | 1320 | 855 | 2215 | 1974 | 1685 | 1631 |
| Ascension .. | 3903 | 3841 | 3713 | 3680 | 2893 | 2857 | 2461 | 2203 | 1620 | 2131 | 1852 | 1478 | 1233 |
| St. Helena .. | 4502 | 4440 | 4312 | 4225 | 3492 | 3470 | 3061 | 2802 | 2270 | 2788 | 2480 | 2115 | 1774 |
| CAPE HORN .. | 7401 | 7337 | 7223 | 7132 | 6440 | 6416 | 5933 | 5708 | 4898 | 4347 | 4047 | 3673 | 3289 |

| Ports | Maceio | Bahia | Victoria | Cape Frio | Rio de Jan. | Santos | St. Catharina | Rio Grande | Maldonado | Monte Video | Buenos Ayres | Nuevo Gulf | Falklands | Cape Virgins | Sierra Leone | Ascension | St. Helena |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bahia .. | 266 | | | | | | | | | | | | | | | | |
| Victoria .. | 693 | 448 | | | | | | | | | | | | | | | |
| Cape Frio .. | 805 | 650 | 202 | | | | | | | | | | | | | | |
| Rio de Janeiro .. | 872 | 737 | 269 | 67 | | | | | | | | | | | | | |
| Santos .. | 1050 | 895 | 447 | 245 | 200 | | | | | | | | | | | | |
| St. Catharina .. | 1262 | 1107 | 659 | 457 | 413 | 253 | | | | | | | | | | | |
| Rio Grande .. | 1565 | 1410 | 962 | 760 | 725 | 579 | 326 | | | | | | | | | | |
| Maldonado .. | 1796 | 1641 | 1193 | 991 | 945 | 815 | 562 | 236 | | | | | | | | | |
| Monte Video .. | 1859 | 1724 | 1256 | 1054 | 1020 | 878 | 625 | 299 | 63 | | | | | | | | |
| Buenos Ayres .. | 1969 | 1814 | 1366 | 1164 | 1130 | 988 | 735 | 409 | 173 | 110 | | | | | | | |
| Nuevo Gulf .. | 2455 | 2300 | 1852 | 1610 | 1604 | 1474 | 1221 | 895 | 659 | 642 | 702 | | | | | | |
| Falklands .. | 2694 | 2539 | 2091 | 1889 | 1872 | 1749 | 1502 | 1202 | 1013 | 1002 | 1067 | 604 | | | | | |
| Cape Virgins . | 2939 | 2784 | 2336 | 2143 | 2106 | 1986 | 1733 | 1407 | 1210 | 1184 | 1244 | 602 | 421 | | | | |
| Sierra Leone .. | 1713 | 1919 | 2323 | 2532 | 2599 | 2777 | 2989 | 3292 | 3523 | 3586 | 3690 | 4182 | 4298 | 4642 | | | |
| Ascension .. | 1291 | 1476 | 1724 | 1823 | 1890 | 2068 | 2217 | 2525 | 2761 | 2824 | 2928 | 3377 | 3407 | 3778 | 1000 | | |
| St. Helena .. | 1838 | 1916 | 1971 | 2073 | 2140 | 2318 | 2491 | 2710 | 2885 | 2948 | 3052 | 3429 | 3308 | 3719 | 1550 | 700 | |
| CAPE HORN .. | 3088 | 2933 | 2485 | 2283 | 2261 | 2175 | 1922 | 1586 | 1373 | 1330 | 1420 | 814 | 441 | 292 | 4732 | 3848 | 3749 |

| | Para | Maranham | Ceara | Ascension |
|---|---|---|---|---|
| Barbados .. | 1165 | 1370 | 1630 | 2991 |
| Demerara .. | 890 | 1130 | 1390 | 2780 |

AFRICAN TO AMERICAN PORTS.

| | New York | Baltimore | Charleston | Jamaica | Barbados | Demerara | Cayenne | Para | Maranham | Pernambuco | Bahia | Rio | Monte Video |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sierra Leone .. | 3803 | 3970 | 3984 | 3781 | 2751 | 2666 | 2360 | 2250 | 1980 | 1631 | 1919 | 2599 | 3586 |
| Cape Palmas .. | 4277 | 4444 | 4397 | 4146 | 3105 | 3008 | 2665 | 2490 | 2230 | 1785 | 2120 | 2660 | 3626 |
| Accra .. | 4734 | 4901 | 4854 | 4603 | 3562 | 3465 | 3122 | 2947 | 2687 | 2245 | 2565 | 3056 | 4002 |
| Lagos .. | 4961 | 5128 | 5081 | 4830 | 3789 | 3692 | 3349 | 3174 | 2914 | 2467 | 2780 | 3262 | 4200 |
| Fernando Po . | 5268 | 5435 | 5388 | 5137 | 4096 | 3998 | 3660 | 3495 | 3212 | 2710 | 3017 | 3447 | 4348 |
| St. Thomas .. | 5175 | 5342 | 5295 | 5044 | 4018 | 3910 | 3400 | 3365 | 3080 | 2550 | 2840 | 3235 | 4122 |
| River Congo .. | 5621 | 5788 | 5758 | 5473 | 4437 | 4300 | 3925 | 3712 | 3410 | 2820 | 3080 | 3364 | 4173 |
| Walfisch Bay . | 6267 | 6332 | 6362 | 5893 | 4863 | 4630 | 4263 | 3968 | 3650 | 2985 | 3083 | 3185 | 3771 |

| | Cadiz | Tangier | St. Vincent | Lisbon | Finisterre | Bordeaux | Ushant | Liverpool | Plymouth | Gravesend |
|---|---|---|---|---|---|---|---|---|---|---|
| Gibraltar | 75 | 30 | 190 | 300 | 550 | 1008 | 930 | 1280 | 1050 | 1297 |
| Cadiz | | 58 | 136 | 246 | 496 | 954 | 872 | 1226 | 990 | 1238 |
| Tangier | | | 170 | 280 | 530 | 988 | 906 | 1260 | 1024 | 1272 |
| St. Vincent | | | | 110 | 360 | 818 | 736 | 1090 | 854 | 1102 |
| Lisbon | | | | | 270 | 728 | 646 | 1000 | 764 | 1012 |
| Finisterre | | | | | | 458 | 376 | 730 | 494 | 742 |
| Bordeaux | | | | | | | 300 | 673 | 420 | 666 |
| Ushant | | | | | | | | 373 | 120 | 366 |
| Liverpool | | | | | | | | | 344 | 627 |
| Plymouth | | | | | | | | | | 294 |

| | HALIFAX | New York | Bermuda | New Orleans | Jamaica | Demerara | Cayenne | Cape S. Roque | PERNAMBUCO | Bahia | Rio de Jan. | Santos | Rio Grande | M. Video | Falklands | C. Virgins | Sierra Leone | Ascension | St. Helena | CAPE OF GOOD HOPE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| New York .. | 580 | | | | | | | | | | | | | | | | | | | |
| Bermuda .. | 760 | 690 | | | | | | | | | | | | | | | | | | |
| New Orleans .. | 2148 | 1717 | 1669 | | | | | | | | | | | | | | | | | |
| Jamaica .. | 1801 | 1484 | 1108 | 1105 | | | | | | | | | | | | | | | | |
| Demerara .. | 2285 | 2206 | 1570 | 2401 | 1306 | | | | | | | | | | | | | | | |
| Cayenne .. | 2457 | 2459 | 1787 | 2777 | 1683 | 376 | | | | | | | | | | | | | | |
| Cape S. Roque .. | 3379 | 3519 | 2830 | 3940 | 2846 | 1530 | 1163 | | | | | | | | | | | | | |
| PERNAMBUCO .. | 3541 | 3681 | 2992 | 4102 | 3008 | 1701 | 1325 | 162 | | | | | | | | | | | | |
| Bahia .. | 3917 | 4057 | 3368 | 4478 | 3384 | 2077 | 1701 | 538 | 376 | | | | | | | | | | | |
| Rio de Janeiro .. | 4614 | 4754 | 4065 | 5175 | 4081 | 2774 | 2398 | 1235 | 1073 | 737 | | | | | | | | | | |
| Santos .. | 4792 | 4932 | 4243 | 5353 | 4259 | 2952 | 2576 | 1413 | 1251 | 895 | 200 | | | | | | | | | |
| Rio Grande .. | 5307 | 5447 | 4758 | 5876 | 4782 | 3475 | 3099 | 1938 | 1766 | 1410 | 725 | 579 | | | | | | | | |
| Monte Video .. | 5601 | 5741 | 5052 | 6162 | 5068 | 3761 | 3385 | 2222 | 2060 | 1704 | 1020 | 878 | 299 | | | | | | | |
| Falklands .. | 6436 | 6576 | 5887 | 6997 | 5903 | 4596 | 4220 | 3057 | 2895 | 2539 | 1872 | 1749 | 1202 | 1012 | | | | | | |
| Cape Virgins .. | 6687 | 6827 | 6138 | 7248 | 6154 | 4847 | 4471 | 3308 | 3149 | 2784 | 2106 | 1986 | 1407 | 1184 | 421 | | | | | |
| Sierra Leone .. | 3409 | 3803 | 3208 | 4879 | 3781 | 2700 | 2352 | 1555 | 1631 | 1919 | 2599 | 2777 | 3292 | 3586 | 4298 | 4642 | | | | |
| Ascension .. | 4137 | 4403 | 3765 | 5105 | 4010 | 2781 | 2405 | 1275 | 1233 | 1476 | 1890 | 2068 | 2525 | 2824 | 3407 | 3778 | 1000 | | | |
| St. Helena | 4830 | 5100 | 4462 | 5775 | 4680 | 3417 | 3041 | 1864 | 1774 | 1916 | 2140 | 2318 | 2491 | 2710 | 3308 | 3719 | 1550 | 700 | | |
| C. OF GOOD HOPE | 6630 | 6817 | 6127 | 7464 | 6369 | 5024 | 4648 | 3511 | 3346 | 3361 | 3270 | 3446 | 3549 | 3600 | 3474 | 3913 | 3192 | 2420 | 1720 | |
| CAPE HORN .. | 6830 | 6970 | 6281 | 5636 | 6297 | 4990 | 4614 | 3461 | 3289 | 2933 | 2261 | 2175 | 1593 | 1360 | 441 | 292 | 4732 | 3948 | 3749 | 3791 |

| | Plymouth | Cape Verde | S. Vincent | Sierra Leone | Ascension | S. Helena | Cape of G. Hope | Rio | Cape Horn | Monte Video | S. Paul's | Trinadad |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S. Paul's Rocks.. | 3230 | 1018 | 997 | 1071 | 1045 | 1725 | 3431 | 1598 | 3814 | 2585 | | |
| Trinadad .. | 4424 | 2227 | 2261 | 1971 | 1153 | 1370 | 2668 | 779 | 2742 | 1654 | 1283 | |
| Tristan d'Acunha | 5347 | 3124 | 3374 | 2754 | 1754 | 1323 | 1512 | 1804 | 2507 | 2145 | 2469 | 1391 |

| | San Diego | C. Virgins | Cape Frio | C. St. Thomé | Ushant | Plymouth | Liverpool |
|---|---|---|---|---|---|---|---|
| C. Horn | 110 | 292 | 2281 | 2356 | 7017 | 7132 | 7337 |
| San Diego | | 182 | 2171 | 2246 | 6907 | 7022 | 7232 |
| C. Virgins | | | 2143 | 2218 | 6879 | 6994 | 7204 |
| C. Frio | | | | 80 | 4736 | 4851 | 5061 |
| C. St. Thomé | | | | | 4656 | 4771 | 4981 |
| Ushant | | | | | | 120 | 373 |
| Plymouth | | | | | | | 344 |

| | Queenstown | Fayal |
|---|---|---|
| Plymouth | 211 | 1261 |
| Lisbon | 810 | 929 |
| Gibraltar | 1090 | 1121 |
| Madeira | 1225 | 676 |
| Tenerife | 1457 | 871 |
| St. Vincent | 2260 | 1323 |
| Para .. | 3825 | 2615 |

| | Queenstown | Fayal |
|---|---|---|
| Maranham | 3875 | 2602 |
| Ceara .. | 3695 | 2603 |
| Pernambuco | 3870 | 2812 |
| Rio .. | 4943 | 3885 |
| Monte Video | 5930 | 4872 |
| C. Virgins .. | 7010 | 5952 |
| C. Horn .. | 7160 | 6101 |

| | |
|---|---|
| Cape of Good Hope to London | 6156 |
| " " " Liverpool | 6113 |
| " " " Fayal | 5170 |

# THE NAVIGABLE MERCATORIAL DISTANCES IN NAUTICAL MILES BETWEEN EUROPE AND THE PRINCIPAL PORTS OF THE WEST COAST OF AFRICA.

| Ports | London | Liverpool | Southampton | Plymouth | Lisbon | Fayal | Madeira | Tenerife | St. Vincent | CAPE VERDE | Bathurst | Sierra Leone | Monrovia | Cape Palmas | C. Three Points | C. Coast Castle | Accra | River Volta | Lagos | C. Formosa | Bonny River | Old Calabar | Fernando Po | Princes I. | St. Thomas | Anno Dom | Ascension | St. Helena | Gaboon Point |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Liverpool | 650 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Southampton | 207 | 464 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Plymouth | 317 | 344 | 131 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Lisbon | 1035 | 1000 | 865 | 764 | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fayal | 1578 | 1401 | 1380 | 1201 | 929 | | | | | | | | | | | | | | | | | | | | | | | | |
| Madeira | 1465 | 1417 | 1300 | 1210 | 525 | 676 | | | | | | | | | | | | | | | | | | | | | | | |
| Tenerife | 1690 | 1651 | 1525 | 1420 | 715 | 871 | 259 | | | | | | | | | | | | | | | | | | | | | | |
| St. Vincent | 2507 | 2459 | 2347 | 2250 | 1560 | 1323 | 1042 | 843 | | | | | | | | | | | | | | | | | | | | | |
| CAPE VERDE | 2514 | 2472 | 2341 | 2242 | 1520 | 1543 | 1075 | 850 | 456 | | | | | | | | | | | | | | | | | | | | |
| Bathurst | 2664 | 2562 | 2431 | 2332 | 1610 | 1633 | 1165 | 920 | 545 | 90 | | | | | | | | | | | | | | | | | | | |
| Sierra Leone | 3000 | 2958 | 2827 | 2728 | 2006 | 2029 | 1561 | 1316 | 855 | 486 | 405 | | | | | | | | | | | | | | | | | | |
| Monrovia | 3204 | 3162 | 3031 | 2932 | 2210 | 2233 | 1765 | 1520 | 1070 | 690 | 602 | 254 | | | | | | | | | | | | | | | | | |
| Cape Palmas | 3424 | 3382 | 3251 | 3152 | 2430 | 2453 | 1985 | 1740 | 1283 | 910 | 822 | 474 | 220 | | | | | | | | | | | | | | | | |
| Cape Three Points | 3758 | 3716 | 3585 | 3486 | 2764 | 2787 | 2319 | 2074 | 1617 | 1244 | 1156 | 808 | 554 | 334 | | | | | | | | | | | | | | | |
| Cape Coast Castle | 3815 | 3773 | 3642 | 3543 | 2821 | 2844 | 2376 | 2131 | 1674 | 1301 | 1213 | 865 | 611 | 391 | 57 | | | | | | | | | | | | | | |
| Accra | 3881 | 3839 | 3708 | 3609 | 2887 | 2910 | 2442 | 2197 | 1740 | 1367 | 1279 | 931 | 677 | 457 | 123 | 66 | | | | | | | | | | | | | |
| River Volta | 3938 | 3896 | 3765 | 3666 | 2944 | 2967 | 2499 | 2254 | 1797 | 1424 | 1336 | 988 | 734 | 514 | 180 | 123 | 57 | | | | | | | | | | | | |
| Lagos | 4108 | 4066 | 3935 | 3836 | 3114 | 3137 | 2669 | 2424 | 1967 | 1594 | 1506 | 1158 | 904 | 684 | 350 | 293 | 227 | 170 | | | | | | | | | | | |
| Cape Formosa | 4247 | 4205 | 4074 | 3975 | 3253 | 3276 | 2808 | 2563 | 2106 | 1733 | 1645 | 1297 | 1043 | 823 | 489 | 440 | 383 | 333 | 205 | | | | | | | | | | |
| Bonny | 4317 | 4275 | 4144 | 4045 | 3323 | 3346 | 2878 | 2633 | 2176 | 1803 | 1715 | 1367 | 1110 | 890 | 559 | 510 | 453 | 403 | 275 | 70 | | | | | | | | | |
| Old Calabar | 4412 | 4370 | 4239 | 4140 | 3418 | 3441 | 2973 | 2728 | 2271 | 1898 | 1810 | 1462 | 1218 | 988 | 654 | 605 | 548 | 498 | 370 | 165 | 105 | | | | | | | | |
| Fernando Po | 4415 | 4373 | 4242 | 4143 | 3421 | 3444 | 2976 | 2731 | 2274 | 1901 | 1813 | 1465 | 1221 | 991 | 657 | 613 | 551 | 501 | 380 | 168 | 110 | 80 | | | | | | | |
| Princes I. | 4346 | 4304 | 4173 | 4074 | 3352 | 3375 | 2807 | 2662 | 2205 | 1832 | 1744 | 1396 | 1152 | 922 | 597 | 562 | 517 | 475 | 375 | 180 | 165 | 207 | 156 | | | | | | |
| St. Thomas | 4322 | 4280 | 4149 | 4050 | 3328 | 3351 | 2883 | 2638 | 2181 | 1808 | 1720 | 1372 | 1118 | 898 | 590 | 557 | 520 | 487 | 417 | 240 | 245 | 296 | 246 | 90 | | | | | |
| Anno Bom | 4293 | 4251 | 4120 | 4021 | 3299 | 3322 | 2854 | 2609 | 2152 | 1779 | 1691 | 1343 | 1089 | 869 | 590 | 565 | 542 | 521 | 488 | 343 | 360 | 418 | 461 | 215 | 125 | | | | |
| Ascension | 3888 | 3846 | 3715 | 3616 | 2894 | 2899 | 2449 | 2204 | 1630 | 1374 | 1291 | 1000 | 875 | 832 | 1049 | 1101 | 1165 | 1215 | 1363 | 1419 | 1478 | 1573 | 1560 | 1423 | 1353 | 1251 | | | |
| St. Helena | 4496 | 4454 | 4323 | 4224 | 3502 | 3514 | 3057 | 2812 | 2270 | 1982 | 1890 | 1570 | 1360 | 1213 | 1247 | 1280 | 1320 | 1348 | 1440 | 1390 | 1428 | 1505 | 1470 | 1303 | 1215 | 1094 | 700 | | |
| Gaboon Point | 4484 | 4442 | 4311 | 4212 | 3490 | 3513 | 3045 | 2800 | 2343 | 1970 | 1882 | 1534 | 1280 | 1060 | 740 | 702 | 657 | 616 | 513 | 303 | 282 | 289 | 216 | 141 | 161 | 246 | 1499 | 1316 | |
| Cape Lopes (C. Lopes) | 4450 | 4408 | 4277 | 4178 | 3456 | 3479 | 3011 | 2766 | 2309 | 1936 | 1848 | 1500 | 1246 | 1026 | 722 | 687 | 648 | 612 | 527 | 335 | 315 | 335 | 271 | 155 | 132 | 192 | 1445 | 1248 | 71 |

Tenerife to Finistère 926

| | Plymouth | Tenerife | Cape Verde | St. Vincent | Sierra Leone | Ascension | St. Helena | Cape of G. Hope | Cape Horn | Monte Video | Rio de Janeiro | S. Paul's Rocks | Trinidad |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S. Paul's Rocks | 3244 | 1820 | 1081 | 997 | 1072 | 1045 | 1725 | 3431 | 3814 | 2585 | 1598 | | |
| Trinidad I. | 4454 | 3030 | 2227 | 2261 | 1971 | 1153 | 1370 | 2668 | 2742 | 1654 | 779 | 1283 | |
| Tristan d'Acunha | 5374 | 3960 | 3124 | 3374 | 2754 | 1754 | 1323 | 1512 | 2507 | 2145 | 1804 | 2409 | 1391 |
| Queenstown | 211 | 1457 | 2277 | 2260 | 2703 | 3641 | 4246 | 5910 | 7163 | 5934 | 4947 | 3252 | 4465 |

| | London | Gravesend | Dover | Finisterre | Madeira | Tenerife | Cape Verde | Jamaica | Pernambuco | Bermuda | Antigua | St. Thomas |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ushant | 389 | 366 | 299 | 376 | 1080 | 1302 | 2125 | 3962 | 3740 | 2848 | 3372 | 3434 |

| | Demerara | Barbados |
|---|---|---|
| Ushant | 3707 | 3466 |

| | Plymouth | Cape Verde | St. Vincent | Sierra Leone | Ascension | St. Helena | Rio de Janeiro | C. Palmas | C. Three Points | Lagos | St. Thomas | C. Lopez | Congo River | Loando | Benguela | Walfisch Bay | Table Bay | CAPE OF GOOD HOPE | Algoa Bay | Natal |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cape Verde | 2242 | | | | | | | | | | | | | | | | | | | |
| St. Vincent | 2250 | 455 | | | | | | | | | | | | | | | | | | |
| Sierra Leone | 2728 | 486 | 855 | | | | | | | | | | | | | | | | | |
| Ascension | 3616 | 1374 | 1630 | 1000 | | | | | | | | | | | | | | | | |
| St. Helena | 4225 | 1982 | 2270 | 1550 | 700 | | | | | | | | | | | | | | | |
| Rio de Janeiro | 4918 | 2749 | 2682 | 2599 | 1900 | 2150 | | | | | | | | | | | | | | |
| Cape Palmas | 3152 | 915 | 1283 | 474 | 832 | 1213 | 2660 | | | | | | | | | | | | | |
| Cape Three Points | 3486 | 1244 | 1617 | 808 | 1049 | 1247 | 3040 | 334 | | | | | | | | | | | | |
| Lagos | 3836 | 1594 | 1967 | 1158 | 1363 | 1440 | 3263 | 684 | 350 | | | | | | | | | | | |
| St. Thomas | 4050 | 1808 | 2181 | 1372 | 1353 | 1215 | 3235 | 898 | 590 | 417 | | | | | | | | | | |
| Cape Lopez | 4178 | 1936 | 2309 | 1500 | 1445 | 1248 | 3314 | 1026 | 722 | 527 | 132 | | | | | | | | | |
| Congo River | 4496 | 2254 | 2627 | 1818 | 1588 | 1220 | 3364 | 1344 | 1080 | 927 | 507 | 400 | | | | | | | | |
| Loando | 4635 | 2393 | 2766 | 1957 | 1643 | 1192 | 3353 | 1483 | 1225 | 1092 | 673 | 562 | 176 | | | | | | | |
| Benguela | 4764 | 2522 | 2895 | 2086 | 1655 | 1145 | 3285 | 1612 | 1384 | 1282 | 868 | 764 | 390 | 222 | | | | | | |
| Walfisch Bay | 5223 | 2981 | 3325 | 2541 | 1897 | 1212 | 3184 | 2071 | 1901 | 1871 | 1472 | 1390 | 1040 | 893 | 700 | | | | | |
| Table Bay | 5852 | 3606 | 3938 | 3162 | 2396 | 1700 | 3270 | 2716 | 2575 | 2554 | 2150 | 2080 | 1743 | 1593 | 1400 | 700 | | | | |
| CAPE OF G. HOPE | 5882 | 3632 | 3960 | 3192 | 2420 | 1720 | 3310 | 2746 | 2605 | 2584 | 2180 | 2210 | 1773 | 1623 | 1430 | 735 | 40 | | | |
| Algoa Bay | 6257 | 4007 | 4335 | 3567 | 2795 | 2095 | 3683 | 3121 | 2980 | 2959 | 2555 | 2485 | 2148 | 1998 | 1805 | 2110 | 415 | 375 | | |
| Natal | 6633 | 4383 | 4711 | 3943 | 3171 | 2471 | 4059 | 3497 | 3356 | 3335 | 2931 | 2861 | 2525 | 2375 | 2181 | 1486 | 791 | 751 | 386 | |
| Delagoa Bay | 6922 | 4672 | 5000 | 4232 | 3460 | 2760 | 4348 | 3786 | 3645 | 1624 | 3220 | 3250 | 2814 | 2664 | 2470 | 1775 | 1080 | 1040 | 675 | 293 |

| | Queenstown | Halifax | New York | Bermuda | Jamaica | Barbados | Gibraltar | Madeira | St. Vincent | Sierra Leone | Cape Coast Castle | Fernando Po | Ascension |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Halifax | 2257 | | | | | | | | | | | | |
| New York | 2800 | 580 | | | | | | | | | | | |
| Bermuda | 2754 | 780 | 690 | | | | | | | | | | |
| Jamaica | 3871 | 1801 | 1484 | 1136 | | | | | | | | | |
| Barbados | 3423 | 1910 | 1820 | 1185 | 1055 | | | | | | | | |
| Gibraltar | 1090 | 2710 | 3256 | 2968 | 3963 | 2245 | | | | | | | |
| Madeira | 1225 | 2300 | 2812 | 2428 | 3377 | 2625 | 610 | | | | | | |
| St. Vincent | 2260 | 2571 | 2955 | 2359 | 2960 | 2019 | 1565 | 1042 | | | | | |
| Sierra Leone | 2763 | 3409 | 3803 | 3208 | 3781 | 2751 | 1986 | 1561 | 855 | | | | |
| Cape Coast Castle | 3576 | 4245 | 4814 | 4019 | 4537 | 3496 | 2801 | 2376 | 1674 | 865 | | | |
| Fernando Po | 4176 | 4845 | 5214 | 4619 | 5137 | 4096 | 3401 | 2976 | 2274 | 1465 | 613 | | |
| Ascension | 3641 | 4137 | 4403 | 3765 | 4010 | 2991 | 2874 | 2449 | 1630 | 1000 | 1101 | 1550 | |
| Cape of Good Hope | 5910 | 6530 | 6817 | 6160 | 6369 | 5292 | 5132 | 4707 | 3976 | 3192 | 2603 | 2469 | 2420 |

Gibraltar to C. Verde, 1500

Cape of Good Hope to London 6156
" " " Liverpool 6113
" " " Cape Horn 3798
" " " Simon's Bay 15

# THE NAVIGABLE MERCATORIAL DISTANCES IN NAUTICAL MILES BETWEEN EUROPE AND THE PRINCIPAL PORTS OF THE EAST INDIES VIA THE SUEZ CANAL.

| Ports | London | Liverpool | Portsmouth | Plymouth | Lisbon | GIBRALTAR | Malta | Brindisi | Alexandria | Port Said | Suez | Jiddah | Musawwa | Hodeida | ADEN | Cape Guardafui | Kurian Murian, I. | Maskat | Bunder Abbas | Abu Shehr | Basrah | Karachi | Bombay | Ratnagiri | Goa | Mangalore | Cochin | C. Comorin | Tuticorin | Colombo |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Liverpool | 650 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Portsmouth | 193 | 463 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Plymouth | 317 | 344 | 130 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Lisbon | 1035 | 1000 | 865 | 764 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| GIBRALTAR | 1320 | 1280 | 1144 | 1060 | 300 | | | | | | | | | | | | | | | | | | | | | | | | | |
| Malta | 2304 | 2261 | 2128 | 2034 | 1279 | 984 | | | | | | | | | | | | | | | | | | | | | | | | |
| Brindisi | 2605 | 2562 | 2429 | 2335 | 1580 | 1285 | 362 | | | | | | | | | | | | | | | | | | | | | | | |
| Alexandria | 3114 | 3071 | 2938 | 2844 | 2089 | 1794 | 820 | 830 | | | | | | | | | | | | | | | | | | | | | | |
| Port Said | 3240 | 3197 | 3064 | 2970 | 2215 | 1920 | 936 | 940 | 146 | | | | | | | | | | | | | | | | | | | | | |
| Suez | 3327 | 3284 | 3151 | 3057 | 2302 | 2007 | 1023 | 1027 | 233 | 87 | | | | | | | | | | | | | | | | | | | | |
| Jiddah | 3957 | 3914 | 3777 | 3687 | 2932 | 2630 | 1657 | 1647 | 863 | 727 | 640 | | | | | | | | | | | | | | | | | | | |
| Musawwa | 4277 | 4234 | 4097 | 4007 | 3252 | 2957 | 1977 | 1967 | 1180 | 1037 | 950 | 350 | | | | | | | | | | | | | | | | | | |
| Hodeida | 4412 | 4369 | 4232 | 4142 | 3392 | 3092 | 2112 | 2102 | 1312 | 1172 | 1085 | 452 | 206 | | | | | | | | | | | | | | | | | |
| ADEN | 4635 | 4592 | 4455 | 4365 | 3610 | 3315 | 2335 | 2335 | 1535 | 1395 | 1308 | 684 | 403 | 232 | | | | | | | | | | | | | | | | |
| Cape Guardafui | 5011 | 4968 | 4831 | 4741 | 3986 | 3691 | 2711 | 2701 | 1911 | 1771 | 1684 | 1070 | 779 | 608 | 376 | | | | | | | | | | | | | | | |
| Kurian Murian, I. | 5335 | 5298 | 5155 | 5065 | 4310 | 4015 | 3035 | 3025 | 2235 | 2095 | 2008 | 1394 | 1103 | 932 | 700 | 433 | | | | | | | | | | | | | | |
| Maskat | 5835 | 5798 | 5655 | 5565 | 4810 | 4515 | 3535 | 3525 | 2735 | 2595 | 2508 | 1894 | 1603 | 1432 | 1200 | 913 | 500 | | | | | | | | | | | | | |
| Bunder Abbas | 6082 | 6045 | 5902 | 5812 | 5057 | 4762 | 3782 | 3772 | 2982 | 2842 | 2755 | 2141 | 1850 | 1679 | 1447 | 1160 | 747 | 247 | | | | | | | | | | | | |
| Abu Shehr | 6419 | 6382 | 6239 | 6149 | 5394 | 5099 | 4119 | 4109 | 3319 | 3179 | 3092 | 2478 | 2187 | 2016 | 1784 | 1497 | 1084 | 584 | 411 | | | | | | | | | | | |
| Basrah | 6595 | 6558 | 6415 | 6325 | 5570 | 5275 | 4295 | 4285 | 3495 | 3355 | 3268 | 2654 | 2363 | 2192 | 1960 | 1666 | 1260 | 760 | 577 | 184 | | | | | | | | | | |
| Karachi | 6085 | 6042 | 5905 | 5815 | 5060 | 4765 | 3785 | 3785 | 2985 | 2845 | 2758 | 2144 | 1853 | 1682 | 1450 | 1180 | 751 | 468 | 643 | 952 | 1107 | | | | | | | | | |
| Bombay | 6272 | 6289 | 6092 | 6002 | 5247 | 4952 | 3972 | 3972 | 3172 | 3032 | 2945 | 2331 | 2040 | 1869 | 1637 | 1303 | 951 | 850 | 1084 | 1421 | 1620 | 500 | | | | | | | | |
| Ratnagiri | 6286 | 6243 | 6106 | 6016 | 5261 | 4966 | 3986 | 3976 | 3186 | 3046 | 2959 | 2345 | 2054 | 1883 | 1651 | 1302 | 982 | 906 | 1153 | 1496 | 1646 | 603 | 120 | | | | | | | |
| Goa | 6303 | 6260 | 6123 | 6033 | 5278 | 4983 | 4003 | 3993 | 3203 | 3063 | 2976 | 2362 | 2071 | 1900 | 1668 | 1312 | 1010 | 977 | 1224 | 1561 | 1717 | 676 | 210 | 94 | | | | | | |
| Mangalore | 6358 | 6315 | 6178 | 6088 | 5333 | 5038 | 4058 | 4048 | 3258 | 3118 | 3031 | 2417 | 2126 | 1955 | 1723 | 1353 | 1098 | 1110 | 1357 | 1694 | 1850 | 846 | 380 | 264 | 170 | | | | | |
| Cochin | 6514 | 6471 | 6334 | 6244 | 5489 | 5194 | 4214 | 4204 | 3414 | 3274 | 3187 | 2573 | 2282 | 2111 | 1879 | 1503 | 1232 | 1289 | 1536 | 1873 | 2029 | 1039 | 573 | 457 | 361 | 197 | | | | |
| Cape Comorin | 6589 | 6546 | 6409 | 6319 | 5564 | 5269 | 4289 | 4279 | 3489 | 3349 | 3262 | 2648 | 2357 | 2186 | 1954 | 1578 | 1332 | 1409 | 1656 | 1993 | 2149 | 1162 | 706 | 580 | 486 | 300 | 126 | | | |
| Tuticorin | 6669 | 6627 | 6489 | 6399 | 5644 | 5349 | 4369 | 4359 | 3569 | 3429 | 3342 | 2728 | 2437 | 2266 | 2034 | 1658 | 1412 | 1489 | 1736 | 2073 | 2229 | 1240 | 776 | 660 | 566 | 380 | 206 | 80 | | |
| Colombo | 6739 | 6696 | 6559 | 6469 | 5714 | 5419 | 4439 | 4429 | 3639 | 3495 | 3408 | 2798 | 2507 | 2336 | 2100 | 1718 | 1494 | 1571 | 1818 | 2155 | 2311 | 1324 | 900 | 742 | 648 | 482 | 288 | 162 | 151 | |
| GALLE | 6769 | 6726 | 6589 | 6499 | 5744 | 5449 | 4469 | 4469 | 3669 | 3529 | 3442 | 2828 | 2537 | 2366 | 2134 | 1768 | 1642 | 1619 | 1866 | 2203 | 2379 | 1372 | 930 | 790 | 696 | 530 | 336 | 210 | 211 | 69 |

Plymouth to Tangier [1024]

Colombo to Albany 3366

GALLE to Albany 3297

| Ports | Madras | Calcutta | Manl-main | Singa-pore | Manila | Hong-kong | C. Leeuwin | Adelaide | Mel-bourne | Hobart | Sydney | Auck-land |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| London | 7305 | 7950 | 7800 | 8270 | 9590 | 9710 | 9600 | 10 770 | 11 080 | 11.230 | 11.540 | 12 640 |
| Liverpool | 7256 | 7906 | 7958 | 8223 | 9546 | 9663 | 9550 | 10 727 | 11.032 | 11.183 | 11.496 | 12 592 |
| Plymouth | 7029 | 7679 | 7731 | 7996 | 9319 | 9436 | 9323 | 10.500 | 10 805 | 10 956 | 11.269 | 12 365 |
| Queenstown | 7069 | 7719 | 7771 | 8036 | 9359 | 9476 | 9363 | 10.540 | 10 845 | 10.996 | 11.309 | 12.405 |
| Gibraltar | 5979 | 6629 | 6681 | 6946 | 8269 | 8386 | 8273 | 9450 | 9755 | 9906 | 10,219 | 11.315 |

| | Halifax | New York | Bermuda | Jamaica | Barbados | Madeira |
|---|---|---|---|---|---|---|
| Aden | 6025 | 6572 | 6283 | 7278 | 6560 | 3918 |
| Galle | 8159 | 8705 | 8417 | 9412 | 8694 | 6052 |
| Singapore | 9656 | 10 208 | 9914 | 10.909 | 10,191 | 7549 |

| | Queenstown |
|---|---|
| Gibraltar | 1090 |
| Malta | 2070 |
| Alexandria | 2890 |
| Port Said | 3010 |
| Aden | 4405 |
| Karachi | 5842 |
| Bombay | 6042 |
| Colombo | 6509 |
| Galle | 6539 |

| | GALLE | Trincomalee | Pondicherry | Madras | Coringa | Gopalpur | Calcutta | Chittagong | Akyab | C. Negrais | Rangoon | Maulmain | Mergui | Penang | Port Blair | PULO BRASSE | ANJER POINT | Diego Garcia | Mahe |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Trincomalee | 250 | | | | | | | | | | | | | | | | | | |
| Pondicherry | 477 | 227 | | | | | | | | | | | | | | | | | |
| Madras | 530 | 280 | 72 | | | | | | | | | | | | | | | | |
| Coringa | 760 | 510 | 330 | 258 | | | | | | | | | | | | | | | |
| Gopalpur | 922 | 672 | 530 | 458 | 200 | | | | | | | | | | | | | | |
| Calcutta | 1180 | 970 | 797 | 780 | 482 | 305 | | | | | | | | | | | | | |
| Chittagong | 1212 | 1018 | 918 | 850 | 626 | 500 | 314 | | | | | | | | | | | | |
| Akyab | 1136 | 956 | 884 | 842 | 624 | 463 | 366 | 143 | | | | | | | | | | | |
| C. Negrais | 1017 | 870 | 870 | 837 | 700 | 572 | 560 | 407 | 264 | | | | | | | | | | |
| Rangoon | 1190 | 1016 | 1047 | 1000 | 877 | 759 | 765 | 584 | 441 | 205 | | | | | | | | | |
| Maulmain | 1230 | 1057 | 1069 | 1040 | 919 | 791 | 800 | 626 | 483 | 240 | 130 | | | | | | | | |
| Mergui | 1195 | 1051 | 1115 | 1097 | 1000 | 904 | 910 | 727 | 584 | 348 | 295 | 250 | | | | | | | |
| Penang | 1213 | 1164 | 1267 | 1280 | 1255 | 1222 | 1290 | 1137 | 994 | 730 | 738 | 722 | 472 | | | | | | |
| Port Blair | 843 | 723 | 743 | 761 | 694 | 663 | 763 | 655 | 512 | 272 | 368 | 405 | 358 | 580 | | | | | |
| PULO BRASSE | 887 | 845 | 996 | 997 | 1020 | 1022 | 1125 | 1030 | 887 | 623 | 676 | 687 | 456 | 307 | 385 | | | | |
| ANJER POINT | 1712 | 1722 | 1909 | 1927 | 2011 | 2062 | 2165 | 2070 | 1927 | 1663 | 1716 | 1707 | 1496 | 1347 | 1426 | 1040 | | | |
| Diego Garcia | 935 | 1134 | 1361 | 1400 | 1777 | 1882 | 2136 | 2211 | 2040 | 1903 | 2345 | 2336 | 1971 | 1872 | 1669 | 1565 | 2013 | | |
| Mahe | 1620 | 1858 | 2085 | 2133 | 2348 | 2503 | 2701 | 2822 | 2703 | 2643 | 2786 | 2822 | 2773 | 2740 | 2447 | 2442 | 3019 | 1017 | |
| Zanzibar | 2583 | 2827 | 3054 | 3108 | 3317 | 3472 | 3730 | 3791 | 3732 | 3612 | 3755 | 3791 | 3748 | 3758 | 3416 | 3451 | 4027 | 2017 | 1017 |

| | Ratnagiri | Goa | Mangalore | Cochin | Colombo |
|---|---|---|---|---|---|
| Natal | 3731 | 3677 | 3612 | 3570 | 3635 |
| Beira | 3163 | 3121 | 3068 | 2998 | 3075 |
| Mozambique | 2690 | 2675 | 2630 | 2580 | 2656 |
| Zanzibar | 2470 | 2460 | 2428 | 2420 | 2555 |
| Mahe | 1676 | 1622 | 1555 | 1510 | 1596 |
| Mauritius | 2405 | 2340 | 2225 | 2112 | 2083 |
| Delagoa | 3554 | 3440 | 3373 | 3360 | 3440 |

## EAST INDIAN AND AUSTRALIAN PORTS VIA CAPE LEEUWIN.

| | Aden | Bombay | Galle | Madras | Calcutta | Singapore | Hongkong | C. LEEUWIN | Adelaide | Melbourne | Hobart Town | Sydney | Auckland | Brisbane |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Madras | 2664 | 1460 | 530 | | | | | | | | | | | |
| Calcutta | 3314 | 2110 | 1180 | 780 | | | | | | | | | | |
| Singapore | 3631 | 2427 | 1497 | 1607 | 1630 | | | | | | | | | |
| Hongkong | 5070 | 3867 | 2937 | 3047 | 3070 | 1440 | | | | | | | | |
| C. LEEUWIN | 4858 | 4020 | 3130 | 3472 | 5793 | 2317 | 3615 | | | | | | | |
| Adelaide | 6135 | 5107 | 4377 | 4649 | 4970 | 3501 | 4791 | 1177 | | | | | | |
| Melbourne | 6440 | 5507 | 4612 | 4914 | 5275 | 3806 | 5096 | 1482 | 498 | | | | | |
| Hobart Town | 6591 | 5656 | 4766 | 5108 | 5429 | 4060 | 5250 | 1633 | 771 | 490 | | | | |
| Sydney | 6904 | 5966 | 5076 | 5418 | 5739 | 4260 | 5557 | 1943 | 990 | 576 | 625 | | | |
| Auckland | 8000 | 7062 | 6172 | 6514 | 6835 | 5359 | 6656 | 3041 | 2057 | 1675 | 1510 | 1280 | | |
| Brisbane | 7384 | 6443 | 5549 | 5891 | 6212 | 4733 | 6030 | 2403 | 1470 | 1056 | 1105 | 480 | 1342 | |
| Wellington | 7795 | 6857 | 5967 | 6309 | 6630 | 5154 | 6452 | 2856 | 1872 | 1489 | 1287 | 1231 | 543 | 1413 |

Singapore to Colombo [1566

## VIA EASTERN ARCHIPELAGO.

| | C. York | Brisbane | Sydney | Auckland | Melbourne | Wellington |
|---|---|---|---|---|---|---|
| Aden | 6041 | 7287 | 7736 | 8456 | 8312 | 8548 |
| Bombay | 4862 | 6108 | 6557 | 7277 | 7133 | 7369 |
| Calcutta | 4080 | 5326 | 5775 | 6495 | 6351 | 6587 |
| Singapore | 2450 | 3695 | 4145 | 4865 | 4721 | 4957 |
| Hongkong | 2767 | 4013 | 4462 | 5182 | 5038 | 5274 |

# THE NAVIGABLE MERCATORIAL DISTANCES IN NAUTICAL MILES BETWEEN ADEN AND THE PRINCIPAL PORTS OF THE EAST INDIES AND EAST COAST OF AFRICA.

| Ports | ADEN | Maskat | Karachi | Bombay | Galle | Madras | Calcutta | Maulmain | PULO BRASSE | ANJER POINT | Keelings | Torres Strait, Cape York | Freemantle | C. LEEUWIN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Maskat .. | 1200 | | | | | | | | | | | | | |
| Karachi .. | 1450 | 468 | | | | | | | | | | | | |
| Bombay .. | 1637 | 850 | 500 | | | | | | | | | | | |
| Galle .. | 2134 | 1619 | 1372 | 930 | | | | | | | | | | |
| Madras .. | 2659 | 2144 | 1897 | 1460 | 530 | | | | | | | | | |
| Calcutta .. | 3314 | 2799 | 2552 | 2110 | 1180 | 780 | | | | | | | | |
| Maulmain .. | 3326 | 2811 | 2564 | 2160 | 1230 | 1040 | 779 | | | | | | | |
| PULO BRASSE .. | 3021 | 2506 | 2259 | 1817 | 887 | 997 | 1125 | 667 | | | | | | |
| ANJER POINT .. | 3821 | 3331 | 3084 | 2642 | 1712 | 1927 | 2165 | 1707 | 1140 | | | | | |
| Keelings .. | 3468 | 3114 | 1854 | 2412 | 1482 | 1815 | 2160 | 1744 | 1077 | 644 | | | | |
| Torres Strait .. | 6041 | 5551 | 5314 | 4862 | 3932 | 4107 | 4130 | 3586 | 3110 | 2230 | 2740 | | | |
| Freemantle .. | 4924 | 4690 | 4306 | 3940 | 3060 | 3392 | 3678 | 3220 | 2553 | 1676 | 1573 | 2547 | | |
| CAPE LEEUWIN .. | 4968 | 4772 | 4486 | 4020 | 3130 | 3472 | 3793 | 3335 | 2700 | 1810 | 1651 | 2067 | 176 | |
| St. Paul's I. .. | 3734 | 3888 | 3852 | 3462 | 2676 | 3115 | 3726 | 3493 | 2826 | 2474 | 1878 | 3985 | 1912 | 1807 |
| C. OF GOOD HOPE | 3918 | 4407 | 4635 | 4552 | 4309 | 4811 | 5439 | 5003 | 4980 | 5151 | 4494 | 6994 | 4902 | 4786 |
| Algoa Bay .. | 3541 | 4030 | 4258 | 4175 | 3932 | 4434 | 5062 | 5126 | 4603 | 4774 | 4117 | 6617 | 4525 | 4409 |
| Natal .. | 3162 | 3651 | 3879 | 3796 | 3597 | 4099 | 4727 | 4791 | 4268 | 4476 | 3822 | 6369 | 4374 | 4305 |
| Delagoa Bay .. | 2940 | 3413 | 3641 | 3556 | 3467 | 3969 | 4567 | 4661 | 4138 | 4346 | 3704 | 6283 | 4345 | 4307 |
| C. St. Mary .. | 2751 | 3156 | 3309 | 3026 | 2804 | 3306 | 3934 | 3998 | 3475 | 3683 | 3041 | 5690 | 3696 | 3666 |
| Bourbon .. | 2366 | 2712 | 2823 | 2604 | 2181 | 2677 | 3305 | 3345 | 2830 | 3087 | 2427 | 5070 | 3281 | 3251 |
| Mauritius .. | 2335 | 2662 | 2748 | 2514 | 2063 | 2557 | 3185 | 3238 | 2706 | 2954 | 2294 | 4948 | 3203 | 3173 |
| Rodrigue .. | 2395 | 2634 | 2664 | 2378 | 1827 | 2312 | 2940 | 2966 | 2395 | 2597 | 1981 | 4413 | 2918 | 2888 |
| Tamatave .. | 2206 | 2612 | 2765 | 2607 | 2381 | 2772 | 3400 | 3535 | 3058 | 3386 | 2766 | 5414 | 3650 | 3620 |
| Johanna .. | 1878 | 2361 | 2585 | 2509 | 2405 | 2919 | 3547 | 3592 | 3231 | 3660 | 3059 | 4325 | 4150 | 4120 |
| Zambesi River .. | 2452 | 2961 | 3189 | 3139 | 3012 | 3525 | 4153 | 4199 | 3814 | 4235 | 3633 | 6353 | 4329 | 4299 |
| Mozambique .. | 2122 | 2611 | 2839 | 2789 | 2678 | 3194 | 3822 | 3865 | 3506 | 3912 | 3312 | 4575 | 4393 | 4363 |
| Zanzibar .. | 1720 | 2226 | 2450 | 2515 | 2580 | 3098 | 3726 | 3791 | 3450 | 4027 | 3433 | 6161 | 4562 | 4539 |
| C. Guardafui .. | 376 | 913 | 1180 | 1303 | 1758 | 2283 | 2938 | 2950 | 2645 | 3445 | 3073 | 5624 | 4548 | 4579 |
| Mahe, Seychelles | 1410 | 1753 | 1893 | 1740 | 1620 | 2133 | 2761 | 2822 | 2442 | 3019 | 2485 | 5182 | 3769 | 3771 |
| Diego Garcia .. | 2085 | 2020 | 2048 | 1569 | 935 | 1409 | 2136 | 2336 | 1565 | 2013 | 1477 | 4162 | 2847 | 2873 |

| Ports | St. Paul's I. | C. OF GOOD HOPE | Algoa Bay | Natal | Delagoa Bay | Cape St. Mary | Réunion or Bourbon | Mauritius | Rodrigue | Tamatave | Johanna | Zambesi River | Mozambique | Zanzibar | C. Guardafui | Mahe, Seychelles |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C. OF GOOD HOPE | 2843 | | | | | | | | | | | | | | | |
| Algoa Bay .. | 2490 | 375 | | | | | | | | | | | | | | |
| Natal .. | 2369 | 751 | 386 | | | | | | | | | | | | | |
| Delagoa Bay .. | 2369 | 1040 | 675 | 293 | | | | | | | | | | | | |
| C. St. Mary .. | 1820 | 1495 | 1128 | 793 | 673 | | | | | | | | | | | |
| Bourbon .. | 1566 | 2118 | 1751 | 1416 | 1286 | 623 | | | | | | | | | | |
| Mauritius .. | 1547 | 2251 | 1884 | 1563 | 1443 | 770 | 136 | | | | | | | | | |
| Rodrigue .. | 1360 | 2558 | 2191 | 2064 | 1970 | 1307 | 684 | 353 | | | | | | | | |
| Tamatave .. | 1921 | 2060 | 1693 | 1363 | 1233 | 570 | 371 | 470 | 793 | | | | | | | |
| Johanna .. | 2488 | 2051 | 1686 | 1300 | 1062 | 873 | 919 | 961 | 1211 | 736 | | | | | | |
| Zambesi River .. | 2453 | 1493 | 1128 | 742 | 514 | 633 | 1256 | 1389 | 1940 | 1202 | 637 | | | | | |
| Mozambique .. | 2517 | 1791 | 1426 | 1040 | 828 | 707 | 1169 | 1211 | 1461 | 973 | 287 | 366 | | | | |
| Zanzibar .. | 2898 | 2344 | 1979 | 1600 | 1381 | 1250 | 1329 | 1371 | 1621 | 1130 | 480 | 903 | 570 | | | |
| C. Guardafui .. | 3358 | 3537 | 3172 | 2786 | 2564 | 2375 | 1900 | 1959 | 2013 | 1830 | 1502 | 2102 | 1746 | 1342 | | |
| Mahe, Seychelles | 2376 | 2801 | 2434 | 2055 | 1818 | 1431 | 981 | 934 | 1012 | 887 | 802 | 1414 | 1083 | 1017 | 1030 | |
| Diego Garcia .. | 1907 | 3416 | 3049 | 2714 | 2584 | 1921 | 1300 | 1167 | 912 | 1484 | 1655 | 2841 | 1915 | 2017 | 1709 | 1017 |

| | Cape of G. Hope | Algoa Bay | Mauritius | Cape Leeuwin | Melbourne | St. Paul's I. | Prince Edward I. | Crozet | Kerguelen |
|---|---|---|---|---|---|---|---|---|---|
| St. Paul's I. .. | 2843 | 2490 | 1547 | 1807 | 3142 | | | | |
| Prince Edward I. | 1148 | 936 | 1856 | 3578 | 4726 | 2519 | | | |
| Crozet Isles .. | 1621 | 1351 | 1597 | 3031 | 4199 | 1279 | 511 | | |
| Kerguelen I. .. | 2416 | 2134 | 1800 | 2176 | 3332 | 698 | 1265 | 769 | |
| Heard I. .. | 2572 | 2317 | 2111 | 2141 | 3126 | 896 | 1395 | 950 | 311 |

Heard I. & C. of Good Hope 2572
„ „ Cape Horn 7608

VIA SUEZ CANAL

| | Zanzibar | Mozambique | Mauritius | Mahe | Diego Garcia | Hongkong | Shanghai | Nagasaki | Yokohama |
|---|---|---|---|---|---|---|---|---|---|
| London | 6350 | 6760 | 6970 | 6040 | 6720 | 9710 | 10.450 | 10 690 | 11.170 |
| Liverpool | 6305 | 6714 | 6927 | 5990 | 6677 | 9662 | 10 406 | 10.639 | 11.125 |
| Plymouth | 6078 | 6487 | 6700 | 5763 | 6450 | 9436 | 10.179 | 10 412 | 10.898 |
| Gibraltar | 5028 | 5437 | 5650 | 4713 | 5400 | 8386 | 9129 | 9362 | 9848 |

SOUTH AFRICAN PORTS

| | Killiman | Chinde River | Beira | Innamban | Delagoa B. | Cape St Mary |
|---|---|---|---|---|---|---|
| Mozambique | 337 | 353 | 484 | 624 | 828 | 707 |
| Killiman | | 60 | 905 | 372 | 590 | 660 |
| Chinde R. | | | 145 | 321 | 540 | 644 |
| Beira | | | | 244 | 485 | 670 |
| Innamban | | | | | 241 | 545 |
| Delagoa B. | | | | | | 673 |

TO EAST INDIES VIA CAPE OF GOOD HOPE.

| | LONDON | Liverpool | Plymouth | New York | Jamaica | Rio de Janeiro | Monte Video | CAPE |
|---|---|---|---|---|---|---|---|---|
| Liverpool .. | 650 | | | | | | | |
| Plymouth .. | 317 | 344 | | | | | | |
| New York .. | 3298 | 3022 | 2981 | | | | | |
| Jamaica .. | 4360 | 4090 | 4029 | 1484 | | | | |
| Rio de Janeiro .. | 5192 | 5128 | 4918 | 4754 | 4081 | | | |
| Monte Video | 6179 | 6215 | 5905 | 5741 | 5068 | 1020 | | |
| C. OF GOOD HOPE | 6156 | 6113 | 5882 | 6817 | 6369 | 3310 | 3700 | |
| Mauritius .. | 8417 | 8364 | 8133 | 9068 | 8690 | 5521 | 5851 | 2258 |
| Freemantle .. | 11,068 | 11,015 | 10 784 | 11.719 | 11 271 | 8172 | 8502 | 4902 |
| Diego Garcia .. | 9582 | 9529 | 9298 | 10 233 | 9785 | 6686 | 7016 | 3416 |
| Mahe, Seychelles | 8967 | 8914 | 8683 | 9618 | 9170 | 5071 | 6401 | 2801 |
| Zanzibar .. | 8505 | 8452 | 8221 | 9156 | 8708 | 5609 | 5939 | 2344 |
| ANJER POINT .. | 11.307 | 11.254 | 11,023 | 11,958 | 11.610 | 8411 | 8741 | 6151 |
| Maulmain .. | 11 659 | 11 606 | 11.375 | 12.310 | 11,862 | 8763 | 9093 | 5503 |
| Calcutta .. | 11.595 | 11.542 | 11,311 | 12.246 | 11 798 | 8699 | 9029 | 5439 |
| Madras .. | 10 967 | 10 914 | 10.683 | 11.618 | 11 170 | 8071 | 8401 | 4811 |
| Galle .. | 10,465 | 10 412 | 10 181 | 11 116 | 10 668 | 7569 | 7899 | 4309 |
| Bombay .. | 10,708 | 10 655 | 10 424 | 11 359 | 10.911 | 7812 | 8142 | 4552 |
| Karachi .. | 10,791 | 10,738 | 10 507 | 11.442 | 10 994 | 7895 | 8225 | 4635 |

| | London | Liverpool | Plymouth | New York | Halifax | Bermuda | Jamaica | Barbados |
|---|---|---|---|---|---|---|---|---|
| Cape of Good Hope | 6156 | 6113 | 5882 | 6817 | 6530 | 6127 | 6369 | 5292 |
| Cape Horn .. | 7401 | 7337 | 7132 | 6970 | 6830 | 6283 | 6297 | 5291 |

EAST INDIAN TO CHINESE AND JAPANESE PORTS.

| | ADEN | Bombay | Galle | Madras | Calcutta | Maulmain | PULO BRASSE | Singapore | Anjer Pt. | Labuan | Bangkok | C. St. James, Saigon | Manila | Hongkong | Amoy | Shanghai | Peiho R. | Nagasaki |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bombay .. | 1637 | | | | | | | | | | | | | | | | | |
| Galle .. | 2134 | 930 | | | | | | | | | | | | | | | | |
| Madras .. | 2664 | 1460 | 525 | | | | | | | | | | | | | | | |
| Calcutta .. | 3314 | 2110 | 1180 | 780 | | | | | | | | | | | | | | |
| Maulmain .. | 3326 | 2008 | 1230 | 1040 | 779 | | | | | | | | | | | | | |
| PULO BRASSE | 3021 | 1817 | 887 | 997 | 1125 | 667 | | | | | | | | | | | | |
| Singapore .. | 3631 | 2427 | 1497 | 1607 | 1630 | 1082 | 610 | | | | | | | | | | | |
| Anjer Pt. .. | 3821 | 2642 | 1712 | 1927 | 2165 | 1707 | 1040 | 507 | | | | | | | | | | |
| Labuan .. | 4345 | 3141 | 2211 | 2321 | 2344 | 1796 | 1324 | 714 | 938 | | | | | | | | | |
| Bangkok .. | 4425 | 3221 | 2291 | 2401 | 2424 | 1876 | 1404 | 794 | 1269 | 1055 | | | | | | | | |
| C. St. James .. | 4225 | 3021 | 2091 | 2201 | 2224 | 1676 | 1204 | 594 | 1000 | 571 | 601 | | | | | | | |
| Manila .. | 4954 | 3750 | 2820 | 2930 | 2953 | 2405 | 1933 | 1323 | 1551 | 664 | 1392 | 836 | | | | | | |
| Hongkong .. | 5070 | 3867 | 2937 | 3047 | 3070 | 2522 | 2050 | 1440 | 1821 | 1031 | 1454 | 853 | 650 | | | | | |
| Amoy .. | 5353 | 4149 | 3219 | 3329 | 3352 | 2804 | 2246 | 1636 | 1945 | 1175 | 1683 | 1083 | 656 | 285 | | | | |
| Shanghai .. | 5814 | 4602 | 3672 | 3782 | 3805 | 3257 | 2793 | 2183 | 2487 | 1693 | 2240 | 1639 | 1130 | 830 | 561 | | | |
| Peiho R. .. | 6372 | 5168 | 4238 | 4348 | 4371 | 3823 | 3351 | 2741 | 3045 | 2250 | 2780 | 2179 | 1690 | 1381 | 1117 | 695 | | |
| Nagasaki .. | 6047 | 4843 | 3913 | 4023 | 4046 | 3498 | 3026 | 2416 | 2719 | 1924 | 2447 | 1853 | 1385 | 1074 | 801 | 467 | 736 | |
| Yokohama .. | 6533 | 5329 | 4399 | 4509 | 4532 | 3984 | 3512 | 2908 | 3179 | 2332 | 2981 | 2386 | 1768 | 1602 | 1344 | 1060 | 1361 | 698 |

# THE NAVIGABLE MERCATORIAL DISTANCES IN NAUTICAL MILES BETWEEN PULO BRASSE AND THE PRINCIPAL PORTS OF CHINA AND JAPAN.

| Ports | Pulo Brasse | Singapore | Anjer Point | Batavia | Labuan | Bangkok. Saigon | C. St. James | Manila | Zebu | Hongkong | Canton | Swatau | Tamsui, Formosa Id. | Amoy. Fuchau | River Min | Wanchu | Ningpo | Shanghai | Chifu. Tientsin | Peiho R. | Newchang | Nagasaki | Kobe | Yokohama | Hakodate | Vladivostock | Nikolaevsk | Petropaulski | Nafa Kiang, Luchu Islands | San Francisco |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Singapore | 610 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Anjer Point | 1040 | 507 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Batavia | 1119 | 509 | 71 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Labuan | 1324 | 714 | 938 | 919 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bangkok | 1404 | 794 | 1269 | 1248 | 1055 | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cape St. James | 1204 | 594 | 1000 | 990 | 571 | 601 | | | | | | | | | | | | | | | | | | | | | | | | |
| Manila | 1933 | 1323 | 1551 | 1583 | 664 | 1392 | 836 | | | | | | | | | | | | | | | | | | | | | | | |
| Zebu | 1942 | 1332 | 1570 | 1551 | 632 | 1592 | 1092 | 386 | | | | | | | | | | | | | | | | | | | | | | |
| Hongkong | 2050 | 1440 | 1821 | 1813 | 1031 | 1454 | 853 | 650 | 1008 | | | | | | | | | | | | | | | | | | | | | |
| Canton | 2106 | 1496 | 1887 | 1879 | 1097 | 1510 | 909 | 723 | 1083 | 79 | | | | | | | | | | | | | | | | | | | | |
| Swatau | 2163 | 1553 | 1881 | 1866 | 1091 | 1575 | 975 | 630 | 961 | 170 | 249 | | | | | | | | | | | | | | | | | | | |
| Tamsui | 2378 | 1768 | 2086 | 2071 | 1259 | 1828 | 1227 | 730 | 1061 | 448 | 527 | 278 | | | | | | | | | | | | | | | | | | |
| Amoy | 2246 | 1636 | 1945 | 1929 | 1175 | 1683 | 1083 | 696 | 1046 | 285 | 364 | 120 | 188 | | | | | | | | | | | | | | | | | |
| River Min | 2417 | 1807 | 2110 | 2095 | 1320 | 1856 | 1255 | 786 | 1120 | 455 | 534 | 297 | 134 | 199 | | | | | | | | | | | | | | | | |
| Wanchu | 2545 | 1935 | 2238 | 2223 | 1443 | 1989 | 1388 | 914 | 1248 | 583 | 662 | 425 | 197 | 320 | 200 | | | | | | | | | | | | | | | |
| Ningpo | 2706 | 2096 | 2399 | 2384 | 1604 | 2144 | 1543 | 1074 | 1408 | 743 | 822 | 582 | 348 | 480 | 361 | 233 | | | | | | | | | | | | | | |
| Shanghai | 2793 | 2183 | 2487 | 2472 | 1693 | 2240 | 1639 | 1130 | 1497 | 824 | 903 | 677 | 453 | 561 | 445 | 318 | 157 | | | | | | | | | | | | | |
| Chifu | 3158 | 2548 | 2852 | 2837 | 2062 | 2582 | 1981 | 1481 | 1870 | 1197 | 1276 | 1050 | 826 | 934 | 827 | 691 | 530 | 527 | | | | | | | | | | | | |
| Peiho River | 3351 | 2741 | 3045 | 3030 | [illegible] | 2780 | 2179 | 1690 | 2054 | 1381 | 1460 | 1234 | 1010 | 1117 | 1002 | 875 | 714 | 711 | 197 | | | | | | | | | | | |
| Newchang | 3354 | 2744 | 3048 | 3033 | 2254 | 2784 | 2183 | 1691 | 2058 | 1385 | 1464 | 1238 | 1014 | 1122 | 1006 | 879 | 718 | 715 | 216 | 242 | | | | | | | | | | |
| Nagasaki | 3026 | 2416 | 2719 | 2704 | 1924 | 2447 | 1853 | 1285 | 1385 | 1074 | 1153 | 903 | 631 | 801 | 685 | 566 | 462 | 470 | 552 | 736 | 740 | | | | | | | | | |
| Kobe | 3253 | 2643 | 3169 | 3154 | 2235 | 2750 | 2151 | 1569 | 1603 | 1372 | 1451 | 1180 | 935 | 1109 | 1017 | 903 | 787 | 787 | 817 | 1000 | 1005 | 381 | | | | | | | | |
| Yokohama | 3512 | 2902 | 3179 | 3164 | 2332 | 2982 | 2386 | 1768 | 1736 | 1602 | 1654 | 1444 | 1156 | 1344 | 1237 | 1120 | 1035 | 1068 | 1170 | 1360 | 1360 | 692 | 356 | | | | | | | |
| Hakodate | 3881 | 3271 | 3751 | 3736 | 2817 | 3235 | 2634 | 2070 | 2185 | 1825 | 1904 | 1758 | 1398 | 1556 | 1449 | 1321 | 1176 | 1176 | 1224 | 1408 | 1412 | 802 | 890 | 508 | | | | | | |
| Vladivostock | 3632 | 3022 | 3378 | 3363 | 2583 | 3069 | 2468 | 1944 | 2044 | 1670 | 1749 | 1509 | 1250 | 1407 | 1300 | 1176 | 1057 | 1057 | 1038 | 1222 | 1226 | 659 | 799 | 927 | 419 | | | | | |
| Nikolaevsk | 4377 | 3767 | 4124 | 4109 | 3329 | 3814 | 3213 | 2690 | 2790 | 2415 | 2494 | 2254 | 1995 | 2152 | 2045 | 1921 | 1799 | 1799 | 1805 | 1989 | 1993 | 1405 | 1515 | 1273 | 765 | 850 | | | | |
| Petropaulski | 4854 | 4244 | 4521 | 4506 | 3674 | 4323 | 3728 | 3110 | 3078 | 2900 | 2979 | 2818 | 2458 | 2716 | 2509 | 2381 | 2230 | 2230 | 2284 | 2468 | 2472 | 1862 | 1950 | 1402 | 1066 | 1341 | 836 | | | |
| Nafa Kiang | 2621 | 2050 | 2557 | 2538 | 1619 | 2130 | 1530 | 932 | 987 | 806 | 885 | 636 | 358 | 546 | 467 | 406 | 405 | 477 | 785 | 969 | 973 | 400 | 675 | 880 | 1202 | 1059 | 1805 | 2212 | | |
| San Francisco | 8300 | 7690 | 7926 | 7909 | 6990 | 7802 | 7201 | 6566 | 6370 | 6444 | 6523 | 6244 | 5966 | 6154 | 5986 | 5875 | 5787 | 5809 | 5930 | 6114 | 6118 | 5426 | 5092 | 4732 | 4469 | 4888 | 3949 | 3412 | 5618 | |
| Sydney | 4643 | 4276 | 3753 | 3824 | 3830 | 4820 | 4280 | 3915 | 3443 | 4462 | 4580 | 4600 | 4620 | 4600 | 4655 | 4600 | 4670 | 4700 | 5030 | 5224 | 5230 | 4490 | 4450 | 4380 | 4740 | 5160 | 5505 | 5264 | 4240 | 6463 |

| | | |
|---|---|---|
| Anjer Point to C. of Good Hope | .. | 5141 |
| " C. Leeuwin | .. | 1794 |
| Singapore to C. Leeuwin | .. | 2317 |

| | VIA SUEZ CANAL | | | | | | | | VIA CAPE | |
|---|---|---|---|---|---|---|---|---|---|---|
| Ports | London | Liverpool | Plymouth | New York | Halifax | Bermuda | Jamaica | Barbados | Rio | Monte Video |
| Pulo Brasse | 7,660 | 7,613 | 7,386 | 9.592 | 9,046 | 9 304 | 10 299 | 9 581 | 8 240 | 8 570 |
| Anjer Point | 8,460 | 8,413 | 8,186 | 10 392 | 9,846 | 10.104 | 11 099 | 10 381 | 8 411 | 8,741 |
| Aden .. | 4,640 | 4.592 | 4.365 | 6,571 | 6.025 | 6 283 | 7 278 | 6.560 | 7.178 | 7.508 |
| Adelaide .. | 10 770 | 10,727 | 10 500 | 12 706 | 12,160 | 12 706 | 13 413 | 12 695 | 8 856 | 9.193 |
| Melbourne .. | 11,080 | 11.032 | 10 805 | 13 011 | 12 465 | 13,011 | 13 718 | 13 000 | 9 043 | 9.380 |
| Sydney .. | 11,540 | 11,496 | 11 269 | 13 475 | 12.929 | 13.475 | 14.182 | 13 464 | 9 482 | 9 819 |
| Hobart .. | 11.230 | 11,183 | 10.956 | 13 162 | 12,616 | 13 162 | 13,869 | 13 151 | 9 042 | 9 379 |
| Auckland .. | 12 640 | 12,592 | 12.365 | 14.571 | 14 025 | 14 571 | 15 278 | 14 560 | 10,502 | 10.839 |

| | Torres Strait, Cape York | | SOUTH OF CAPE: Rio | Monte Video |
|---|---|---|---|---|
| Singapore | 2,450 | Adelaide .. | 8 708 | 8 907 |
| Batavia .. | 2,160 | Melbourne | 8,895 | 8 984 |
| Bangkok | 3,120 | Sydney .. | 9,335 | 9,424 |
| Manila .. | 2,220 | Hobart .. | 8 893 | 8 982 |
| Hongkong | 2 767 | Auckland | 10 351 | 10 440 |

## ADEN, CAPE OF GOOD HOPE, AND CAPE HORN, TO THE AUSTRALIAN PORTS. See p. 641.

| Ports | Aden | C. of Good Hope (via lat. 46° S.) | Fremantle | C. Leeuwin | Albany | Adelaide | Melbourne | Hobart | Sydney | Newcastle | Brisbane | Rockhampton | Townsville | Cook Town | Thursday Id. | Port Darwin | Auckland | Wellington | Lyttleton | Otago |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C. of Good Hope | 3918 | | | | | | | | | | | | | | | | | | | |
| Fremantle .. | 4924 | 4774 | | | | | | | | | | | | | | | | | | |
| C. LEEUWIN .. | 4938 | 4606 | 176 | | | | | | | | | | | | | | | | | |
| Albany .. | 5125 | 4761 | 343 | 167 | | | | | | | | | | | | | | | | |
| Adelaide .. | 6135 | 5574 | 1353 | 1177 | 1019 | | | | | | | | | | | | | | | |
| Melbourne .. | 6440 | 5761 | 1658 | 1482 | 1324 | 498 | | | | | | | | | | | | | | |
| Hobart .. | 6591 | 5759 | 1809 | 1633 | 1475 | 771 | 490 | | | | | | | | | | | | | |
| Sydney .. | 6904 | 6201 | 2119 | 1943 | 1785 | 990 | 576 | 625 | | | | | | | | | | | | |
| Newcastle .. | 6969 | 6266 | 2184 | 2008 | 1850 | 1055 | 641 | 690 | 65 | | | | | | | | | | | |
| Brisbane .. | 7384 | 6681 | 2599 | 2423 | 2265 | 1470 | 1056 | 1105 | 480 | 430 | | | | | | | | | | |
| Rockhampton | 7650 | 6946 | 2864 | 2688 | 2530 | 1735 | 1321 | 1370 | 745 | 695 | 334 | | | | | | | | | |
| Townsville .. | 8000 | 7298 | 3216 | 3040 | 2882 | 2087 | 1673 | 1722 | 1097 | 1047 | 688 | 375 | | | | | | | | |
| Cook Town .. | 8240 | 7548 | 3456 | 3280 | 3122 | 2327 | 1913 | 1962 | 1337 | 1278 | 928 | 615 | 240 | | | | | | | |
| Thursday Id. .. | 8635 | 7933 | 3851 | 3675 | 3517 | 2722 | 2308 | 2357 | 1732 | 1682 | 1323 | 1010 | 635 | 395 | | | | | | |
| Port Darwin .. | 5378 | 6240 | 1815 | 1951 | 2109 | 3158 | 3033 | 3082 | 2457 | 2407 | 2048 | 1735 | 1360 | 1120 | 725 | | | | | |
| Auckland .. | 8000 | 7221 | 3218 | 3042 | 2884 | 2058 | 1675 | 1510 | 1289 | 1274 | 1342 | 1541 | 1893 | 2133 | 2528 | 3253 | | | | |
| Wellington .. | 7814 | 6998 | 3032 | 2856 | 2698 | 1872 | 1489 | 1287 | 1231 | 1235 | 1413 | 1641 | 1998 | 2233 | 2628 | 3353 | 513 | | | |
| Lyttleton .. | 7948 | 7132 | 3166 | 2990 | 2832 | 2006 | 1628 | 1421 | 1366 | 1369 | 1547 | 1775 | 2127 | 2376 | 2762 | 3478 | 666 | 166 | | |
| Otago .. | 8111 | 7295 | 3329 | 3153 | 2995 | 2161 | 1788 | 1584 | 1529 | 1532 | 1710 | 1938 | 2290 | 2530 | 2925 | 3750 | 805 | 327 | 190 | |
| Cape Horn .. | 12048 | 10210 | 7486 | 7110 | 6911 | 6078 | 5871 | 5432 | 5782 | 5823 | 6025 | 6253 | 6605 | 6845 | 7240 | 7935 | 4815 | 4612 | 4510 | 4600 |

Thursday Id. & C. York 35

Wellington, Lyttleton, Otago: To Australian Ports and Hobart, via Cook Strait.
Cape Horn, via latitude 52° S.

| | | |
|---|---|---|
| Aden to C. Horn | .. .. | 7710 |
| C. of Good Hope to C. Horn | | 3791 |

## AUSTRALIAN PORTS TO ISLAND PORTS IN THE PACIFIC OCEAN.

| Ports | Melbourne | Sydney | Hobart | Auckland | Brisbane | Torres Str. Thursday I. | Noumea | Levuka | Tongatabu | Apia | Vanua Lava | Port Praslin | Tahiti |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sydney .. | 576 | | | | | | | | | | | | |
| Hobart .. | 490 | 625 | | | | | | | | | | | |
| Auckland .. | 1675 | 1289 | 1510 | | | | | | | | | | |
| Brisbane .. | 1056 | 480 | 1105 | 1342 | | | | | | | | | |
| Thursday I. .. | 2306 | 1730 | 2355 | 2450 | 1281 | | | | | | | | |
| Noumea .. | 1594 | 1063 | 1609 | 1006 | 805 | 1601 | | | | | | | |
| Levuka .. | 2289 | 1786 | 2248 | 1162 | 1583 | 2814 | 807 | | | | | | |
| Tongatabu .. | 2402 | 1934 | 2322 | 1101 | 1769 | 2549 | 1103 | 400 | | | | | |
| Apia .. | 2849 | 2400 | 2795 | 1585 | 2272 | 2742 | 1421 | 614 | 493 | | | | |
| Vanua Lava .. | 2095 | 1517 | 2135 | 1478 | 1161 | 1517 | 622 | 723 | 1114 | 1211 | | | |
| Port Praslin .. | 2187 | 1602 | 2227 | 2053 | 1259 | 1146 | 1181 | 1413 | 1814 | 1818 | 700 | | |
| Tahiti .. | 3742 | 3338 | 3595 | 2221 | 3238 | 4002 | 2561 | 1902 | 1458 | 1284 | 2485 | 3111 | |
| Honolulu .. | 4936 | 4410 | 4950 | 3805 | 4076 | 4266 | 3393 | 2715 | 2751 | 2269 | 2931 | 3120 | 2400 |

## SOUTH OF NEW ZEALAND.

| | Fremantle | Albany | Adelaide | Melbourne | Hobart | Sydney |
|---|---|---|---|---|---|---|
| Lyttleton | 3010 | 2676 | 1972 | 1566 | 1261 | 1411 |
| Otago .. | 2829 | 2495 | 1791 | 1385 | 1089 | 1230 |

# THE NAVIGABLE MERCATORIAL DISTANCES IN NAUTICAL MILES BETWEEN CAPE HORN AND THE PRINCIPAL PORTS OF THE WEST COAST OF SOUTH AMERICA.

| Ports | Cape Horn | Cape Virgins | Sandy Point | Cape Pillar | Port Henry | C. Tres Montes | Port St. Carlos | Port Montt | Valdivia | Lota | Talcahuano | Valparaiso | Juan Fernandez | Coquimbo | Huasco | Caldera | Antifogasta | Cobija | Iquique | Arica | Islay | Pisco | Callao | Chimbote | PAYTA | Guayaquil | Manta | Buenaventura | PANAMA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cape Virgins | 292 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Sandy Point | 403 | 111 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cape Pillar | 357 | 304 | 193 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Port Henry | 526 | 473 | 362 | 169 | | | | | | | | | | | | | | | | | | | | | | | | | |
| C. Tres Montes | 712 | 659 | 548 | 355 | 186 | | | | | | | | | | | | | | | | | | | | | | | | |
| Port St. Carlos | 1041 | 988 | 877 | 684 | 515 | 329 | | | | | | | | | | | | | | | | | | | | | | | |
| Port Montt | 1083 | 1030 | 919 | 726 | 557 | 371 | 55 | | | | | | | | | | | | | | | | | | | | | | |
| Valdivia | 1156 | 1103 | 992 | 799 | 630 | 444 | 123 | 178 | | | | | | | | | | | | | | | | | | | | | |
| Lota | 1335 | 1282 | 1171 | 978 | 809 | 623 | 303 | 358 | 187 | | | | | | | | | | | | | | | | | | | | |
| Talcahuano | 1362 | 1309 | 1198 | 1005 | 836 | 650 | 330 | 385 | 214 | 37 | | | | | | | | | | | | | | | | | | | |
| Valparaiso | 1578 | 1525 | 1414 | 1221 | 1052 | 866 | 546 | 601 | 430 | 261 | 238 | | | | | | | | | | | | | | | | | | |
| Juan Fernandez | 1530 | 1477 | 1366 | 1173 | 1004 | 824 | 550 | 605 | 455 | 349 | 345 | 369 | | | | | | | | | | | | | | | | | |
| Coquimbo | 1762 | 1709 | 1598 | 1405 | 1236 | 1050 | 730 | 785 | 611 | 450 | 427 | 191 | 444 | | | | | | | | | | | | | | | | |
| Huasco | 1852 | 1799 | 1688 | 1495 | 1326 | 1140 | 820 | 875 | 704 | 536 | 513 | 275 | 501 | 98 | | | | | | | | | | | | | | | |
| Caldera | 1942 | 1889 | 1778 | 1585 | 1416 | 1230 | 910 | 965 | 794 | 626 | 603 | 365 | 567 | 188 | 90 | | | | | | | | | | | | | | |
| Antifogasta | 2147 | 2094 | 1983 | 1790 | 1621 | 1435 | 1115 | 1170 | 999 | 831 | 808 | 570 | 741 | 393 | 295 | 205 | | | | | | | | | | | | | |
| Cobija | 2223 | 2160 | 2059 | 1866 | 1697 | 1511 | 1191 | 1246 | 1075 | 907 | 884 | 646 | 802 | 469 | 371 | 281 | 79 | | | | | | | | | | | | |
| Iquique | 2354 | 2301 | 2190 | 1997 | 1828 | 1642 | 1322 | 1377 | 1206 | 1054 | 1031 | 793 | 937 | 616 | 518 | 428 | 230 | 151 | | | | | | | | | | | |
| Arica | 2455 | 2402 | 2291 | 2098 | 1929 | 1743 | 1423 | 1478 | 1307 | 1137 | 1107 | 888 | 1021 | 711 | 613 | 523 | 330 | 251 | 100 | | | | | | | | | | |
| Islay | 2530 | 2477 | 2366 | 2173 | 2004 | 1818 | 1500 | 1555 | 1384 | 1223 | 1193 | 975 | 1071 | 790 | 700 | 620 | 427 | 360 | 230 | 150 | | | | | | | | | |
| Pisco | 2715 | 2662 | 2551 | 2358 | 2189 | 2003 | 1696 | 1751 | 1579 | 1425 | 1400 | 1185 | 1210 | 1015 | 941 | 866 | 680 | 640 | 530 | 450 | 321 | | | | | | | | |
| Callao | 2812 | 2759 | 2648 | 2455 | 2286 | 2100 | 1794 | 1849 | 1680 | 1519 | 1495 | 1295 | 1305 | 1125 | 1051 | 976 | 790 | 750 | 640 | 580 | 431 | 120 | | | | | | | |
| Chimbote | 2997 | 2944 | 2833 | 2640 | 2471 | 2285 | 1980 | 2035 | 1867 | 1707 | 1683 | 1485 | 1475 | 1315 | 1243 | 1170 | 990 | 950 | 840 | 780 | 631 | 320 | 200 | | | | | | |
| PAYTA | 3246 | 3192 | 3081 | 2888 | 2719 | 2533 | 2230 | 2285 | 2127 | 1974 | 1950 | 1770 | 1718 | 1600 | 1528 | 1455 | 1275 | 1235 | 1125 | 1065 | 916 | 606 | 490 | 300 | | | | | |
| Guayaquil | 3463 | 3410 | 3299 | 3106 | 2937 | 2751 | 2448 | 2503 | 2345 | 2192 | 2168 | 1988 | 1936 | 1818 | 1746 | 1673 | 1493 | 1453 | 1343 | 1283 | 1134 | 823 | 708 | 518 | 218 | | | | |
| Manta | 3507 | 3454 | 3343 | 3150 | 2981 | 2795 | 2492 | 2547 | 2389 | 2236 | 2212 | 2032 | 1988 | 1862 | 1798 | 1717 | 1537 | 1497 | 1387 | 1327 | 1178 | 867 | 752 | 562 | 262 | 231 | | | |
| Buenaventura | 3877 | 3824 | 3713 | 3520 | 3351 | 3165 | 2862 | 2917 | 2759 | 2606 | 2582 | 2402 | 2350 | 2232 | 2160 | 2087 | 1907 | 1867 | 1759 | 1697 | 1548 | 1237 | 1122 | 932 | 632 | 601 | 375 | | |
| PANAMA | 4097 | 4044 | 3933 | 3740 | 3571 | 3385 | 3082 | 3137 | 2979 | 2826 | 2802 | 2622 | 2570 | 2452 | 2380 | 2307 | 2127 | 2087 | 1977 | 1917 | 1768 | 1457 | 1348 | 1152 | 852 | 821 | 596 | 345 | |
| Galapagos Ids. (Charles Island) | 3537 | 3484 | 3373 | 3180 | 3014 | 2840 | 2583 | 2638 | 2483 | 2340 | 2322 | 2171 | 2042 | 2021 | 1951 | 1900 | 1763 | 1722 | 1623 | 1562 | 1412 | 1121 | 1023 | 847 | 605 | 693 | 583 | 861 | 914 |

## IMPORTANT DISTANCES.

| | London | Liverpool | Plymouth | New York | Jamaica | Rio | Monte Video | Valparaiso | Honolulu | Fiji Islands | San Francisco |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Cape Horn | 7401 | 7337 | 7132 | 6970 | 6297 | 2261 | 1460 | 1578 | 6598 | 5566 | 6342 |
| C. of Good Hope | 6156 | 6113 | 5882 | 6817 | 6369 | 3310 | 3700 | 5369 | 10.389 | 7914 | 10.133 |
| Panama | 4729 | 4666 | 4576 | 10,873 | 597 | 4288 | 5275 | 2622 | 4692 | 6278 | 3243 |
| Aden | 4635 | 4592 | 4365 | 6571 | 7278 | 7178 | 7508 | 9277 | 14.300 | 13 436 | 14.051 |
| Anjer Point | 11,307 | 11,254 | 11.023 | 11,958 | 11,510 | 8411 | 8741 | 10,520 | 15.540 | 14.680 | 15.284 |
| Gibraltar | 1320 | 1280 | 1050 | 3256 | 3693 | 4200 | 5187 | 7801 | 12,825 | 12.143 | 12.569 |

## PORTS ON THE WEST COAST OF NORTH AMERICA

| | San Fran. | Monterey | Los Angeles | San Diego | Magdalena | Clipperton Rk. |
|---|---|---|---|---|---|---|
| Sandy Point | 6178 | 6104 | 5868 | 5812 | 5240 | 4377 |
| Valparaiso | 5145 | 5070 | 4815 | 4737 | 4165 | 3373 |
| Coquimbo | 5016 | 4936 | 4681 | 4603 | 4031 | 3257 |
| Callao | 3990 | 3913 | 3558 | 3580 | 3010 | 2333 |
| Payta | 3522 | 3447 | 3192 | 3114 | 2542 | 1905 |
| Los Angeles | 364 | 290 | — | 82 | 660 | 1495 |
| Clipperton Rk. | 1811 | 1737 | 1495 | 1415 | 880 | — |

## THE PRINCIPAL PORTS OF THE PACIFIC OCEAN TO EUROPE, VIA LAT. 52° S., AND STRAIT OF MAGELLAN.*

| Ports | LONDON | Liverpool | Plymouth | Gibraltar | New York | Rio de Janeiro | Monte Video | CAPE HORN | Sandy Point | Valparaiso | Coquimbo | Callao | Guayaquil | Panama | Acapulco | Mazatlan | San Francisco | Esquimalt | Honolulu | Tahiti |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Liverpool | 647 | | | | | | | | | | | | | | | | | | | |
| Plymouth | 317 | 346 | | | | | | | | | | | | | | | | | | |
| Gibraltar | 1323 | 1277 | 1050 | | | | | | | | | | | | | | | | | |
| New York | 3298 | 3222 | 2981 | 3256 | | | | | | | | | | | | | | | | |
| Rio de Janeiro | 5192 | 5128 | 4918 | 4200 | 4754 | | | | | | | | | | | | | | | |
| Monte Video | 6179 | 6115 | 5905 | 5187 | 3256 | 1020 | | | | | | | | | | | | | | |
| CAPE HORN | 7401 | 7337 | 7127 | 6418 | 6663 | 2261 | 1360 | | | | | | | | | | | | | |
| Sandy Point | 7379 | 7315 | 7105 | 6391 | 6940 | 2217 | 1295 | 403 | | | | | | | | | | | | |
| Valparaiso | 8793 | 8728 | 8519 | 7801 | 8354 | 3631 | 2709 | 1578 | 1414 | | | | | | | | | | | |
| Coquimbo | 8977 | 8913 | 8703 | 7985 | 8538 | 3815 | 2893 | 1762 | 1598 | 191 | | | | | | | | | | |
| Callao | 10027 | 9962 | 9753 | 9035 | 9588 | 4865 | 3943 | 2812 | 2648 | 1295 | 1125 | | | | | | | | | |
| Guayaquil | 10678 | 10613 | 10404 | 9686 | 10239 | 5516 | 4594 | 3463 | 3299 | 1988 | 1818 | 708 | | | | | | | | |
| Panama | 11312 | 11247 | 11038 | 10320 | 10873 | 6150 | 5228 | 4097 | 3933 | 2622 | 2452 | 1342 | 821 | | | | | | | |
| Acapulco | 11927 | 11863 | 11653 | 10935 | 11488 | 6765 | 5843 | 4712 | 4548 | 3381 | 3231 | 2191 | 1737 | 1411 | | | | | | |
| Mazatlan | 12397 | 12333 | 12123 | 11405 | 11958 | 7235 | 6313 | 5182 | 5018 | 3878 | 3737 | 2720 | 2282 | 1983 | 572 | | | | | |
| San Francisco | 13566 | 13502 | 13292 | 12574 | 13127 | 8395 | 7473 | 6342 | 6178 | 5145 | 5016 | 3990 | 3558 | 3243 | 1832 | 1341 | | | | |
| Esquimalt | 14297 | 14233 | 14023 | 13305 | 13858 | 9135 | 8213 | 7082 | 6918 | 5911 | 5761 | 4730 | 4283 | 3968 | 2557 | 2066 | 740 | | | |
| Honolulu | 13817 | 13753 | 13543 | 12825 | 13378 | 8655 | 7733 | 6598 | 6438 | 5942 | 5842 | 5163 | 4864 | 4692 | 3304 | 2841 | 2086 | 2343 | | |
| Tahiti | 11706 | 11642 | 11432 | 10714 | 11267 | 6544 | 5622 | 4434 | 4327 | 4308 | 4311 | 4196 | 4234 | 4475 | 3583 | 3513 | 3652 | 4234 | 2400 | |
| Easter Island | 9763 | 9699 | 9489 | 8771 | 9324 | 4601 | 3679 | 2526 | 2384 | 1993 | 2001 | 2026 | 2258 | 2750 | 2965 | 3045 | 3962 | 4688 | 4046 | 2295 |

* The passage made v. C. Horn adds 100 m. to these distances

| | Yokohama | Shanghai | Hongkong | Cape York | Fiji Islands | Brisbane | Sydney | Auckland | Wellington | Hobart | Melbourne | Adelaide |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| London | 16,662 | 17,308 | 17,361 | 14,423 | 12 871 | 13.299 | 13,086 | 12.119 | 11 916 | 12.744 | 13.142 | 13,382 |
| Liverpool | 16.625 | 17,271 | 17,324 | 14,391 | 12.833 | 13.262 | 13 049 | 12.082 | 11.879 | 12,707 | 13.105 | 13 345 |
| Plymouth | 16,408 | 17 054 | 17,107 | 14.174 | 12,616 | 13,045 | 12,832 | 11,865 | 11 662 | 12 489 | 12,888 | 13,128 |
| Gibraltar | 15,682 | 16,328 | 16,381 | 13.448 | 11.890 | 12,319 | 12,106 | 11.139 | 10.936 | 11,763 | 12,162 | 12 402 |
| New York | 16,229 | 16 875 | 16 928 | 13,995 | 12 437 | 12.866 | 12,653 | 11 686 | 11.483 | 12,310 | 12,709 | 12 949 |
| Rio | 11,508 | 12,154 | 12,207 | 9274 | 7716 | 8145 | 7932 | 6965 | 6762 | 7589 | 7988 | 8228 |
| Monte Video | 10,586 | 11,232 | 11,285 | 8352 | 6794 | 7223 | 7010 | 6043 | 5840 | 6667 | 7066 | 7306 |

## CAPE COLONY AND AUSTRALIAN PORTS, VIA LAT. 46° AND 26° S.

| Ports | Albany | Adelaide | Melbourne | Hobart | Sydney | Auckland | Wellington | Otago |
|---|---|---|---|---|---|---|---|---|
| Natal | 4459 | 5332 | 5519 | 5517 | 5959 | 6975 | 6725 | 6419 |
| Algoa B. | 4496 | 5369 | 5556 | 5554 | 5996 | 7012 | 6762 | 6456 |
| Cape | 4700 | 5574 | 5761 | 5760 | 6200 | 7220 | 6970 | 6660 |
| Natal | 4845 | 5855 | 6160 | 6311 | 6621 | 7719 | 7515 | 7340 |
| Algoa B. | 5127 | 6137 | 6442 | 6593 | 6903 | 8001 | 7797 | 7622 |
| Cape | 5502 | 6512 | 6817 | 6986 | 7276 | 8376 | 8172 | 7997 |

# THE NAVIGABLE MERCATORIAL DISTANCES IN NAUTICAL MILES BETWEEN PANAMA AND THE PRINCIPAL PORTS OF THE PACIFIC OCEAN.

## DISTANCES BETWEEN STATIONS OF "ALL BRITISH" CABLE.

| | |
|---|---|
| Vancouver to Fanning Island .. .. .. .. | 3355 |
| Fanning Island to Suva, Fiji .. .. .. .. | 1861 |
| Suva, Fiji, to Norfolk Island .. .. .. .. | 839 |
| Norfolk Island to Brisbane .. .. .. .. | 800 |
| Norfolk Island to New Zealand, Doubtless Bay .. | 453 |

## VIA SUEZ CANAL.

| | Yokohama | Shanghai | Hongkong | Manila | Singapure | Batavia | Brisbane | Sydney | Auckland | Wellington | Hobart | Melbourne | Adelaide | Fiji |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| London .. | 11,170 | 10,450 | 9710 | 9590 | 8270 | 8530 | 11,927 | 11,540 | 12,640 | 12,450 | 11,830 | 11,080 | 10,770 | 12,890 |
| Liverpool .. | 11,125 | 10,406 | 9662 | 9546 | 8223 | 8484 | 11,884 | 11,496 | 12,592 | 12,387 | 11,783 | 11,032 | 10,727 | 12,817 |
| Plymouth .. | 10,898 | 10,171 | 9435 | 9319 | 7996 | 8257 | 11,657 | 11,269 | 12,364 | 12,160 | 10,956 | 10,805 | 10,500 | 12,590 |
| New York .. | 13,104 | 12,377 | 11,641 | 11,525 | 10,202 | 10,463 | 13,863 | 13,475 | 14,571 | 14,366 | 13,162 | 13,011 | 12,706 | 14,796 |
| Jamaica .. | 13,811 | 13,084 | 12,348 | 12,232 | 10,909 | 11,170 | 14,570 | 14,182 | 15,278 | 15,073 | 13,869 | 13,718 | 13,413 | 15,503 |
| **VIA CAPE OF GOOD HOPE (BY LAT. 40° S. TO AUSTRALIAN PORTS).** | | | | | | | | | | | | | | |
| London .. | 14,476 | 13,794 | 13,118 | 12,848 | 11,820 | 11,368 | 12,836 | 12,356 | 13,376 | 13,154 | 11,016 | 11,917 | 11,730 | 14,070 |
| Liverpool .. | 14,433 | 13,741 | 13,075 | 12,805 | 11,774 | 11,325 | 12,793 | 12,313 | 13,333 | 13,083 | 11,873 | 11,874 | 11,687 | 14,027 |
| Plymouth .. | 14,202 | 13,510 | 12,844 | 12,574 | 11,546 | 11,094 | 12,562 | 12,082 | 13,108 | 12,852 | 11,642 | 11,643 | 11,456 | 13,796 |
| New York .. | 15,137 | 14,445 | 13,779 | 13,509 | 12,481 | 12,029 | 13,497 | 13,017 | 14,037 | 13,787 | 12,577 | 12,578 | 12,391 | 14,731 |
| Jamaica .. | 14,689 | 13,997 | 13,331 | 13,061 | 12,033 | 11,581 | 12,049 | 12,569 | 13,589 | 13,339 | 12,129 | 12,130 | 11,943 | 14,283 |
| Rio de Jan. | 11,590 | 10,898 | 10,232 | 9962 | 8934 | 8482 | 9950 | 9470 | 10,490 | 10,240 | 9030 | 9031 | 8844 | 11,184 |
| Monte Video | 11,920 | 11,228 | 10,562 | 10,292 | 9264 | 8812 | 10,280 | 9800 | 10,820 | 10,570 | 9360 | 9362 | 9174 | 11,514 |
| C. of G. Hope | 8320 | 7628 | 6962 | 6692 | 5664 | 5212 | 6680 | 6200 | 7220 | 6998 | 5760 | 5762 | 5574 | 7946 |

| Ports | Panama | Chirique | Punta Burica | Punta Arenas | San Juan del Sur | Realejo | Port La Union | Acajutla | San Jose de Guatemala | Salina Cruz | Acapulco | MANZANILLA | San Blas | Mazatlan | La Paz | Guaymas | San Diego | Monterey | San Francisco | Columbia River | Esquimalt | Vancouver | Port Simpson | Sitka | Iliuliuk, Aleutian Is. | Honolulu | Nukahiva | Tahiti | Easter Id. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Chirique .. | 271 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Punta Burica .. | 277 | 43 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Punta Arenas .. | 452 | 218 | 175 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| San Juan del Sur | 591 | 357 | 314 | 169 | | | | | | | | | | | | | | | | | | | | | | | | | |
| Realejo .. | 663 | 429 | 386 | 260 | 104 | | | | | | | | | | | | | | | | | | | | | | | | |
| Port La Union .. | 731 | 497 | 454 | 328 | 176 | 72 | | | | | | | | | | | | | | | | | | | | | | | |
| Acajutla | 810 | 576 | 533 | 407 | 267 | 171 | 149 | | | | | | | | | | | | | | | | | | | | | | |
| S. Jose de Guatemala | 877 | 643 | 600 | 474 | 338 | 242 | 220 | 71 | | | | | | | | | | | | | | | | | | | | | |
| Salina Cruz .. | 1158 | 924 | 881 | 755 | 624 | 528 | 506 | 357 | 286 | | | | | | | | | | | | | | | | | | | | |
| Acapulco .. | 1411 | 1177 | 1134 | 1008 | 884 | 797 | 776 | 626 | 555 | 300 | | | | | | | | | | | | | | | | | | | |
| MANZANILLA .. | 1703 | 1469 | 1426 | 1300 | 1176 | 1089 | 1067 | 918 | 847 | 592 | 292 | | | | | | | | | | | | | | | | | | |
| San Blas .. | 1889 | 1655 | 1662 | 1492 | 1362 | 1275 | 1253 | 1104 | 1033 | 778 | 478 | 186 | | | | | | | | | | | | | | | | | |
| Mazatlan .. | 1983 | 1749 | 1706 | 1580 | 1456 | 1369 | 1347 | 1198 | 1127 | 872 | 572 | 280 | 113 | | | | | | | | | | | | | | | | |
| La Paz .. | 2181 | 1947 | 1904 | 1778 | 1654 | 1567 | 1545 | 1396 | 1325 | 1070 | 770 | 478 | 327 | 243 | | | | | | | | | | | | | | | |
| Guaymas .. | 2355 | 2121 | 2078 | 1952 | 1828 | 1741 | 1719 | 1570 | 1499 | 1244 | 944 | 652 | 495 | 382 | 218 | | | | | | | | | | | | | | |
| San Diego .. | 2727 | 2493 | 2450 | 2324 | 2200 | 2113 | 2091 | 1942 | 1871 | 1616 | 1316 | 1120 | 891 | 825 | 776 | 973 | | | | | | | | | | | | | |
| Monterey .. | 3161 | 2927 | 2884 | 2758 | 2634 | 2547 | 2525 | 2376 | 2305 | 2050 | 1750 | 1458 | 1325 | 1259 | 1210 | 1407 | 363 | | | | | | | | | | | | |
| San Francisco .. | 3243 | 3009 | 2966 | 2840 | 2716 | 2629 | 2607 | 2458 | 2387 | 2132 | 1832 | 1540 | 1407 | 1341 | 1292 | 1489 | 445 | 80 | | | | | | | | | | | |
| Columbia River | 3789 | 3555 | 3512 | 3386 | 3262 | 3175 | 3153 | 3004 | 2933 | 2678 | 2378 | 2086 | 1953 | 1887 | 1838 | 2035 | 991 | 628 | 564 | | | | | | | | | | |
| Esquimalt .. | 3968 | 3734 | 3691 | 3565 | 3441 | 3354 | 3332 | 3183 | 3112 | 2857 | 2557 | 2265 | 2132 | 2066 | 2017 | 2214 | 1170 | 807 | 740 | 208 | | | | | | | | | |
| Vancouver .. | 4041 | 3807 | 3764 | 3638 | 3514 | 3427 | 3405 | 3256 | 3185 | 2930 | 2630 | 2338 | 2205 | 2139 | 2090 | 2287 | 1243 | 880 | 813 | 271 | 77 | | | | | | | | |
| Port Simpson .. | 4318 | 4084 | 4041 | 3915 | 3791 | 3704 | 3682 | 3533 | 3462 | 3207 | 2907 | 2615 | 2482 | 2416 | 2367 | 2564 | 1520 | 1157 | 1090 | 598 | 529 | 460 | | | | | | | |
| Sitka .. | 4520 | 4286 | 4243 | 4114 | 3993 | 3906 | 3884 | 3735 | 3664 | 3409 | 3109 | 2817 | 2684 | 2618 | 2569 | 2766 | 1722 | 1359 | 1292 | 814 | 751 | 680 | 272 | | | | | | |
| Iliuliuk .. | 5280 | 5046 | 5003 | 4877 | 4755 | 4666 | 4644 | 4495 | 2424 | 4169 | 3869 | 3577 | 3449 | 3384 | 3334 | 3527 | 2472 | 2132 | 2062 | 1703 | 1669 | 1600 | 1333 | 1079 | | | | | |
| Honolulu .. | 4692 | 4458 | 4415 | 4275 | 4185 | 4086 | 4060 | 3928 | 3854 | 3024 | 3304 | 3132 | 2891 | 2841 | 2791 | 2984 | 2261 | 2095 | 2086 | 2241 | 2343 | 2416 | 2395 | 2363 | 2295 | | | | |
| Nukahiva .. | 3817 | 3120 | 3077 | 3012 | 2977 | 3395 | 3392 | 3300 | 3236 | 3050 | 2847 | 2699 | 2732 | 2762 | 2749 | 2942 | 2816 | 2915 | 2971 | 3423 | 3603 | 3676 | 3818 | 3981 | 3976 | 2095 | | | |
| Tahiti .. | 4475 | 4285 | 4231 | 4175 | 4153 | 4125 | 4115 | 4000 | 3961 | 3801 | 3583 | 3449 | 3483 | 3513 | 3500 | 3693 | 3532 | 3604 | 3652 | 4061 | 4234 | 4307 | 4429 | 4525 | 4430 | 2380 | 751 | | |
| Easter Islands .. | 2750 | 2628 | 2588 | 2630 | 2657 | 2600 | 2733 | 2687 | 2687 | 2725 | 2695 | 2782 | 2928 | 3045 | 3110 | 3310 | 3615 | 3881 | 3962 | 4509 | 4688 | 4761 | 4985 | 5195 | 5714 | 4046 | 2054 | 2295 | |
| Galapagos Ids. .. | 914 | 760 | 724 | 764 | 807 | 855 | 900 | 900 | 927 | 1091 | 1230 | 1475 | 1655 | 1755 | 1953 | 2127 | 2499 | 2933 | 3015 | 3561 | 3740 | 3813 | 4090 | 4292 | 5069 | 4177 | 2995 | 3608 | 1881 Charles I. |

Vancouver—Esquimalt to Cape Flattery 60

## CENTRAL AMERICAN PORTS.

| | Punta Arenas | Port La Union | San Jose | Salina Cruz | Acapulco | Manzanilla |
|---|---|---|---|---|---|---|
| Payta .. | 931 | 1190 | 1292 | 1532 | 1727 | 1993 |
| Guayaquil | 915 | 1175 | 1286 | 1528 | 1738 | 2013 |
| Manta .. | 700 | 961 | 1086 | 1328 | 1559 | 1829 |
| Callao .. | 1421 | 1680 | 1781 | 2082 | 2191 | 2464 |
| Coquimbo | 2531 | 2790 | 2864 | 3093 | 3231 | 3505 |
| Valparaiso | 2701 | 2960 | 3065 | 3274 | 3381 | 3644 |
| Sandy Pt. | 3990 | 4212 | 4280 | 4464 | 4548 | 4774 |

## DISTANCES BETWEEN THE PRINCIPAL PORTS OF THE PACIFIC OCEAN.

BY SOUTHERN ROUTE (Cape Horn, Sandy Point, Valparaiso, Coquimbo, Callao).

| | Cape Horn | Sandy Point | Valparaiso | Coquimbo | Callao | Guayaquil | Panama | Acapulco | Mazatlan | San Fran. | Esquimalt | Honolulu | Tahiti | Petropauliski | Yokohama | Shanghai | Hongkong | Nukahiva | Fiji Ids. (Levuka) | Brisbane | Sydney | Auckland | Melbourne | Wellington |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Petropauliski .. | 9795 | 9728 | 9988 | 10068 | 10533 | 7038 | 6681 | 5285 | 4715 | 3412 | 2983 | 2768 | 5023 | | | | | | | | | | | |
| Yokohama .. | 9458 | 9391 | 9602 | 9700 | 10147 | 8298 | 8019 | 6544 | 6000 | 4732 | 4420 | 3393 | 5138 | 1402 | | | | | | | | | | |
| Shanghai .. | 100 4 | 9937 | 10248 | 10346 | 10793 | 9406 | 9158 | 7671 | 7155 | 5809 | 5429 | 4416 | 5945 | 2222 | 1068 | | | | | | | | | |
| Hongkong .. | 10061 | 9994 | 10305 | 10403 | 10850 | 9902 | 9726 | 8256 | 7681 | 6444 | 6093 | 4860 | 6140 | 2900 | 1602 | 894 | | | | | | | | |
| Nukahiva .. | 4565 | 4500 | 4758 | 4856 | 5303 | 3655 | 3817 | 2847 | 2762 | 2971 | 3603 | 2095 | 751 | 4879 | 5277 | 6179 | 6498 | | | | | | | |
| Fiji Islands .. | 5566 | 5500 | 6000 | 6100 | 6643 | 6081 | 6278 | 5242 | 5025 | 4703 | 5063 | 2715 | 1902 | 4365 | 3891 | 4457 | 4491 | 2430 | | | | | | |
| Brisbane .. | 5995 | 5928 | 6533 | 6669 | 7229 | 7488 | 7762 | 6774 | 6544 | 6156 | 6420 | 4096 | 3238 | 4835 | 3915 | 4230 | 4013 | 3948 | 1583 | | | | | |
| Sydney .. | 5782 | 5715 | 6303 | 6439 | 7046 | 7505 | 7839 | 6940 | 6780 | 6463 | 6764 | 4416 | 3338 | 5204 | 4380 | 4700 | 4462 | 4081 | 1786 | 480 | | | | |
| Auckland .. | 4815 | 4748 | 5333 | 5469 | 5904 | 6219 | 6590 | 5814 | 5739 | 5676 | 6121 | 3805 | 2221 | 5455 | 4800 | 5164 | 5182 | 2976 | 1162 | 1309 | 1260 | | | |
| Melbourne .. | 5838 | 5771 | 6392 | 6528 | 7164 | 7844 | 8217 | 7340 | 7185 | 6095 | 7310 | 4956 | 3742 | 5840 | 4956 | 5276 | 5038 | 4516 | 2289 | 1056 | 576 | 1675 | | |
| Wellington .. | 4629 | 4559 | 5150 | 5286 | 5846 | 6272 | 6902 | 5920 | 5853 | 5890 | 6360 | 4057 | 2240 | 5720 | 5025 | 5364 | 5274 | 3091 | 1487 | 1383 | 1200 | 528 | 1470 | |
| Hobart .. | 5440 | 5372 | 5960 | 6096 | 6858 | 7374 | 7914 | 7223 | 7105 | 6900 | 7293 | 4950 | 3595 | 5890 | 5005 | 5325 | 5087 | 4376 | 2248 | 1105 | 625 | 1531 | 490 | 1281 |

## BY NORTHERN ROUTE.

| | San Francisco | Esquimalt |
|---|---|---|
| Yokohama | 4470 | 4225 |
| Shanghai | 5460 | 5080 |
| Hongkong | 6030 | 5750 |

# THE NAVIGABLE DISTANCES IN NAUTICAL MILES BETWEEN PORTS IN THE MEDITERRANEAN SEA AND THE PRINCIPAL PORTS OF THE WORLD.

## WESTERN MEDITERRANEAN PORTS.

| | LONDON | Liverpool | Plymouth | Southampton | Ushant | Lisbon | Cadiz | GIBRALTAR | Malaga | C. de Gata | Cartagena | C. San Antonio | Barcelona | Marseilles | Toulon | Genoa | Spezzia | Leghorn | Bonifacio | Naples | C. Spartivento | Palermo | MESSINA | Syracuse | C. Passaro | Malta | C. Bon | Tunis | Algiers | Venice | Constantinople |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ushant .. | 389 | 373 | 120 | 216 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Lisbon .. | 1035 | 1000 | 764 | 865 | 645 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cadiz .. | 1260 | 1226 | 990 | 1049 | 872 | 244 | | | | | | | | | | | | | | | | | | | | | | | | | |
| GIBRALTAR | 1320 | 1280 | 1060 | 1146 | 930 | 300 | 75 | | | | | | | | | | | | | | | | | | | | | | | | |
| Malaga .. | 1381 | 1338 | 1111 | 1205 | 991 | 356 | 136 | 61 | | | | | | | | | | | | | | | | | | | | | | | |
| C. de Gata .. | 1477 | 1435 | 1208 | 1302 | 1088 | 453 | 233 | 158 | 107 | | | | | | | | | | | | | | | | | | | | | | |
| Cartagena .. | 1556 | 1513 | 1286 | 1380 | 1166 | 531 | 311 | 236 | 185 | 78 | | | | | | | | | | | | | | | | | | | | | |
| C. San Antonio | 1654 | 1611 | 1384 | 1478 | 1264 | 629 | 409 | 334 | 283 | 176 | 104 | | | | | | | | | | | | | | | | | | | | |
| Barcelona .. | 1832 | 1789 | 1562 | 1656 | 1442 | 807 | 587 | 512 | 461 | 354 | 282 | 178 | | | | | | | | | | | | | | | | | | | |
| Marseilles .. | 2007 | 1964 | 1737 | 1831 | 1617 | 982 | 762 | 690 | 636 | 529 | 457 | 353 | 184 | | | | | | | | | | | | | | | | | | |
| Toulon .. | 2017 | 1974 | 1747 | 1841 | 1627 | 992 | 772 | 697 | 646 | 539 | 467 | 363 | 196 | 39 | | | | | | | | | | | | | | | | | |
| Genoa .. | 2168 | 2125 | 1898 | 1992 | 1778 | 1143 | 923 | 852 | 797 | 690 | 614 | 513 | 350 | 198 | 166 | | | | | | | | | | | | | | | | |
| Spezzia .. | 2187 | 2144 | 1917 | 2011 | 1797 | 1162 | 942 | 867 | 816 | 709 | 635 | 538 | 379 | 223 | 191 | 51 | | | | | | | | | | | | | | | |
| Leghorn .. | 2183 | 2140 | 1913 | 2007 | 1793 | 1158 | 938 | 863 | 812 | 705 | 631 | 536 | 380 | 237 | 198 | 79 | 40 | | | | | | | | | | | | | | |
| Bonifacio .. | 2070 | 2027 | 1800 | 1894 | 1680 | 1045 | 825 | 750 | 699 | 592 | 526 | 440 | 311 | 210 | 178 | 198 | 176 | 147 | | | | | | | | | | | | | |
| Naples .. | 2295 | 2252 | 2025 | 2119 | 1905 | 1270 | 1050 | 980 | 924 | 817 | 749 | 681 | 550 | 449 | 417 | 336 | 303 | 263 | 239 | | | | | | | | | | | | |
| C. Spartivento | 2018 | 1975 | 1748 | 1842 | 1628 | 993 | 773 | 698 | 649 | 542 | 474 | 406 | 342 | 322 | 296 | 357 | 337 | 307 | 198 | 275 | | | | | | | | | | | |
| Palermo .. | 2233 | 2190 | 1963 | 2057 | 1843 | 1208 | 988 | 913 | 857 | 750 | 690 | 624 | 562 | 495 | 463 | 426 | 392 | 356 | 285 | 168 | 220 | | | | | | | | | | |
| MESSINA .. | 2345 | 2302 | 2075 | 2169 | 1955 | 1320 | 1100 | 1025 | 974 | 867 | 800 | 730 | 674 | 580 | 546 | 490 | 454 | 416 | 370 | 175 | 332 | 118 | | | | | | | | | |
| Syracuse .. | 2350 | 2307 | 2080 | 2174 | 1960 | 1325 | 1105 | 1030 | 971 | 864 | 814 | 755 | 699 | 649 | 615 | 559 | 523 | 485 | 439 | 243 | 387 | 187 | 69 | | | | | | | | |
| C. Passaro .. | 2320 | 2277 | 2050 | 2144 | 1930 | 1295 | 1075 | 1000 | 941 | 834 | 784 | 725 | 669 | 634 | 602 | 589 | 553 | 515 | 424 | 274 | 326 | 217 | 100 | 30 | | | | | | | |
| Malta .. | 2304 | 2261 | 2034 | 2128 | 1914 | 1279 | 1059 | 984 | 929 | 822 | 768 | 709 | 665 | 634 | 602 | 585 | 551 | 510 | 424 | 327 | 316 | 223 | 153 | 83 | 53 | | | | | | |
| C. Bon .. | 2121 | 2077 | 1850 | 1944 | 1730 | 1095 | 875 | 800 | 745 | 638 | 584 | 525 | 489 | 468 | 446 | 452 | 425 | 391 | 284 | 270 | 150 | 140 | 251 | 230 | 200 | 184 | | | | | |
| Tunis .. | 2108 | 2065 | 1838 | 1932 | 1718 | 1083 | 863 | 788 | 735 | 628 | 574 | 515 | 475 | 462 | 440 | 471 | 444 | 411 | 302 | 306 | 147 | 182 | 293 | 268 | 238 | 222 | 38 | | | | |
| Algiers .. | 1728 | 1685 | 1460 | 1554 | 1340 | 705 | 485 | 410 | 358 | 251 | 200 | 181 | 279 | 408 | 400 | 511 | 537 | 528 | 396 | 577 | 302 | 504 | 618 | 619 | 589 | 573 | 389 | 380 | | | |
| Venice .. | 2983 | 2942 | 2715 | 2809 | 2595 | 1960 | 1740 | 1665 | 1614 | 1507 | 1440 | 1370 | 1313 | 1217 | 1185 | 1129 | 1093 | 1055 | 1010 | 814 | 971 | 757 | 650 | 668 | 690 | 740 | 890 | 928 | 1279 | | |
| Constantinople | 3120 | 3077 | 2850 | 2944 | 2730 | 2095 | 1875 | 1800 | 1749 | 1642 | 1583 | 1525 | 1478 | 1388 | 1350 | 1294 | 1258 | 1220 | 1174 | 980 | 1136 | 922 | 805 | 794 | 800 | 830 | 1000 | 1038 | 1389 | 1165 | |
| PORT SAID .. | 3240 | 3197 | 2970 | 3064 | 2850 | 2215 | 1995 | 1920 | 1864 | 1757 | 1703 | 1644 | 1586 | 1520 | 1482 | 1426 | 1390 | 1352 | 1306 | 1111 | 1278 | 1054 | 936 | 921 | 921 | 940 | 1119 | 1157 | 1508 | 1319 | 795 |

Ushant & Bordeaux, 300
Lisbon & Bordeaux, 728
Cadiz & Tangier, 60
GIBRALTAR & Port Mahon, 533
Malaga & Nice, 720. Nice & Civita Vecchia, 230
C. de Gata & Tangier, 137
Naples & Civita Vecchia, 245
Palermo & Nice, 440
C. Passaro & Philippeville, 413
Malta & Santorin, 540
Algiers & Philippeville, 296
Venice & Ancona, 124

## GIBRALTAR AND PORTS IN THE ATLANTIC AND WESTERN HEMISPHERE.

| St. Michaels | Madeira | St. Vincent | Fayal | Sierra Leone | Bermuda | Quebec | Halifax | Boston | New York | Baltimore | Charleston | New Orleans | St. Thomas | Havana | Jamaica | Colon |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1030 | 610 | 1565 | 1121 | 1977 | 2968 | 3221 | 2710 | 3084 | 3256 | 3555 | 3701 | 4817 | 3336 | 4237 | 3963 | 4263 |

| Barbados | Demerara | Bahia | Rio | Monte Video | Ascension | St. Helena | Sandy Point | Cape Horn | Valparaiso | Callao | Tahiti | Honolulu | S. Francisco |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3245 | 3397 | 3516 | 4200 | 5187 | 2857 | 3470 | 6391 | 6416 | 7801 | 9035 | 10,724 | 12,825 | 12,569 |

## GIBRALTAR AND EUROPEAN PORTS.

| Oporto | Bordeaux | Brest | Cherbourg | Dover | Antwerp | Hamburg | Christiania | Copenhagen | Bergen | Danzig | Memel | Revel | Stockholm | S. Petersburg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 345 | 1010 | 927 | 1092 | 1230 | 1365 | 1630 | 1855 | 1900 | 1815 | 2165 | 2210 | 2412 | 2320 | 2590 |

| Havre | Belfast | Cardiff | Cork | Glasgow | Hull | Leith | Newcastle | Dundee |
|---|---|---|---|---|---|---|---|---|
| 1165 | 1296 | 1152 | 1090 | 1388 | 1440 | 1620 | 1313 | 1634 |

## EASTERN MEDITERRANEAN PORTS.

Port Said to Suez 87

| | LONDON | Liverpool | Plym'th | Southamptn | Gibraltr | Marseilles | Malta | Messina | Cape Passaro | Venice | Constantinople | Port Said | Cape Bon | Brindisi | Trieste | Corfu | Patras | CERIGO | Piræus | Salonica | Gallipoli | Danube | Odessa | Sebastopol | Smyrna | Rhodes | Famagousta | Tripoli | Beirut | Jaffa | Alexandria | Ras al Hilil | Tripoli |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Brindisi .. | 2605 | 2562 | 2335 | 2429 | 1285 | 840 | 362 | 260 | 306 | 380 | 785 | 940 | 506 | | | | | | | | | | | | | | | | | | | | |
| Trieste .. | 2977 | 2933 | 2707 | 2801 | 1657 | 1212 | 734 | 632 | 678 | 60 | 1157 | 1311 | 878 | 372 | | | | | | | | | | | | | | | | | | | |
| Corfu .. | 2618 | 2575 | 2348 | 2442 | 1298 | 853 | 365 | 273 | 312 | 488 | 697 | 840 | 512 | 116 | 478 | | | | | | | | | | | | | | | | | | |
| Patras .. | 2657 | 2614 | 2387 | 2481 | 1337 | 892 | 380 | 312 | 340 | 620 | 608 | 762 | 540 | 240 | 612 | 135 | | | | | | | | | | | | | | | | | |
| CERIGO .. | 2701 | 2658 | 2431 | 2525 | 1381 | 960 | 410 | 380 | 381 | 748 | 417 | 558 | 581 | 368 | 740 | 280 | 191 | | | | | | | | | | | | | | | | |
| Piræus .. | 2810 | 2767 | 2540 | 2634 | 1490 | 1068 | 520 | 488 | 489 | 856 | 358 | 599 | 689 | 476 | 848 | 388 | 300 | 108 | | | | | | | | | | | | | | | |
| Salonica .. | 3017 | 2973 | 2746 | 2840 | 1696 | 1275 | 724 | 695 | 696 | 1063 | 339 | 745 | 896 | 683 | 1055 | 595 | 506 | 315 | 257 | | | | | | | | | | | | | | |
| Gallipoli .. | 3003 | 2959 | 2732 | 2826 | 1682 | 1261 | 711 | 681 | 682 | 1049 | 115 | 680 | 882 | 669 | 1041 | 581 | 492 | 301 | 243 | 284 | | | | | | | | | | | | | |
| Danube .. | 3373 | 3330 | 3103 | 3197 | 2053 | 1632 | 1082 | 1052 | 1053 | 1420 | 256 | 1051 | 1253 | 1040 | 1412 | 952 | 863 | 672 | 614 | 595 | 371 | | | | | | | | | | | | |
| Odessa .. | 3458 | 3414 | 3187 | 3281 | 2137 | 1716 | 1166 | 1136 | 1137 | 1504 | 340 | 1135 | 1337 | 1124 | 1496 | 1036 | 947 | 756 | 698 | 679 | 455 | 94 | | | | | | | | | | | |
| Sebastopol .. | 3408 | 3364 | 3137 | 3231 | 2087 | 1666 | 1116 | 1086 | 1087 | 1454 | 290 | 1085 | 1287 | 1074 | 1446 | 986 | 897 | 706 | 648 | 629 | 405 | 163 | 163 | | | | | | | | | | |
| Smyrna .. | 2066 | 2923 | 2606 | 2790 | 1646 | 1225 | 675 | 645 | 646 | 1013 | 283 | 628 | 846 | 633 | 1005 | 545 | 456 | 265 | 207 | 258 | 168 | 539 | 623 | 573 | | | | | | | | | |
| Rhodes .. | 2954 | 2911 | 2684 | 2778 | 1634 | 1223 | 663 | 643 | 634 | 1011 | 445 | 368 | 834 | 631 | 1003 | 543 | 454 | 263 | 253 | 390 | 330 | 701 | 785 | 735 | 214 | | | | | | | | |
| Famagousta .. | 3276 | 3232 | 3005 | 3099 | 1955 | 1541 | 984 | 961 | 955 | 1332 | 781 | 250 | 1155 | 952 | 1324 | 861 | 775 | 571 | 589 | 726 | 666 | 1037 | 1121 | 1071 | 580 | 336 | | | | | | | |
| Tripoli .. | 2343 | 3300 | 3073 | 3167 | 2023 | 1609 | 1052 | 1029 | 1023 | 1400 | 845 | 265 | 1223 | 1020 | 1390 | 930 | 843 | 639 | 653 | 790 | 730 | 1101 | 1185 | 1135 | 644 | 400 | 100 | | | | | | |
| Beirut .. | 3339 | 3296 | 3069 | 3163 | 2019 | 1595 | 1040 | 1015 | 1018 | 13 6 | 834 | 227 | 1219 | 1008 | 1478 | 907 | 829 | 627 | 641 | 779 | 719 | 1090 | 1174 | 1124 | 633 | 389 | 105 | 42 | | | | | |
| Jaffa .. | 3327 | 3284 | 3057 | 3151 | 2007 | 1596 | 1029 | 1016 | 1007 | 1387 | 859 | 133 | 1208 | 1009 | 1379 | 908 | 830 | 626 | 667 | 804 | 744 | 1115 | 1190 | 1149 | 658 | 414 | 189 | 161 | 120 | | | | |
| Alexandria .. | 3114 | 3071 | 2844 | 3938 | 1794 | 1398 | 820 | 818 | 800 | 1206 | 739 | 146 | 994 | 830 | 1200 | 727 | 650 | 465 | 511 | 672 | 624 | 905 | 1079 | 1029 | 540 | 326 | 328 | 314 | 333 | 261 | | | |
| Ras al Hilil .. | 2720 | 2677 | 2450 | 2544 | 1400 | 1036 | 418 | 456 | 414 | 890 | 616 | 535 | 600 | 510 | 882 | 422 | 348 | 197 | 312 | 515 | 501 | 869 | 953 | 906 | 465 | 382 | 619 | 684 | 666 | 636 | 402 | | |
| Tripoli .. | 2392 | 2349 | 2122 | 2216 | 1072 | 740 | 198 | 347 | 247 | 937 | 947 | 987 | 272 | 557 | 929 | 544 | 537 | 524 | 636 | 846 | 832 | 1203 | 1287 | 1237 | 790 | 801 | 1062 | 1135 | 1112 | 1088 | 854 | 452 | |
| Sphax .. | 2329 | 2286 | 2059 | 2153 | 1009 | 677 | 223 | 362 | 262 | 950 | 1034 | 1121 | 209 | 570 | 942 | 579 | 578 | 617 | 717 | 932 | 918 | 1289 | 1373 | 1322 | 882 | 871 | 1176 | 1243 | 1228 | 1211 | 988 | 586 | 166 |

Patras & Zante, 53
Piræus & Nauplia, 96
Smyrna & Nauplia, 260
Beirut & Haifa, 70
Jaffa & Haifa, 58

## PORT SAID AND PORTS IN THE EASTERN HEMISPHERE.

| Aden | Karachi | Bombay | Colombo | Galle | Madras | Calcutta | Maulmain | Batavia | Singapore | Diego Garcia | Seychelles | Mauritius | Zanzibar | Natal | Algoa Bay | Cape | Manila |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1395 | 2832 | 3032 | 3495 | 3529 | 4054 | 4709 | 4721 | 5287 | 5026 | 3480 | 2793 | 3730 | 3108 | 4557 | 4936 | 5313 | 6349 |

| Hong Kong | Shanghai | Nagasaki | Yokohama | Fremantle | Adelaide | Melbourne | Hobart | Sydney | Brisbane | Auckland | Wellington |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 6465 | 7209 | 7442 | 7928 | 6320 | 7530 | 7835 | 7986 | 8299 | 8698 | 9395 | 9190 |

## CORINTH CANAL AND

| Venice | Brindisi | Messina | Piræus | Smyrna | Constantinople |
|---|---|---|---|---|---|
| 686 | 305 | 378 | 36 | 233 | 384 |

## THE NAVIGABLE DISTANCES IN NAUTICAL MILES BETWEEN PORTS IN THE BRITISH ISLES AND NORTH SEA, BALTIC AND NORWEGIAN PORTS.

| Ports | Gravesend | Harwich | Hull | Newcastle | Leith | Aberdeen | Dover * | Antwerp | Rotterdam | Amsterdam | Wilhelmshaven | Hamburg | Brunsbuttel | The Skaw | Göteborg | Copenhagen | Kiel | Swinemunde | Danzig | Memel | Riga | Revel | Helsingfors | Kronstadt | Stockholm | Carlscrona | Christiania | Christiansand | Skudenes | Odde | Bergen | Molde | Trondhjem | Tromso | Hammerfest | North Cape |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dover | 67 | 63 | 210 | 283 | 390 | 404 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Antwerp | 170 | 140 | 250 | 325 | 422 | 440 | 134 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Rotterdam | 164 | 127 | 210 | 287 | 390 | 395 | 137 | 113 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Amsterdam | 185 | 140 | 210 | 274 | 369 | 380 | 160 | 140 | 69 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Wilhelmshaven | 340 | 297 | 315 | 358 | 432 | 415 | 381 | 315 | 245 | 210 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Hamburg | 411 | 372 | 386 | 435 | 498 | 476 | 400 | 391 | 320 | 287 | 123 | | | | | | | | | | | | | | | | | | | | | | | | | |
| Brunsbuttel | 366 | 325 | 339 | 378 | 451 | 429 | 353 | 344 | 273 | 240 | 76 | 47 | | | | | | | | | | | | | | | | | | | | | | | | |
| The Skaw | 537 | 487 | 455 | 433 | 468 | 413 | 525 | 523 | 452 | 418 | 327 | 367 | 278 | | | | | | | | | | | | | | | | | | | | | | | |
| Göteborg | 582 | 532 | 500 | 478 | 513 | 458 | 570 | 568 | 497 | 463 | 372 | 412 | 282 | 45 | | | | | | | | | | | | | | | | | | | | | | |
| Copenhagen | 682 | 632 | 600 | 578 | 613 | 558 | 670 | 668 | 597 | 563 | 472 | 512 | 211 | 145 | 138 | | | | | | | | | | | | | | | | | | | | | |
| Kiel | 761 | 712 | 679 | 657 | 692 | 637 | 740 | 747 | 676 | 642 | 551 | 591 | 54 | 224 | 228 | 157 | | | | | | | | | | | | | | | | | | | | |
| Swinemunde | 808 | 758 | 726 | 704 | 739 | 684 | 796 | 794 | 723 | 689 | 598 | 638 | 234 | 271 | 264 | 176 | 180 | | | | | | | | | | | | | | | | | | | |
| Danzig | 947 | 897 | 865 | 843 | 875 | 823 | 935 | 933 | 862 | 828 | 737 | 772 | 385 | 405 | 403 | 265 | 331 | 195 | | | | | | | | | | | | | | | | | | |
| Memel | 992 | 942 | 910 | 888 | 923 | 868 | 980 | 978 | 916 | 873 | 782 | 822 | 454 | 455 | 448 | 310 | 400 | 260 | 117 | | | | | | | | | | | | | | | | | |
| Riga | 1147 | 1097 | 1065 | 1043 | 1075 | 1023 | 1135 | 1133 | 1062 | 1028 | 937 | 977 | 599 | 610 | 603 | 465 | 545 | 443 | 325 | 236 | | | | | | | | | | | | | | | | |
| Revel | 1194 | 1144 | 1112 | 1090 | 1125 | 1070 | 1182 | 1180 | 1110 | 1075 | 984 | 1024 | 651 | 657 | 650 | 512 | 597 | 495 | 395 | 298 | 275 | | | | | | | | | | | | | | | |
| Helsingfors | 1225 | 1175 | 1143 | 1121 | 1156 | 1101 | 1213 | 1211 | 1140 | 1106 | 1015 | 1055 | 676 | 683 | 681 | 543 | 622 | 514 | 412 | 324 | 306 | 45 | | | | | | | | | | | | | | |
| Kronstadt | 1354 | 1304 | 1272 | 1250 | 1285 | 1230 | 1342 | 1340 | 1270 | 1235 | 1144 | 1184 | 811 | 817 | 810 | 672 | 757 | 655 | 555 | 458 | 435 | 170 | 150 | | | | | | | | | | | | | |
| Stockholm | 1102 | 1052 | 1020 | 998 | 1033 | 978 | 1090 | 1088 | 1017 | 983 | 892 | 932 | 532 | 565 | 558 | 420 | 498 | 403 | 318 | 264 | 271 | 220 | 240 | 378 | | | | | | | | | | | | |
| Carlscrona | 827 | 777 | 745 | 723 | 758 | 703 | 815 | 813 | 742 | 708 | 617 | 657 | 284 | 290 | 274 | 145 | 230 | 145 | 161 | 193 | 334 | 380 | 401 | 540 | 285 | | | | | | | | | | | |
| Christiania | 656 | 580 | 558 | 520 | 540 | 481 | 625 | 620 | 543 | 506 | 420 | 468 | 421 | 130 | 157 | 268 | 354 | 394 | 533 | 578 | 733 | 780 | 811 | 940 | 688 | 473 | | | | | | | | | | |
| Christiansand | 506 | 447 | 408 | 370 | 390 | 330 | 490 | 490 | 412 | 380 | 288 | 335 | 288 | 90 | 135 | 235 | 314 | 361 | 500 | 545 | 700 | 747 | 778 | 907 | 655 | 380 | 158 | | | | | | | | | |
| Skudenes | 510 | 472 | 400 | 335 | 333 | 262 | 505 | 510 | 453 | 418 | 350 | 405 | 358 | 215 | 260 | 360 | 439 | 486 | 625 | 670 | 825 | 872 | 903 | 1032 | 780 | 505 | 285 | 140 | | | | | | | | |
| Odde | 631 | 593 | 521 | 456 | 454 | 383 | 626 | 631 | 574 | 539 | 477 | 526 | 479 | 336 | 381 | 481 | 560 | 607 | 746 | 791 | 946 | 993 | 1024 | 1153 | 901 | 626 | 406 | 261 | 121 | | | | | | | |
| Bergen | 590 | 552 | 470 | 395 | 380 | 305 | 585 | 590 | 533 | 498 | 436 | 485 | 438 | 295 | 340 | 440 | 519 | 566 | 705 | 750 | 905 | 952 | 983 | 1112 | 860 | 585 | 365 | 220 | 80 | 120 | | | | | | |
| Molde | 770 | 732 | 640 | 546 | 530 | 448 | 767 | 772 | 717 | 685 | 626 | 677 | 630 | 490 | 535 | 635 | 714 | 761 | 900 | 945 | 1100 | 1147 | 1180 | 1307 | 1055 | 780 | 560 | 415 | 275 | 325 | 205 | | | | | |
| Trondhjem | 885 | 847 | 755 | 661 | 645 | 560 | 882 | 885 | 834 | 800 | 741 | 792 | 745 | 605 | 650 | 750 | 829 | 876 | 1015 | 1060 | 1215 | 1262 | 1293 | 1422 | 1170 | 895 | 675 | 530 | 390 | 440 | 320 | 144 | | | | |
| Tromso | 1273 | 1237 | 1145 | 1051 | 1035 | 953 | 1272 | 1275 | 1224 | 1190 | 1131 | 1182 | 1135 | 995 | 1040 | 1140 | 1219 | 1266 | 1405 | 1450 | 1605 | 1652 | 1683 | 1812 | 1560 | 1285 | 1065 | 920 | 780 | 630 | 710 | 535 | 480 | | | |
| Hammerfest | 1395 | 1357 | 1265 | 1171 | 1155 | 1073 | 1392 | 1395 | 1344 | 1310 | 1251 | 1202 | 1255 | 1115 | 1160 | 1260 | 1339 | 1386 | 1525 | 1570 | 1725 | 1772 | 1803 | 1932 | 1680 | 1405 | 1185 | 1040 | 900 | 950 | 830 | 655 | 600 | 120 | | |
| North Cape | 1455 | 1417 | 1325 | 1231 | 1215 | 1133 | 1452 | 1455 | 1404 | 1370 | 1311 | 1362 | 1315 | 1175 | 1220 | 1320 | 1396 | 1446 | 1585 | 1640 | 1785 | 1832 | 1863 | 1992 | 1740 | 1465 | 1245 | 1100 | 960 | 1010 | 890 | 715 | 660 | 180 | 60 | |
| Arkhangel | 2082 | 2044 | 1952 | 1858 | 1842 | 1760 | 2079 | 2082 | 2031 | 1997 | 1938 | 1989 | 1942 | 1802 | 1847 | 1947 | 2026 | 2073 | 2212 | 2257 | 2412 | 2459 | 2490 | 2619 | 2367 | 2092 | 1872 | 1727 | 1587 | 1637 | 1517 | 1342 | 1287 | 807 | 687 | 627 |

Antwerp to Flushing .. 45
Rotterdam to Pier ends Buoy 18
Cuxhaven to Brunsbuttel .. 16
Stockholm to Sandhamn .. 37
Kronstadt to St. Petersburg 18

| Ports | The Skaw | Christiania | Skudenes | Bergen | Molde | Trondhjem | Tromso | Hammerfest | Vadso | Arkhangel |
|---|---|---|---|---|---|---|---|---|---|---|
| Kirkwall | 436 | 500 | 260 | 277 | 390 | 500 | 880 | 1000 | 1233 | 1687 |
| Lerwick | 400 | 470 | 210 | 210 | 300 | 420 | 790 | 910 | 1143 | 1597 |

Harwich to Shipwash Lt. .. 16
Hull to outer buoy .. 25
Leith to May Island .. 24
Amsterdam to 5 fms. buoy .. 15
Wilhelmshaven to Whistle buoy 25
Cuxhaven to Elbe Lt. .. 18

| | Tuskar | Queenstown | Falmouth | Longships | Ushant | Holyhead | Plymouth | Gib. |
|---|---|---|---|---|---|---|---|---|
| Finisterre | 576 | 540 | 470 | 460 | 376 | 660 | 496 | 548 |

| | Gravesend | Harwich | Hull | Shields | Leith | Aberdeen |
|---|---|---|---|---|---|---|
| Harwich | 62 | | | | | |
| Hull | 214 | 162 | | | | |
| Shields | 291 | 239 | 132 | | | |
| Leith | 396 | 344 | 233 | 107 | | |
| Aberdeen | 411 | 359 | 254 | 132 | 85 | |
| Kirkwall | 525 | 480 | 379 | 250 | 215 | 131 |
| Lerwick | 565 | 520 | 422 | 306 | 270 | 181 |

Lerwick and Kirkwall 97. Kirkwall and Dover 520. Lerwick and Dover 562.

North Cape to Vadso 173

| | Dover | Dungeness | Spithead | Southampton | Havre | Casquets | Portland Bill | Start | Ushant | Plymouth | Falmouth | Lizard | Longships | Cardiff | Pembroke | Queenstown | Dublin | Liverpool | Belfast |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dungeness | 18 | | | | | | | | | | | | | | | | | | |
| Spithead | 103 | 85 | | | | | | | | | | | | | | | | | |
| Southampton | 119 | 99 | 14 | | | | | | | | | | | | | | | | |
| Havre | 113 | 97 | 90 | 104 | | | | | | | | | | | | | | | |
| Casquets | 166 | 148 | 85 | 86 | 101 | | | | | | | | | | | | | | |
| Portland Bill | 154 | 136 | 55 | 56 | 116 | 48 | | | | | | | | | | | | | |
| Start | 201 | 183 | 104 | 105 | 151 | 57 | 48 | | | | | | | | | | | | |
| Ushant | 299 | 281 | 219 | 216 | 234 | 133 | 162 | 121 | | | | | | | | | | | |
| Plymouth | 227 | 209 | 130 | 131 | 178 | 78 | 74 | 26 | 120 | | | | | | | | | | |
| Falmouth | 255 | 237 | 158 | 159 | 209 | 105 | 102 | 54 | 102 | 37 | | | | | | | | | |
| Lizard | 263 | 244 | 166 | 167 | 208 | 113 | 110 | 62 | 90 | 47 | 15 | | | | | | | | |
| Longships | 287 | 268 | 190 | 191 | 232 | 134 | 134 | 86 | 100 | 71 | 39 | 24 | | | | | | | |
| Cardiff | 431 | 412 | 334 | 335 | 376 | 278 | 278 | 230 | 244 | 215 | 183 | 168 | 144 | | | | | | |
| Pembroke | 397 | 378 | 300 | 301 | 342 | 244 | 244 | 196 | 210 | 181 | 149 | 134 | 110 | 96 | | | | | |
| Queenstown | 428 | 409 | 331 | 332 | 373 | 275 | 275 | 227 | 235 | 212 | 180 | 165 | 141 | 202 | 125 | | | | |
| Dublin | 494 | 475 | 397 | 398 | 439 | 341 | 341 | 293 | 307 | 279 | 246 | 231 | 207 | 202 | 125 | 160 | | | |
| Liverpool | 560 | 541 | 463 | 464 | 505 | 407 | 407 | 350 | 373 | 344 | 312 | 297 | 273 | 268 | 193 | 241 | 120 | | |
| Belfast | 584 | 565 | 487 | 488 | 530 | 431 | 431 | 383 | 397 | 368 | 336 | 321 | 297 | 292 | 216 | 251 | 107 | 140 | |
| Glasgow | 667 | 648 | 571 | 571 | 612 | 514 | 514 | 466 | 480 | 451 | 419 | 404 | 380 | 375 | 300 | 340 | 195 | 220 | 115 |

### BY NORTHERN ROUTE.

| Ports | Inistrahull | Cape Wrath | Newcastle | Leith | Aberdeen | The Skaw | Skudenes | Christiansand | Christiania | Bergen | Trondhjem | Tromso |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Glasgow | 133 | 391 | 618 | 574 | 492 | 819 | 641 | 743 | 884 | 667 | 879 | 1247 |
| Belfast | 87 | 384 | 581 | 537 | 455 | 782 | 604 | 706 | 847 | 630 | 842 | 1210 |
| Liverpool | 202 | 395 | 692 | 648 | 566 | 893 | 715 | 817 | 958 | 741 | 953 | 1321 |
| Dublin | 170 | 363 | 660 | 616 | 534 | 861 | 683 | 785 | 926 | 709 | 921 | 1289 |
| C. Wrath | 215 | | 297 | 253 | 171 | 498 | 320 | 422 | 563 | 346 | 558 | 826 |

* In the preceding Tables the distances to Dover may be found by taking 40 m. from the London distances.

Gravesend to London 23
" to Ushant 356

Holyhead to Tuskar 87

### BY KAISER WILHELM CANAL.

| Ports | Dover | Gravesend | Harwich | Hull | Newcastle | Leith | Aberdeen | Antwerp | Rotterdam | Amsterdam | Wilhelmshaven | Hamburg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Kiel | 405 | 420 | 380 | 393 | 439 | 505 | 483 | 398 | 327 | 294 | 130 | 101 |
| Swinemunde | 585 | 600 | 560 | 573 | 612 | 685 | 663 | 578 | 507 | 474 | 310 | 281 |
| Danzig | 736 | 751 | 711 | 724 | 763 | 836 | 814 | 729 | 658 | 625 | 461 | 432 |
| Memel | 805 | 820 | 760 | 793 | 832 | 905 | 893 | 798 | 727 | 691 | 530 | 501 |
| Riga | 950 | 965 | 925 | 938 | 977 | 1050 | 1028 | 943 | 872 | 839 | 675 | 646 |
| Revel | 1002 | 1017 | 977 | 990 | 1029 | 1102 | 1080 | 995 | 924 | 891 | 727 | 698 |
| Kronstadt | 1162 | 1177 | 1137 | 1150 | 1189 | 1267 | 1240 | 1155 | 1084 | 1051 | 887 | 858 |
| Helsingfors | 1027 | 1042 | 1002 | 1015 | 1054 | 1127 | 1105 | 1120 | 949 | 916 | 752 | 723 |
| Stockholm | 903 | 918 | 878 | 891 | 930 | 1003 | 981 | 896 | 825 | 792 | 628 | 599 |
| Carlscrona | 635 | 650 | 610 | 623 | 662 | 735 | 713 | 628 | 557 | 524 | 360 | 331 |
| Copenhagen | 562 | 577 | 537 | 550 | 589 | 662 | 640 | 555 | 484 | 451 | 287 | 258 |

| | Glasgow | Liverpool | Belfast | Dublin | Cardiff | Queenstown | Longships | Bishop | Cape Verde | Cape Frio |
|---|---|---|---|---|---|---|---|---|---|---|
| Holyhead | 188 | 70 | 106 | 59 | 199 | 175 | 204 | 220 | 2400 | 4091 |
| Tuskar | 229 | 128 | 172 | 85 | 131 | 81 | 130 | [illegible] | [illegible] | [illegible] |

THE AVERAGE NAVIGABLE DISTANCES IN NAUTICAL MILES BETWEEN GRAVESEND, PORT SAID, THE CAPE, AND PORTS IN THE PACIFIC OCEAN; ON THE TRACKS FOLLOWED BY SAILING SHIPS AND VESSELS WITH AUXILIARY STEAM POWER.

| Ports | | | | | | | VIA CAPE OF GOOD HOPE.* | | | | | | | | | | | | | | VIA CAPE HORN. | | | | | | | | | | | | | Ports |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gravesend | Gravesend v. S. Canal | Hamburg | Hamburg v. S. Canal | Cape of Good Hope | Port Said | Petropauloski | Yokohama | Shanghai | Hongkong | Singapore | Manila | Batavia | Cape York | Brisbane | Auckland | Sydney | Wellington | Melbourne | Hobart | Esquimalt | San Francisco | Mazatlan | Panama | Guayaquil | Callao | Valparaiso | Sandy Point | Cape Horn | Honolulu | Nukahiva | Tahiti | Levuka | |
| Gravesend | | — | 411 | — | 7446 | 3217 | 17327 | 15985 | 15293 | 14627 | 13329 | 14357 | 12877 | 15037 | 13977 | 14515 | 13499 | 14265 | 13059 | 13057 | 14980 | 14730 | 14380 | 11477 | 10843 | 10192 | 8958 | 7356 | 7380 | 13978 | 11894 | 11814 | 14107 | Gravesend |
| Do. v. Suez Can. | — | | — | — | | — | 12487 | 11145 | 10426 | 9683 | 8243 | 9566 | 8504 | 10664 | 11904 | 12612 | 11516 | 12407 | 11052 | 11203 | 15385 | 15615 | 16835 | 18745 | 18697 | 18253 | 17557 | 16590 | 16660 | 14925 | 15937 | 15137 | 12832 | Do. v. S. Can. |
| Hamburg | 411 | — | | — | 7779 | 3550 | 17660 | 16318 | 15626 | 14960 | 13662 | 14690 | 13210 | 15370 | 14310 | 14848 | 13832 | 14498 | 13392 | 13390 | 15313 | 15063 | 14713 | 11810 | 11176 | 10525 | 9291 | 7689 | 7713 | 14311 | 12227 | 12147 | 14140 | Hamburg |
| Do. v. Suez Can. | — | — | — | | 8863 | — | 12820 | 11478 | 10759 | 10016 | 8576 | 9899 | 8837 | 10997 | 12237 | 12945 | 11849 | 12740 | 11385 | 11536 | 15718 | 15948 | 17118 | 19078 | 19030 | 18586 | 17890 | 16923 | 16993 | 15258 | 16270 | 15470 | 13165 | Do. v. S. Can. |
| C. of Good Hope | 7423 | 8530 | 7736 | 8863 | | 5314 | 10029 | 8687 | 7995 | 7329 | 6031 | 7059 | 5579 | 7739 | 6680 | 7220 | 6200 | 6970 | 5761 | 5760 | 12857 | 13087 | 14307 | 13880 | 13242 | 12816 | 12120 | 10170 | 10240 | 12467 | 10500 | 9700 | 7925 | C. of G. Hope |
| Port Said | 3217 | — | 3550 | — | 5314 | | 9270 | 7928 | 7209 | 6465 | 5026 | 6349 | 5287 | 7446 | 8692 | 9395 | 8299 | 9185 | 7835 | 7986 | 12100 | 12328 | 13548 | 15528 | 15462 | 15036 | 14340 | 13373 | 13443 | 11638 | 12666 | 11915 | 10 04 | Port Said |
| Petropauloski | 18314 | 12487 | 18647 | 12820 | 10891 | 9270 | | 1432 | 2232 | 2900 | 6020 | 5370 | 5720 | 4460 | 5050 | 5710 | 5270 | 6027 | 5876 | 5975 | 2840 | 3300 | 4550 | 6460 | 6910 | 10533 | 9988 | 9728 | 9795 | 2820 | 5230 | 5220 | 4600 | Petropauloski |
| Yokohama | 17309 | 11145 | 17642 | 11478 | 9886 | 7928 | 1402 | | 1068 | 1602 | 5015 | 4340 | 4715 | 3520 | 4680 | 5210 | 5020 | 5472 | 5596 | 5645 | 4240 | 4470 | 5690 | 7600 | 8050 | 11080 | 10543 | 10008 | 10078 | 3780 | 6310 | 6180 | 4545 | Yokohama |
| Shanghai | 18062 | 10426 | 18395 | 10759 | 10639 | 7209 | 2220 | 1068 | | 824 | 5768 | 5100 | 5468 | 4258 | 5530 | 6055 | 5900 | 6300 | 6476 | 6525 | 5100 | 5470 | 6690 | 8600 | 9050 | 12086 | 11543 | 11006 | 11076 | 4780 | 7310 | 7180 | 5543 | Shanghai |
| Hongkong | 14394 | 9683 | 14677 | 10016 | 6972 | 6465 | 2900 | 1602 | 824 | | 1930 | 650 | 2313 | 2700 | 6070 | 7187 | 6440 | 7504 | 7016 | 7065 | 5766 | 6000 | 7220 | 9130 | 9580 | 12626 | 12077 | 11540 | 11610 | 5312 | 7840 | 7710 | 6077 | Hongkong |
| Singapore | 13096 | 8243 | 13379 | 8576 | 5673 | 5026 | 4244 | 2902 | 2183 | 1440 | | 1323 | 509 | 2500 | 5730 | 6360 | 5250 | 6146 | 4800 | 4887 | 7072 | 7302 | 8522 | 10430 | 10882 | 11649 | 10826 | 10244 | 10311 | 6612 | 9212 | 9082 | 6975 | Singapore |
| Manila | 14125 | 9566 | 14407 | 9899 | 6702 | 6349 | 3110 | 1768 | 1130 | 650 | 1323 | | 1583 | 2175 | 4190 | 4720 | 4560 | 4960 | 5136 | 5185 | 5938 | 6168 | 7388 | 9300 | 9748 | 12199 | 11372 | 10754 | 10821 | 5478 | 8078 | 7948 | 7485 | Manila |
| Batavia | 12645 | 8504 | 12927 | 8837 | 5222 | 5287 | 4506 | 3164 | 2472 | 1813 | 509 | 1583 | | 2160 | 5375 | 5981 | 4882 | 5776 | 4426 | 4523 | 7334 | 7564 | 8784 | 10700 | 11144 | 11289 | 10462 | 9634 | 97 1 | 6874 | 9474 | 9344 | 6460 | Batavia |
| Cape York | 14523 | 10664 | 15087 | 10997 | 7100 | 7446 | 4790 | 3465 | 3180 | 2767 | 2450 | 2220 | 2160 | | 1246 | 2415 | 1695 | 2512 | 2271 | 2320 | 7035 | 7865 | 8985 | 9414 | 8784 | 8358 | 7662 | 7074 | 7141 | 7175 | 6042 | 5242 | 2829 | Cape York |
| Brisbane | 14278 | 11904 | 14611 | 12237 | 7718 | 8692 | 4835 | 3915 | 4230 | 4013 | 3696 | 3466 | 3406 | 1288 | | 1342 | 480 | 1413 | 1056 | 1105 | 7970 | 8200 | 8213 | 8284 | 7654 | 7229 | 6533 | 5928 | 5995 | 6513 | 4913 | 4113 | 1583 | Brisbane |
| Auckland | 13098 | 12612 | 13431 | 12945 | 8336 | 9861 | 5455 | 4800 | 5164 | 5182 | 4865 | 4635 | 4575 | 2415 | 1342 | | 1289 | 543 | 1675 | 1510 | 7940 | 7640 | 6600 | 6959 | 6329 | 5904 | 5333 | 4745 | 4815 | 5360 | 3300 | 2960 | 1162 | Auckland |
| Sydney | 14065 | 11516 | 14398 | 11849 | 7238 | 8299 | 5264 | 4380 | 4700 | 4462 | 4145 | 3915 | 3865 | 1695 | 480 | 1289 | | 1231 | 576 | 625 | 8390 | 8628 | 8030 | 8102 | 7472 | 7046 | 6300 | 5712 | 5782 | 6330 | 4730 | 3930 | 1786 | Sydney |
| Wellington | 12912 | 12407 | 13245 | 12740 | 8132 | 9958 | 5720 | 5025 | 5364 | 5274 | 4957 | 4727 | 4672 | 2512 | 1413 | 543 | 1231 | | 1489 | 1287 | 7710 | 7410 | 6830 | 6902 | 6272 | 5846 | 5130 | 4559 | 4629 | 5130 | 3530 | 2730 | 1487 | Wellington |
| Melbourne | 14121 | 11052 | 14454 | 11385 | 6777 | 7835 | 5840 | 4956 | 5276 | 5038 | 4721 | 4491 | 4431 | 2271 | 1056 | 1675 | 576 | 1489 | | 490 | 9180 | 8880 | 8300 | 8270 | 7590 | 7164 | 6392 | 5771 | 5838 | 6600 | 5000 | 4200 | 2289 | Melbourne |
| Hobart | 13723 | 11203 | 14056 | 11536 | 6928 | 7986 | 5889 | 5025 | 5325 | 5087 | 4770 | 4540 | 4480 | 2320 | 1105 | 1510 | 625 | 1287 | 490 | | 8900 | 8600 | 7960 | 7914 | 7374 | 6858 | 5960 | 5372 | 5440 | 6320 | 4660 | 3900 | 2248 | Hobart |
| Esquimalt | 16241 | 16496 | 16574 | 16829 | 12055 | 13618 | 5850 | 6000 | 6816 | 7250 | 8253 | 7153 | 8323 | 6513 | 6420 | 6121 | 6764 | 6360 | 7310 | 7293 | | 740 | 2066 | 3968 | 4418 | 7810 | 8085 | 7888 | 7958 | 2343 | 3603 | 4234 | 5063 | Esquimalt |
| San Francisco | 15501 | 16239 | 15834 | 16572 | 11315 | 13353 | 5536 | 5686 | 6502 | 6936 | 7996 | 6896 | 8066 | 6256 | 6156 | 5676 | 6463 | 5890 | 6995 | 6990 | 740 | | 1341 | 3243 | 3693 | 7070 | 7318 | 7148 | 7218 | 2086 | 2971 | 3652 | 4703 | San Franc. |
| Mazatlan | 14531 | 16994 | 14864 | 17327 | 10345 | 14108 | 6291 | 6441 | 7257 | 7710 | 8751 | 7650 | 8820 | 6950 | 6544 | 5739 | 6780 | 5853 | 7185 | 7105 | 3160 | 2010 | | 1983 | 2433 | 6224 | 6348 | 6180 | 6248 | 2841 | 2762 | 3513 | 5025 | Mazatlan |
| Panama | 14103 | 19423 | 14436 | 19756 | 9917 | 16467 | 8650 | 8800 | 9616 | 10140 | 11180 | 9990 | 10840 | 8620 | 8050 | 6811 | 7928 | 6930 | 8332 | 8185 | 5710 | 5460 | 5180 | | 821 | 5580 | 5214 | 5700 | 5800 | 5200 | 3940 | 4590 | 6410 | Panama |
| Guayaquil | 12431 | 19033 | 12764 | 19366 | 8245 | 157 6 | 8314 | 8464 | 9356 | 9880 | 10740 | 9720 | 10450 | 8290 | 7488 | 6455 | 7672 | 6574 | 7976 | 7830 | 5450 | 5200 | 4920 | 821 | | 1140 | 3672 | 4008 | 4148 | 4864 | 3655 | 4234 | 6081 | Guayaquil |
| Callao | 11563 | 19033 | 11896 | 19366 | 7447 | 15661 | 8610 | 8763 | 9706 | 10137 | 10740 | 9930 | 10450 | 8290 | 7363 | 6417 | 7534 | 6536 | 7938 | 7790 | 5860 | 5610 | 5180 | 1342 | 708 | | 2590 | 3208 | 3350 | 5163 | 3721 | 4196 | 6036 | Callao |
| Valparaiso | 10063 | 18833 | 10396 | 19165 | 5877 | 15629 | 9392 | 9326 | 10266 | 10521 | 10624 | 10068 | 10330 | 8170 | 7526 | 6529 | 7638 | 6648 | 8050 | 7903 | 6730 | 6480 | 6120 | 2622 | 1988 | 1295 | | 1616 | 1780 | 5942 | 4063 | 4308 | 60 3 | Valparaiso |
| Sandy Point | 8353 | 19225 | 8686 | 19558 | 4167 | 16008 | 9880 | 9715 | 10620 | 10819 | 11022 | 10440 | 10732 | 8561 | 7917 | 6900 | 8017 | 6983 | 8421 | 8279 | 7436 | 7208 | 6856 | 3953 | 3319 | 2648 | 1414 | | 403 | 6430 | 4438 | 4679 | 6600 | Sandy Point |
| Cape Horn | 8283 | 19367 | 8616 | 19700 | 4097 | 16150 | 10022 | 9857 | 10762 | 10961 | 11164 | 10580 | 10874 | 8703 | 8059 | 7042 | 8159 | 7125 | 8563 | 8419 | 7600 | 7350 | 7000 | 4097 | 3463 | 2812 | 1578 | 401 | | 6572 | 4580 | 4821 | 6727 | Cape Horn |
| Honolulu | 15140 | 14153 | 15373 | 14486 | 10954 | 11267 | 3450 | 3600 | 4416 | 4860 | 5910 | 4810 | 5980 | 4170 | 4096 | 3805 | 4410 | 4057 | 4956 | 4950 | 2580 | 2280 | 3430 | 5340 | 5790 | 7683 | 6898 | 6790 | 6857 | | 3151 | 2400 | 2715 | Honolulu |
| Nukahiva | 12848 | 15403 | 15181 | 15736 | 8662 | 12107 | 4879 | 5277 | 6179 | 6498 | 7160 | 6150 | 6820 | 4660 | 3948 | 2970 | 4081 | 3091 | 4516 | 4376 | 3820 | 3570 | 3300 | 5210 | 5779 | 5303 | 4758 | 4500 | 4565 | 2095 | | 757 | 2439 | Nukahiva |
| Tahiti | 12737 | 14631 | 13070 | 14964 | 8551 | 11414 | 5023 | 5138 | 5945 | 6140 | 6417 | 5760 | 6127 | 3967 | 3238 | 2221 | 3338 | 2340 | 3742 | 3595 | 4571 | 4321 | 4051 | 6099 | 5469 | 5283 | 4498 | 4387 | 4454 | 2400 | 751 | | 1902 | Tahiti |
| Levuka | 13861 | 12843 | 14149 | 13176 | 8537 | 9625 | 4365 | 3891 | 4457 | 4491 | 4629 | 4080 | 4339 | 2179 | 1583 | 1162 | 1786 | 1487 | 2289 | 2248 | 5560 | 5550 | 5750 | 7600 | 6969 | 6543 | 6000 | 5511 | 5578 | 4440 | 3700 | 2800 | | Levuka |

These Distances have necessarily been measured both ways; e.g. the Distance for a Sailing Ship, or Vessel with only Auxiliary Steam Power, from Valparaiso to Callao is 1295 miles, but from Callao to Valparaiso the Distance is 2590 miles. Similarly the Distance from San Francisco to Manila is 6896 miles, but from Manila to San Francisco it is 6168 miles.

Take 25 miles from Gravesend Distances to find Liverpool Distances.

Add 100 miles to Gravesend Distances to find Glasgow Distances.

Take 67 miles from Gravesend Distances to find Dover Distances, and so connect with Baltic and North Sea ports. See p. 643A. Port Said is connected with European ports. See p. 643.

* Calling at Cape Town adds about 200 miles to these distances.

If bound to Atlantic ports of the U.S. or Halifax *from* the Pacific, add 7500 miles to the Cape Horn, and 6800 miles to the Cape of Good Hope Distances. If bound *to* the Pacific, add 7800 miles to the Cape Horn, and 7700 miles to the Cape of Good Hope Distances.

## TIME SIGNALS, 1902*

It will be noticed that many countries have now adopted a uniform time system.

Great Britain, Belgium, Netherlands, Spain, and Portugal have adopted Greenwich mean time as a standard.

In Ireland the mean time of the Observatory at Dublin is the standard, $25^m$ $22^s$ slow of G.M.T.

Austria-Hungary, Denmark, Germany, Italy, Norway and Sweden, and the British Colony of Malta have adopted the Meridian of 15° E. from Greenwich as a standard, or 1 hour fast of G.M.T. This is known as Mid European time. France and Algeria use the Meridian of Paris, $9^m$ $21^s$ fast of G.M.T.

Cape Colony has adopted the Meridian of 22½° E. as a standard, or 1½ hours fast of G.M.T. This is known as Cape Colony mean time. Egypt and Natal have adopted Meridian of 30° E., or $2^h$ fast of G.M.T.

Japan has adopted as a standard the Meridian of 135° East from Greenwich, or 9 hours fast of G.M.T. This is known as Japan mean time. Straits Settlements, Mer. of Ft. Fullerton, Singapore, $6^h$ $55^m$ $25^s$ fast of G.M.T.

In the Colony of West Australia and Phillipine Islands, the standard time of the Meridian of 120° E. of Greenwich, or 8 hours fast of G.M.T., has been established.

In the Colony of South Australia the standard time of the Meridian of 142° 30′ E. of Greenwich, or 9 hours 30 min. fast of G.M.T., has been established.

In the Colonies of Queensland, New South Wales, Victoria, and Tasmania the standard time of the Meridian of 150° E., or 10 hours fast of G.M.T. has been established.

New Zealand has adopted as a standard the Meridian of 172½° E. from Greenwich, or 11½ hours fast of G.M.T. This is known as New Zealand mean time.

In the United States of America, at the Atlantic ports and Cuba, the standard time of the Meridian of 75° W. of Greenwich, or 5 hours slow of G.M.T. has been established. At Pacific ports and British Columbia the standard time is that of the Meridian of 120° W., or 8 hours slow of G.M.T.*

| Lat. | Long. | Place | Signal adopted | Situation of Time Signal | Time of Signal being made: Greenwich Mean Time | Time of Signal being made: Local Mean Time | Greenwich Time of Preparatory Signal |
|---|---|---|---|---|---|---|---|
| ° ′ ″ | ° ′ ″ | | | | h m s | h m s | h m s |
| 51 28 39 N. | 0 0 0 | Greenwich | Ball | Royal Observatory | 1 00 00 | 1 00 00 | 12 55 00 and<br>12 57 30 |
| 51 26 45 N. | 0 44 45 E. | Sheerness | Ball | Garrison Flagstaff | 1 00 00 | 1 2 59 | — |
| 51 13 17 N. | 1 24 22 E. | Deal | Ball | Telegraph Tower | 1 00 00 | 1 05 37 | 12 55 00 and<br>12 57 00 |
| 51 7 15 N. | 1 19 40 E. | Dover | Gun | Drop Battery | 0 00 00 | 0 05 19 | — |
| 50 48 0 N. | 1 6 18 W. | Portsmouth | Ball | Dock Yd. Semaphore | 1 00 00 | 0 55 35 | 12 55 00 |
| 50 8 45 N. | 5 2 45 W. | Falmouth | Ball | Pendennis Castle | 1 00 00 | 0 39 49 | — |
| 50 53 39 N. | 1 24 5 W. | Southampton | Ball | South Castle | 1 00 00 | 0 54 24 | 12 55 00 |
| 50 22 0 N. | 4 10 20 W. | Devonport | Ball | Mount Wise | 1 00 00 | 0 43 19 | 12 55 00 |
| — | — | " | Gun | " | 1 00 00 | 0 43 19 | — |
| 51 36 55 N. | 3 55 35 W. | Swansea | Gun | On old Eastern Pier | 1 00 00 | 0 44 18 | — |
| 53 24 4 N. | 3 0 36 W. | Liverpool | Gun | Birkenhead, Morpeth Dock | 1 00 00 | 0 47 58 | — |
| 56 27 56 N. | 2 58 45 W. | Dundee | Gun | — | 1 00 00 | 0 48 05 | — |
| 55 57 23 N. | 3 10 54 W. | Edinburgh | Ball | Nelson's Monument | 1 00 00 | 0 47 16 | 12 55 00 and<br>12 57 00 |
| — | — | " | Gun | Edinburgh Castle | 1 00 00 | 0 47 16 | — |
| 55 0 32 N. | 1 27 28 W. | North Shields | Gun | Near Albert Edward Dock | 1 00 00 | 0 54 10 | — |
| 51 53 53 N. | 8 27 17 W. | Cork | Gun | Victoria Quay | 1 00 00 | 0 26 11 | — |
| 51 51 9 N. | 8 16 37 W. | Queenstown | Gun | Near Military Hosp. | 1 00 00 | 0 26 53 | — |
| 53 20 46 N. | 6 15 30 W. | Dublin | Ball | Docks Board Building | 1 00 00 | 0 34 58 | — |
| 24 49 11 N. | 66 58 00 E. | Karachi | Ball | Merewether Pier | 20 32 8 | 1 00 00 | 20 27 8 |
| 18 55 51 N. | 72 50 33 E. | Bombay† | Ball | Bombay Castle | 20 08 44 | 1 00 00 | 20 03 44 |
| 18 57 13 N. | 72 50 46 E. | " | Ball | Clock Tower, Docks | 15 00 00 | 7 51 16 | 14 55 00 |
| 6 56 34 N. | 79 50 34 E. | Colombo | Sema. | Master Attendant's | 22 54 1 | 4 15 00‡ | 22 49 1 |
| 16 46 0 N. | 96 10 0 E. | Rangoon | Ball | Sailors' Home | 17 35 20 | 0 00 00 | 17 30 20 |
| 13 5 47 N. | 80 17 37 E. | Madras | Semaphore | Master Attendant's Office | 19 39 00 | 1 00 00 | — |
| 22 33 25 N. | 88 20 12 E. | Calcutta | Ball | Fort William | 19 06 39 | 1 00 00 | 19 01 39 |
| — | — | " | Ball | Port Commissioner's | 19 06 39 | 1 00 00 | 19 01 39 |
| 22 17 44 N. | 114 10 8 E. | Hongkong | Ball | Kau'ung Tower | 17 23 18 | 1 00 00 | 17 18 18 |
| 1 17 33 N. | 103 50 53 E. | Singapore | Ball | Ft. Canning Flagstaff | 18 4 35 | 1 00 00 | 18 00 00 |
| 1 15 45 N | 103 50 00 E. | " | Ball | Pulo Brani | 18 4 35 | 1 00 00 | 18 00 00 |
| 6 5 48 S. | 106 53 07 E. | Batavia | Discs | Tanjung Priok Basin | 16 52 28 | 0 00 00 | 16 47 28 |
| — | — | " | Discs | " | 18 00 00 | 1 07 32 | 17 55 00 |
| 7 12 10 S. | 112 43 40 E. | Sourabaya | Discs | Kalimas River | 16 29 05 | 0 00 00 | 16 24 05 |
| 15 55 0 S. | 5 42 30 W. | St. Helena | Ball | Ladder Hill Flagstaff | 1 00 00 | 0 37 10 | 12 55 00 |
| — | — | " | Ball | Time Office | 1 00 00 | 0 37 10 | 12 55 00 |
| 5 31 48 N. | 0 11 30 W. | Accra | Flag | Telegraph Office | 11 00 46 | 11 00 00 | — |
| 8 48 45 S. | 13 13 20 E. | Paul de Loanda | Ball | Observatory | 0 7 7 | 1 00 00 | 0 2 7 |

* For more detailed and later information on Time Signals see Admiralty List of Time Signals, sold by J. D. Potter, Agent for Admiralty Charts, 145 Minories, E.

† Clock on N.E. Bastion shows Bombay mean time.

‡ Madras mean time, also at $8^h$ $15^m$ a.m.

TIME SIGNALS, 1902

| Lat. | Long. | Place | Signal adopted | Situation of Time Signal | Time of Signal being made: Greenwich Mean Time | Time of Signal being made: Local Mean Time | Greenwich Time of Preparatory Signal |
|---|---|---|---|---|---|---|---|
| ° ′ ″ | ° ′ ″ | | | | h m s | h m s | h m s |
| 33 54 24 S. | 18 25 15 E. | Table Bay * . | Ball | At Alfred Docks . | 0 00 00 | 1 30 00 | — |
| — | — | " | Gun | On Imhoff Battery . | 0 00 00 | 1 30 00 | — |
| 34 11 35 S. | 18 25 58 E. | Simons Bay . | Disc | Telegraph Office . | 0 00 00 | 1 30 00 | 23 55 00 |
| 33 57 43 S. | 25 37 19 E. | Port Elizabeth | Ball | At the Lighthouse . | 0 00 00 | 1 30 00 | — |
| 33 36 10 S. | 26 54 5 E. | Port Alfred . | Ball | — | 0 00 00 | 1 30 00 | — |
| 33 1 50 S. | 27 34 55 E. | East London | Ball | Signal Hill . . | 0 00 00 | 1 30 00 | — |
| 29 52 30 S. | 31 3 0 E. | Natal . . | Ball | North Entrance Point | 22 55 59 | 0 25 59 | — |
| 20 10 5 S. | 57 29 0 E. | Mauritius . . | Ball | Signal Mt. Pt. Louis | 21 09 47 | 1 00 00 | 21 04 47 |
| 32 3 12 S. | 115 44 15 E. | Fremantle . | Ball | Arthur Head . . | 17 0 0 | 0 42 57 | 16 57 00 |
| 34 51 6 S. | 138 28 50 E. | Adelaide† . | Ball | At the Semaphore . | 15 30 00 | 0 43 55 | 15 25 00 |
| 37 52 7 S. | 144 54 47 E. | Port Phillip . | Ball | Gellibrand Point . | 15 00 00 | 0 39 39 | 14 55 00 |
| 38 9 00 S. | 144 21 00 E. | — | Ball | Telegraph, Geelong . | 15 00 00 | 0 37 24 | 14 55 00 |
| 38 16 27 S. | 144 39 45 E. | — | Flag | Queenscliff Signals . | 15 00 00 | 0 38 39 | — |
| 33 51 41 S. | 151 12 23 E. | Sydney . | Ball | Observatory . . | 15 00 00 | 1 04 49 | 14 53 00 |
| 32 55 43 S. | 151 47 28 E. | Newcastle . | Ball | Custom House . | 15 00 00 | 1 07 10 | 14 53 00 |
| 27 28 3 S. | 153 1 31 E. | Brisbane . | Ball | Signal Tower . . | 15 00 00 | 1 12 06 | 14 55 00 |
| 42 53 22 S. | 147 20 28 E. | Hobart . . | Ball | Fort Mulgrave . | 15 00 00 | 0 49 20 | 14 50 00 |
| — | — | " | Gun | Queen's Battery | — | — | — |
| 43 36 42 S. | 172 44 50 E. | Lyttelton . | Ball | Observatory . . | 13 30 00 | 1 00 59 | 13 25 00 |
| 41 16 50 S. | 174 46 55 E. | Wellington . | Ball | Railway Wharf‡ . | 12 30 00 | 0 09 08 | — |
| 45 49 0 S. | 170 39 0 E. | Otago . . | Ball | Signal Staff, Port | 12 30 00 | 11 52 36 | Once a week |
| 36 50 44 S. | 174 45 52 E. | Auckland . | Ball | Post Office Flagstaff | 12 30 00 | 0 09 03 | 12 25 00 |
| 47 34 10 N. | 52 40 27 W. | St. John's . | Gun | Signal Hill . . | 3 30 43 ? | 0 00 00 | — |
| 45 15 42 N. | 66 3 45 W. | St. John, N.B. | Ball | New Custom House | 5 00 00 | 1 00 00 | 4 45 00 |
| 46 48 23 N. | 71 12 17 W. | Quebec. . | Ball | At Citadel . . | 6 00 00 | 1 15 11 | 5 55 00 |
| 45 31 0 N. | 73 33 15 W. | Montreal . | Ball | Harbour Office . | 5 00 00 | 0 5 47 | 4 55 00 |
| 32 19 22 N. | 64 49 35 W. | Bermuda § . | Ball | Dockyard Flagstaff | 4 19 18 | 0 00 00 | 4 14 18 |
| 23 08 30 N. | 82 20 50 W. | Havana . | Ball | Naval Office . . | 5 00 00 | 11 30 36 | 4 50 00 |
| 14 00 53 N. | 61 00 00 W. | St. Lucia . | Ball | Harbour Master's Office, Castries | 4 04 00 | 0 00 00 | 3 59 00 |
| 6 48 48 N. | 58 9 52 W. | Demerara . | Ball | General Post Office . | 3 52 39 | 0 00 00 | 3 47 46 |
| 10 39 0 N. | 61 30 38 W. | Trinidad . | Ball | Observatory Tower | 4 06 02 ? | 0 00 00 | — |
| 5 49 30 N. | 55 8 48 W. | Paramaribo . | Disc | Guardship . . | 3 40 35 | 0 00 00 | 3 35 35 |
| 12 6 45 N. | 68 56 44 W. | Curaçao . | Flag | Guardship . . | 4 35 47 | 0 00 00 | 4 30 47 |
| 22 54 24 S. | 43 10 21 W. | Rio de Janeiro | Drum | Mount Castello . . | 2 52 41 | 0 00 00 | 2 47 41 |
| 34 52 33 S. | 57 54 43 W. | Rio de la Plata | Ball | Dock Engine Ho. . | 2 51 39 ? | 23 00 00 | 2 47 39 |
| 34 35 50 S. | 58 22 15 W. | Buenos Aires | Ball | Hyd. Office . | 5 16 48 | 1 23 19 | 5 14 48 |
| 51 13 15 N. | 4 24 15 E. | Antwerp . | Discs | Hanseatic House . | 1 00 00 | 1 17 37 | 12 55 00 |
| 51 26 33 N. | 3 35 48 E. | Flushing . | Discs | Stone Tower of sluice | 23 45 37 | 0 00 00 | 23 40 37 |
| 51 49 19 N. | 4 7 40 E. | Hellevoetsluis | Discs | Marine Establishment | 23 43 29 | 0 00 00 | 23 38 29 |
| 52 22 40 N. | 4 54 45 E. | Amsterdam . | Discs | Commercial Quay . | 23 40 21 | 0 00 00 | 23 35 21 |
| 51 54 39 N. | 4 29 47 E. | Rotterdam . | Discs | Gate Building . | 23 42 01 | 0 00 00 | 13 37 01 |
| 52 57 50 N. | 4 46 36 E. | Willemsoord | Discs | Marine Office . . | 23 40 54 | 0 00 00 | 23 35 54 |
| 53 31 54 N. | 8 8 48 E. | Wilhelmshaven¶ | Ball | Observatory . . | 23 00 00 | 11 32 35 | 20 50 00 |
| — | — | | Ball | " | 0 00 00 | 0 32 35 | 23 57 00 |
| 53 32 51 N. | 8 34 7 E. | Bremerhaven | Ball | S.W. of Lighthouse | 23 00 00 | 11 34 16 | 22 50 00 |
| — | — | | Ball | " | 0 00 00 | 0 34 16 | 23 57 00 |
| 53 52 24 N. | 8 42 30 E. | Cuxhaven . | Ball | E. of Lighthouse . | 23 00 00 | 11 34 50 | 22 50 00 |
| — | — | | Ball | " | 0 00 00 | 0 34 50 | 23 57 00 |
| 53 32 30 N. | 9 58 57 E. | Hamburg . | Ball | On the Kaiser Quay | 0 00 00 | 0 39 56 | 23 50 00 |
| 54 19 18 N. | 10 9 40 E. | Kiel . . | Ball | Imperial Wharf . . | 23 00 00 | 11 40 39 | 22 50 00 |
| — | — | " | Gun | Guardship . . | 23 00 00 | 11 40 39 | — |
| 53 54 36 N. | 14 15 58 E. | Swinemunde . | Ball | S.W. of Lighthouse | 22 00 00 | 10 57 4 | 21 50 00 |
| — | — | | Ball | " | 3 00 00 | 3 57 4 | 2 50 00 |
| 54 24 18 N. | 18 40 10 E. | Neufahrwasser | Ball | Lighthouse . . | 23 00 00 | 1 14 41 | 22 50 00 |
| 56 2 4 N. | 12 37 24 E. | Elsinore . | Ball | Quarantine House . | 0 00 00 | 0 50 30 | 23 55 00 |
| 57 42 34 N. | 11 58 0 E. | Gothenburg . | Ball | Navigation School . | 0 00 00 | 0 47 52 | 23 55 00 |
| 55 40 42 N. | 12 35 7 E. | Copenhagen . | Ball | Nikolai Tower . . | 0 00 00 | 0 50 19 | 23 55 00 |
| 55 37 0 N. | 13 0 15 E. | Malmo . . | Ball | School of Navigation | 0 00 00 | 0 52 02 | 23 55 00 |
| 56 09 28 N. | 15 35 36 E. | Carlskrona . | Ball | Dockyard Tower . | 0 00 00 | 1 2 23 | 23 54 00 |
| 59 19 10 N. | 18 4 44 E. | Stockholm . | Ball | School of Navigation | 0 00 00 | 1 12 19 | 23 55 00 |

* Cape Colony mean time.
† Balls dropped at 1h 00m 00s, standard times, of the Australian Colonies and New Zealand.
‡ Once a week. § On Saturdays only. ‖ At Demerara, on Wednesday and Saturday only.
¶ Balls dropped at 1h 00m 00s, Mid-European time, throughout Germany and Denmark.

## TIME SIGNALS, 1902

| Lat. | Long. | Place | Signal adopted | Situation of Time Signal | Time of Signal being made: Greenwich Mean Time | Time of Signal being made: Local Mean Time | Greenwich Time of Preparatory Signal |
|---|---|---|---|---|---|---|---|
| ° ′ ″ | ° ′ ″ | | | | h m s | h m s | h m s |
| 56 56 52 N. | 24 05 30 E. | Riga | Ball | Sailors' Home | 23 23 32 | 0 59 54 | 23 18 32 |
| 59 59 24 N. | 29 45 54 E. | Kronstadt | Ball | Marine Telegraph | 22 00 56 | 0 00 00 | 21 52 56 |
| 59 56 31 N. | 30 18 22 E. | St. Petersburg | Gun | Fort Petri-Paul | 21 58 41 | 0 00 00 | — |
| 60 9 49 N. | 24 57 7 E. | Helsingfors | Ball | Observatory | 22 20 11 | 0 00 00 | 22 16 11 |
| 60 26 57 N. | 22 17 43 E. | Abo | Ball | Navigating School | 22 30 51 | 0 00 00 | 22 24 51 |
| 65 1 19 N. | 25 30 30 E. | Uleaborg | Ball | Navigation School | 22 17 58 | 0 00 00 | 22 12 58 |
| 63 25 40 N. | 10 22 4 E. | Trondhjem* | Ball | Observatory | 23 00 00 | 23 41 28 | 22 45 00 |
| 60 23 53 N. | 5 18 35 E. | Bergen*. | Ball | Observatory | 23 00 00 | 23 21 13 | 22 45 00 |
| 59 45 44 N. | 10 43 33 E. | Christiania* | Drum | Observatory | 23 00 00 | 23 42 54 | 22 55 00 |
| 49 38 42 N. | 1 37 34 W. | Cherbourg | Disc | Marine Observatory | 21 50 39 | 10 00 00† | 21 45 39 |
| 48 22 46 N. | 4 29 48 W. | Brest | Flag | Observatory | 21 50 39 | 10 00 00† | 21 45 39 |
| 47 44 45 N. | 3 21 15 W. | L'Orient | Ball | Harbour Tower | 21 50 39 | 10 00 00† | 21 45 39 |
| 45 59 10 N. | 1 5 50 W. | Fouras | Balloon | Tower | 21 50 39 | 10 00 00† | 21 45 39 |
| 45 56 10 N. | 0 57 35 W. | Rochefort | Balloon | St. Louis Tower | 21 50 39 | 10 00 00† | 21 45 39 |
| 38 42 18 N. | 9 8 24 W. | Lisbon | Ball | Naval School | 1 36 45 | 1 00 00 | 1 31 45 |
| 36 27 41 N. | 6 12 24 W. | Cadiz | Ball | Observatory | 1 24 50 | 1 00 00 | 1 14 50 |
| 43 7 22 N. | 5 55 27 E. | Toulon | Ball | Naval Observatory | 21 50 39 | 10 00 00† | 21 40 39 |
| 36 47 0 N. | 3 3 15 E. | Algier | Clock | Town Hall | Clock shows Paris Mean Time. | | |
| 44 25 10 N. | 8 55 21 E. | Genoa‡ | Gun | Fort Castellaccio | 23 00 00 | 23 35 41 | 22 55 00 |
| 44 6 55 N. | 9 49 33 E. | Spezia | Gun | Laguna Mole | 23 00 00 | 23 39 18 | — |
| 40 28 20 N. | 17 14 10 E. | Taranto | Ball | St. Angelo Castle | 23 00 00 | 0 8 57 | 22 55 00 |
| 44 52 8 N. | 13 50 45 E. | Pola | Ball | Harbour Castle | 23 00 00 | 23 55 23 | 22 55 00 |
| 45 38 56 N. | 13 45 30 E. | Trieste | Ball | Lighthouse | 23 00 00 | 23 55 02 | 22 55 00 |
| 45 19 36 N. | 14 25 44 E. | Fiume | Ball | Staff, Mole end | 23 00 00 | 23 57 43 | 22 55 00 |
| 44 31 49 N. | 14 28 6 E. | Lussin Piccolo | Discs | S.W. Quay | 23 00 00 | 23 57 52 | — |
| 35 53 50 N. | 14 30 55 E. | Malta | Ball | Palace Valetta | 23 00 00 | 23 58 4 | 22 55 00 |
| | | | Ball | Custom House | 23 00 00 | 23 58 4 | 22 55 00 |
| 40 50 5 N. | 14 15 30 E. | Naples | Ball | Vincenzo Mole | 23 00 00 | 23 57 2 | 22 55 00 |
| 31 11 39 N. | 29 53 15 E. | Alexandria§ | Ball | Fort Napoleon | 22 00 00 | 23 59 33 | 21 55 00 |
| 31 15 45 N. | 32 18 45 E. | Port Said ‖ | Ball | High Light Ho. | 22 00 00 | 0 00 00 | 21 55 00 |
| 46 58 21 N. | 31 58 28 E. | Nicolaev (Black Sea) | Ball | Observatory | 21 52 06 | 0 00 00 | 21 47 6 |
| 46 29 0 N. | 30 45 0 E. | Odessa | Ball | Russian S.N.Co. Office | 21 57 0 | 0 00 00 | 21 52 00 |
| 41 31 30 N. | 70 40 20 W. | Woods Holl ¶ | Ball | Water Tower | 5 00 00 | 0 17 19 | — |
| 41 29 36 N. | 71 19 39 W. | Newport | Ball | Torpedo Station | 5 00 00 | 0 14 41 | — |
| 40 43 0 N. | 74 0 25 W. | New York | Ball | Union Telegraph Office | 5 00 00 | 0 03 58 | 4 55 00 |
| 39 56 45 N. | 75 9 10 W. | Philadelphia | Ball | Maritime Exchange | 5 00 00 | 23 59 23 | 4 50 00 |
| 39 17 51 N. | 76 36 57 W. | Baltimore | Ball | Baltimore Railway | 5 00 00 | 23 53 32 | — |
| 38 53 39 N. | 77 3 8 W. | Washington | Ball | Naval Observatory | 5 00 00 | 23 51 47 | 4 50 00 |
| 37 0 0 N. | 76 18 25 W. | Hampton Roads | Ball | Hygeia Hotel | 5 00 00 | 23 54 46 | — |
| 32 4 50 N. | 81 5 10 W. | Savannah | Ball | Custom House | 5 00 00 | 23 35 39 | — |
| 29 57 8 N. | 90 3 50 W. | New Orleans | Ball | Sugar House | 5 00 00 | 22 59 43 | 4 55 00 |
| 29 18 0 N. | 94 47 30 W. | Galveston | Ball | Levy Building | 5 00 00 | 23 0 0 | 4 55 00 |
| 37 47 40 N. | 122 23 35 W. | San Francisco | Ball | Tower of Ferry Ho.** | 8 00 00 | 23 50 23 | 7 55 00 |
| 38 5 53 N. | 122 16 16 W. | Mare Island | Ball | The Observatory** | 8 00 00 | 23 50 55 | 7 55 00 |
| 49 17 30 N. | 123 7 0 W. | Vancouver | Gun | Brockton Point | 17 00 00 | 9 00 00 | — |
| 33 1 50 N. | 71 38 30 W. | Valparaiso | Ball | Naval School | 4 46 34 | 0 00 00 | 4 41 34 |
| 21 18 13 N. | 157 51 47 W. | Honolulu | Whistle | Steam Mills | 12 00 00 | 1 28 33 | — |
| 14 36 0 N. | 120 58 0 E. | Manila | Ball | Meteorological Office | 16 00 00 | 0 3 52 | 15 55 00 |
| 20 51 56 N. | 106 39 54 E. | Haifong | Ball | Observatory | 13 53 20 | 21 00 00 | 13 43 20 |
| 23 21 43 N. | 116 40 30 E. | Swatau | Ball | Harbour Office | 16 13 05 | 0 00 00 | — |
| 24 27 25 N. | 118 3 33 E. | Amoy | Gun | Kulangsoo | 16 07 44 | 0 00 00 | 16 02 44 |
| 31 14 7 N. | 121 29 10 E. | Shangai | Ball | Semaphore | 15 54 03 | 0 00 00 | 15 49 3 |
| 37 33 10 N. | 121 25 20 E. | Chifu | Ball | Mast near Tower Hill | 15 54 20 | 1 00 00* | — |
| 34 1 0 N. | 135 11 0 E. | Kobe | Ball | On the Bund | 15 00 00 | 0 00 00 | — |
| 41 46 35 W. | 140 43 50 E. | Hakodate | Flag | Obsy. Fl. staff | 15 00 00 | 0 22 55 | 14 55 00 |
| 43 7 0 N. | 131 52 44 E. | Vladivostock | Ball & Gun | Harbour Office | 15 12 29 | 0 00 00 | 15 07 20 |

* On Wednesdays and Saturdays. † Paris mean time.

‡ Guns fired and balls dropped at $1^h\ 00^m\ 00^s$ Mid-European time, throughout Norway, Austria, and Italy.

§ Throughout Egypt, the official time kept is standard time of the meridian of 30° E.

‖ Ball at Port Said dropped also at $8^h$ a.m. and $4^h$ p.m., standard time.

¶ All time balls on the Atlantic and Gulf of Mexico coasts of the United States are dropped at noon, mean time of the 75th meridian West from Greenwich—equivalent to $5^h\ 00^m\ 00^s$ p.m. Greenwich mean time.

** Balls dropped at noon, mean time of 120th meridian West from Greenwich.

N.B.—When the report of the gun is used allow for time of passage of sound. *See* p. 180.

| EPACTS | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Years | | | | | | | | Months | | | |
| Year | Epact | Year | Epact | Year | Epact | Year | Epact | Month | Epact | Month | Epact |
| | d h | | d h | | d h | | d h | | d h | | d h |
| 1891 | 20 9 | 1897 | 27 6 | 1903 | 2 11 | 1909 | 9 4 | Jan. | 0 0 | July | 3 20 |
| 1892L | 1 10 | 1898 | 8 8 | 1904L | 13 2 | 1910 | 19 19 | Feb. | 1 11 | Aug. | 5 7 |
| 1893 | 13 5 | 1899 | 19 0 | 1905 | 24 17 | 1911 | 0 22 | March | 29 11 | Sept. | 6 18 |
| 1894 | 24 5 | 1900 | 0 2 | 1906 | 5 19 | 1912L | 11 13 | April | 1 10 | Oct. | 7 5 |
| 1895 | 5 0 | 1901 | 10 17 | 1907 | 16 11 | 1913 | 23 4 | May | 1 21 | Nov. | 8 17 |
| 1896L | 15 15 | 1902 | 21 8 | 1908L | 27 2 | 1914 | 4 7 | June | 3 8 | Dec. | 9 4 |

## TABLE 15.

**SEMIMENSTRUAL INEQUALITY OF THE TIME OF HIGH WATER,**
**For London, Liverpool, Pembroke, Ramsgate, Sheerness, Portsmouth, Plymouth, and Brest.**

| Moon's Transit | Sem. Ineq. | Moon's Transit | Sem. Ineq. | Moon's Transit | Sem. Ineq. | Moon's Transit | Sem. Ineq. | Moon's Transit | Sem. Ineq. |
|---|---|---|---|---|---|---|---|---|---|
| | sub. | | sub. | | sub. | | sub. | | add |
| $0^h\ 0^m$ | $0^h\ 0^m$ | $2^h\ 30^m$ | $0^h\ 36^m$ | $5^h\ 0^m$ | $1^h\ 3^m$ | $7^h\ 30^m$ | $0^h\ 30^m$ | $10^h\ 0^m$ | $0^h\ 16^m$ |
| 10 | 0 2 | 40 | 0 38 | 10 | 1 4 | 40 | 0 25 | 10 | 0 16 |
| 20 | 0 4 | 50 | 0 41 | 20 | 1 5 | 50 | 0 20 | 20 | 0 15 |
| 30 | 0 6 | 3 0 | 0 43 | 30 | 1 5 | 8 0 | 0 15 | 30 | 0 15 |
| 40 | 0 8 | 10 | 0 45 | 40 | 1 5 | 10 | 0 10 | 40 | 0 14 |
| 50 | 0 11 | 20 | 0 47 | 50 | 1 4 | 20 | 0 5 | 50 | 0 12 |
| 1 0 | 0 13 | 30 | 0 49 | 6 0 | 1 3 | 30 | 0 1 | 11 0 | 0 11 |
| | | | | | | | add | | |
| 10 | 0 15 | 40 | 0 51 | 10 | 1 1 | 40 | 0 3 | 10 | 0 10 |
| 20 | 0 18 | 50 | 0 53 | 20 | 0 59 | 50 | 0 6 | 20 | 0 8 |
| 30 | 0 20 | 4 0 | 0 55 | 30 | 0 56 | 9 0 | 0 9 | 30 | 0 6 |
| 40 | 0 23 | 10 | 0 57 | 40 | 0 52 | 10 | 0 12 | 40 | 0 4 |
| 50 | 0 25 | 20 | 0 59 | 50 | 0 48 | 20 | 0 14 | 50 | 0 2 |
| 2 0 | 0 28 | 30 | 1 0 | 7 0 | 0 44 | 30 | 0 15 | 12 0 | 0 0 |
| 10 | 0 30 | 40 | 1 1 | 10 | 0 39 | 40 | 0 15 | | |
| 20 | 0 33 | 50 | 1 2 | 20 | 0 35 | 50 | 0 16 | | |

## TABLE 16.

**APPROXIMATE RISE AND FALL OF THE TIDE AT ANY TIME FROM HIGH OR LOW WATER**

| Range of the Tide in feet | $0^h$ | | | $1^h$ | | | $2^h$ | | | $3^h$ | | | $4^h$ | | | $5^h$ | | | $6^h$ | Range of the Tide in feet |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | m 0 | m 20 | m 40 | m 0 | m 20 | m 40 | m 0 | m 20 | m 40 | m 0 | m 20 | m 40 | m 0 | m 20 | m 40 | m 0 | m 20 | m 40 | m 0 | |
| 0 | 0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0 |
| 2 | 0 | 0·0 | 0·1 | 0·1 | 0·2 | 0·4 | 0·5 | 0·7 | 0·8 | 1·0 | 1·2 | 1·3 | 1·5 | 1·6 | 1·8 | 1·9 | 1·9 | 2·0 | 2 | 2 |
| 4 | 0 | 0·0 | 0·1 | 0·3 | 0·5 | 0·7 | 1·0 | 1·3 | 1·7 | 2·0 | 2·3 | 2·7 | 3·0 | 3·3 | 3·5 | 3·7 | 3·9 | 4·0 | 4 | 4 |
| 6 | 0 | 0·0 | 0·2 | 0·4 | 0·7 | 1·1 | 1·5 | 2·0 | 2·5 | 3·0 | 3·5 | 4·0 | 4·5 | 4·9 | 5·3 | 5·6 | 5·8 | 6·0 | 6 | 6 |
| 8 | 0 | 0·1 | 0·2 | 0·5 | 0·9 | 1·3 | 2·0 | 2·6 | 3·3 | 4·0 | 4·7 | 5·4 | 6·0 | 6·6 | 7·1 | 7·5 | 7·8 | 7·9 | 8 | 8 |
| 10 | 0 | 0·1 | 0·3 | 0·7 | 1·1 | 1·8 | 2·5 | 3·3 | 4·1 | 5·0 | 5·9 | 6·7 | 7·5 | 8·2 | 8·9 | 9·3 | 9·7 | 9·9 | 10·0 | 10 |
| 12 | 0 | 0·1 | 0·4 | 0·8 | 1·4 | 2·1 | 3·0 | 3·9 | 5·0 | 6·0 | 7·0 | 8·1 | 9·0 | 9·9 | 10·6 | 11·2 | 11·6 | 11·8 | 12·0 | 12 |
| 14 | 0 | 0·1 | 0·4 | 0·9 | 1·6 | 2·5 | 3·5 | 4·3 | 5·8 | 7·0 | 8·2 | 9·4 | 10·5 | 11·5 | 12·4 | 13·1 | 13·6 | 13·9 | 14·0 | 14 |
| 16 | 0 | 0·1 | 0·5 | 1·1 | 1·9 | 2·9 | 4·0 | 5·6 | 6·6 | 8·0 | 9·4 | 10·7 | 12·0 | 13·1 | 14·1 | 14·9 | 15·5 | 15·9 | 16·0 | 16 |
| 18 | 0 | 0·1 | 0·6 | 1·2 | 2·1 | 3·1 | 4·5 | 5·9 | 7·4 | 9·0 | 10·6 | 12·1 | 13·5 | 14·8 | 15·9 | 16·8 | 17·5 | 17·0 | 18·0 | 18 |
| 20 | 0 | 0·2 | 0·6 | 1·3 | 2·3 | 3·6 | 5·0 | 6·6 | 8·3 | 10·0 | 11·7 | 13·4 | 15·0 | 16·4 | 17·7 | 18·7 | 19·4 | 19·8 | 20·0 | 20 |
| 22 | 0 | 0·2 | 0·7 | 1·5 | 2·6 | 3·9 | 5·5 | 7·2 | 9·1 | 11·0 | 12·9 | 14·8 | 16·5 | 18·1 | 19·4 | 20·5 | 21·3 | 21·8 | 22·0 | 22 |
| 24 | 0 | 0·2 | 0·7 | 1·6 | 2·8 | 4·3 | 6·0 | 7·9 | 9·9 | 12·0 | 14·1 | 16·1 | 18·0 | 19·7 | 21·2 | 22·4 | 23·3 | 23·8 | 24·0 | 24 |
| 26 | 0 | 0·2 | 0·8 | 1·7 | 3·0 | 4·6 | 6·5 | 8·6 | 10·7 | 13·0 | 15·3 | 17·4 | 19·5 | 21·4 | 23·0 | 24·3 | 25·2 | 25·8 | 26·0 | 26 |
| 28 | 0 | 0·2 | 0·8 | 1·9 | 3·3 | 5·0 | 7·0 | 9·2 | 11·6 | 14·0 | 16·4 | 18·8 | 21·0 | 23·0 | 24·7 | 26·1 | 27·2 | 27·8 | 28·0 | 28 |
| 30 | 0 | 0·2 | 0·9 | 2·0 | 3·5 | 5·4 | 7·5 | 9·9 | 12·4 | 15·0 | 17·6 | 20·1 | 22·5 | 24·6 | 26·5 | 28·0 | 29·1 | 29·8 | 30·0 | 30 |
| 32 | 0 | 0·2 | 1·0 | 2·1 | 3·7 | 5·7 | 8·0 | 10·5 | 13·2 | 16·0 | 18·8 | 21·5 | 24·0 | 26·3 | 28·3 | 29·9 | 31·0 | 31·8 | 32·0 | 32 |
| 34 | 0 | 0·3 | 1·0 | 2·3 | 4·0 | 6·1 | 8·5 | 11·2 | 14·0 | 17·0 | 20·0 | 22·8 | 25·5 | 27·9 | 30·0 | 31·7 | 33·0 | 33·7 | 34·0 | 34 |
| 36 | 0 | 0·3 | 1·1 | 2·4 | 4·2 | 6·4 | 9·0 | 11·8 | 14·9 | 18·0 | 21·1 | 24·2 | 27·0 | 29·6 | 31·8 | 33·6 | 34·9 | 35·7 | 36·0 | 36 |
| 38 | 0 | 0·3 | 1·1 | 2·5 | 4·4 | 6·8 | 9·5 | 12·5 | 15·7 | 19·0 | 22·3 | 25·5 | 28·5 | 31·2 | 33·6 | 35·5 | 36·9 | 37·7 | 38·0 | 38 |
| 40 | 0 | 0·3 | 1·2 | 2·7 | 4·7 | 7·1 | 10·0 | 13·2 | 16·5 | 20·0 | 23·5 | 26·8 | 30·0 | 32·9 | 35·3 | 37·3 | 38·8 | 39·7 | 40·0 | 40 |
| 42 | 0 | 0·3 | 1·3 | 2·8 | 4·9 | 7·5 | 10·5 | 13·8 | 17·4 | 21·0 | 24·6 | 28·2 | 31·5 | 34·5 | 37·1 | 39·2 | 40·7 | 41·7 | 42·0 | 42 |
| 44 | 0 | 0·3 | 1·3 | 2·9 | 5·1 | 7·9 | 11·0 | 14·5 | 18·2 | 22·0 | 25·8 | 29·5 | 33·0 | 36·1 | 38·9 | 41·1 | 42·7 | 43·7 | 44·0 | 44 |
| 46 | 0 | 0·3 | 1·4 | 3·1 | 5·4 | 8·2 | 11·5 | 15·1 | 19·0 | 23·0 | 27·0 | 30·9 | 34·5 | 37·8 | 40·6 | 42·9 | 44·6 | 45·7 | 46·0 | 46 |
| 48 | 0 | 0·4 | 1·4 | 3·2 | 5·6 | 8·6 | 12·0 | 15·8 | 19·8 | 24·0 | 28·2 | 32·0 | 36·0 | 39·4 | 42·4 | 45·8 | 44·6 | 47·6 | 48·0 | 48 |
| 50 | 0 | 0·4 | 1·5 | 3·3 | 5·9 | 8·9 | 12·5 | 17·4 | 20·7 | 25·0 | 29·3 | 33·6 | 37·5 | 41·1 | 44·1 | 46·7 | 48·5 | 49·6 | 50·0 | 50 |

## TABLE 17.

| ARC. | | | | | |
|---|---|---|---|---|---|
| ° | H.M. | ′ | M. S | ″ | S. |
| 0 | 0 0 | 0 | 0 0 | 0 | 0·00 |
| 1 | 0 4 | 1 | 0 4 | 1 | 0·07 |
| 2 | 0 8 | 2 | 0 8 | 2 | 0·13 |
| 3 | 0 12 | 3 | 0 12 | 3 | 0·20 |
| 4 | 0 16 | 4 | 0 16 | 4 | 0·27 |
| 5 | 0 20 | 5 | 0 20 | 5 | 0·33 |
| 6 | 0 24 | 6 | 0 24 | 6 | 0·40 |
| 7 | 0 28 | 7 | 0 28 | 7 | 0·47 |
| 8 | 0 32 | 8 | 0 32 | 8 | 0·53 |
| 9 | 0 36 | 9 | 0 36 | 9 | 0·60 |
| 10 | 0 40 | 10 | 0 40 | 10 | 0·67 |
| 11 | 0 44 | 11 | 0 44 | 11 | 0·73 |
| 12 | 0 48 | 12 | 0 48 | 12 | 0·80 |
| 13 | 0 52 | 13 | 0 52 | 13 | 0·87 |
| 14 | 0 56 | 14 | 0 56 | 14 | 0·93 |
| 15 | 1 0 | 15 | 1 0 | 15 | 1·00 |
| 16 | 1 4 | 16 | 1 4 | 16 | 1·07 |
| 17 | 1 8 | 17 | 1 8 | 17 | 1·13 |
| 18 | 1 12 | 18 | 1 12 | 18 | 1·20 |
| 19 | 1 16 | 19 | 1 16 | 19 | 1·27 |
| 20 | 1 20 | 20 | 1 20 | 20 | 1·33 |
| 30 | 2 0 | 21 | 1 24 | 21 | 1·40 |
| 40 | 2 40 | 22 | 1 28 | 22 | 1·47 |
| 50 | 3 20 | 23 | 1 32 | 23 | 1·53 |
| 60 | 4 0 | 24 | 1 36 | 24 | 1·60 |
| 70 | 4 40 | 25 | 1 40 | 25 | 1·67 |
| 80 | 5 20 | 26 | 1 44 | 26 | 1·73 |
| 90 | 6 0 | 27 | 1 48 | 27 | 1·80 |
| 100 | 6 40 | 28 | 1 52 | 28 | 1·87 |
| 110 | 7 20 | 29 | 1 56 | 29 | 1·93 |
| 120 | 8 0 | 30 | 2 0 | 30 | 2·00 |
| 130 | 8 40 | 31 | 2 4 | 31 | 2·07 |
| 140 | 9 20 | 32 | 2 8 | 32 | 2·13 |
| 150 | 10 0 | 33 | 2 12 | 33 | 2·20 |
| 160 | 10 40 | 34 | 2 16 | 34 | 2·27 |
| 170 | 11 20 | 35 | 2 20 | 35 | 2·33 |
| 180 | 12 0 | 36 | 2 24 | 36 | 2·40 |
| | | 37 | 2 28 | 37 | 2·47 |
| | | 38 | 2 32 | 38 | 2·53 |
| | | 39 | 2 36 | 39 | 2·60 |
| | | 40 | 2 40 | 40 | 2·67 |
| | | 41 | 2 44 | 41 | 2·73 |
| | | 42 | 2 48 | 42 | 2·80 |
| | | 43 | 2 52 | 43 | 2·87 |
| | | 44 | 2 56 | 44 | 2·93 |
| | | 45 | 3 0 | 45 | 3·00 |
| | | 46 | 3 4 | 46 | 3·07 |
| | | 47 | 3 8 | 47 | 3·13 |
| | | 48 | 3 12 | 48 | 3·20 |
| | | 49 | 3 16 | 49 | 3·27 |
| | | 50 | 3 20 | 50 | 3·33 |
| | | 51 | 3 24 | 51 | 3·40 |
| | | 52 | 3 28 | 52 | 3·47 |
| | | 53 | 3 32 | 53 | 3·53 |
| | | 54 | 3 36 | 54 | 3·60 |
| | | 55 | 3 40 | 55 | 3·67 |
| | | 56 | 3 44 | 56 | 3·73 |
| | | 57 | 3 48 | 57 | 3·80 |
| | | 58 | 3 52 | 58 | 3·87 |
| | | 59 | 3 56 | 59 | 3·93 |

## TABLE 18

| TIME. | | | | | | | |
|---|---|---|---|---|---|---|---|
| H. | ° | M. | ° ′ | S. | ′ ″ | 10ths | ″ |
| 0 | 0 | 0 | 0 0 | 0 | 0 0 | 0·0 | 0·0 |
| 1 | 15 | 1 | 0 15 | 1 | 0 15 | 0·1 | 1·5 |
| 2 | 30 | 2 | 0 30 | 2 | 0 30 | 0·2 | 3·0 |
| 3 | 45 | 3 | 0 45 | 3 | 0 45 | 0·3 | 4·5 |
| 4 | 60 | 4 | 1 0 | 4 | 1 0 | 0·4 | 6·0 |
| 5 | 75 | 5 | 1 15 | 5 | 1 15 | 0·5 | 7·5 |
| 6 | 90 | 6 | 1 30 | 6 | 1 30 | 0·6 | 9·0 |
| 7 | 105 | 7 | 1 45 | 7 | 1 45 | 0·7 | 10·5 |
| 8 | 120 | 8 | 2 0 | 8 | 2 0 | 0·8 | 12·0 |
| 9 | 135 | 9 | 2 15 | 9 | 2 15 | 0·9 | 13·5 |
| 10 | 150 | 10 | 2 30 | 10 | 2 30 | 1·0 | 15·0 |
| 11 | 165 | 11 | 2 45 | 11 | 2 45 | | |
| 12 | 180 | 12 | 3 0 | 12 | 3 0 | | |
| 13 | 195 | 13 | 3 15 | 13 | 3 15 | | |
| 14 | 210 | 14 | 3 30 | 14 | 3 30 | | |
| 15 | 225 | 15 | 3 45 | 15 | 3 45 | | |
| 16 | 240 | 16 | 4 0 | 16 | 4 0 | | |
| 17 | 255 | 17 | 4 15 | 17 | 4 15 | | |
| 18 | 270 | 18 | 4 30 | 18 | 4 30 | | |
| 19 | 285 | 19 | 4 45 | 19 | 4 45 | | |
| 20 | 300 | 20 | 5 0 | 20 | 5 0 | | |
| 21 | 315 | 21 | 5 15 | 21 | 5 15 | | |
| 22 | 330 | 22 | 5 30 | 22 | 5 30 | | |
| 23 | 345 | 23 | 5 45 | 23 | 5 45 | | |
| 24 | 360 | 24 | 6 0 | 24 | 6 0 | | |
| | | 25 | 6 15 | 25 | 6 15 | | |
| | | 26 | 6 30 | 26 | 6 30 | | |
| | | 27 | 6 45 | 27 | 6 45 | | |
| | | 28 | 7 0 | 28 | 7 0 | | |
| | | 29 | 7 15 | 29 | 7 15 | | |
| | | 30 | 7 30 | 30 | 7 30 | | |
| | | 31 | 7 45 | 31 | 7 45 | | |
| | | 32 | 8 0 | 32 | 8 0 | | |
| | | 33 | 8 15 | 33 | 8 15 | | |
| | | 34 | 8 30 | 34 | 8 30 | | |
| | | 35 | 8 45 | 35 | 8 45 | | |
| | | 36 | 9 0 | 36 | 9 0 | | |
| | | 37 | 9 15 | 37 | 9 15 | | |
| | | 38 | 9 30 | 38 | 9 30 | | |
| | | 39 | 9 45 | 39 | 9 45 | | |
| | | 40 | 10 0 | 40 | 10 0 | | |
| | | 41 | 10 15 | 41 | 10 15 | | |
| | | 42 | 10 30 | 42 | 10 30 | | |
| | | 43 | 10 45 | 43 | 10 45 | | |
| | | 44 | 11 0 | 44 | 11 0 | | |
| | | 45 | 11 15 | 45 | 11 15 | | |
| | | 46 | 11 30 | 46 | 11 30 | | |
| | | 47 | 11 45 | 47 | 11 45 | | |
| | | 48 | 12 0 | 48 | 12 0 | | |
| | | 49 | 12 15 | 49 | 12 15 | | |
| | | 50 | 12 30 | 50 | 12 30 | | |
| | | 51 | 12 45 | 51 | 12 45 | | |
| | | 52 | 13 0 | 52 | 13 0 | | |
| | | 53 | 13 15 | 53 | 13 15 | | |
| | | 54 | 13 30 | 54 | 13 30 | | |
| | | 55 | 13 45 | 55 | 13 45 | | |
| | | 56 | 14 0 | 56 | 14 0 | | |
| | | 57 | 14 15 | 57 | 14 15 | | |
| | | 58 | 14 30 | 58 | 14 30 | | |
| | | 59 | 14 45 | 59 | 14 45 | | |

## CORRECTION OF THE SUN'S DECLINATION AT NOON, AT SEA,

### FOR LONGITUDE AND FOR TIME

| Long. | Declination | | | | | | | | | | | | | | | | | | | Time from Noon |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0° | 2° | 4° | 6° | 8° | 10° | 12° | 14° | 16° | 17° | 18° | 19° | 20° | 21° | 21¼° | 22° | 22½° | 23° | 23¼° | |
| 0° | 0′ | 0′ | 0′ | 0′ | 0′ | 0′ | 0′ | 0′ | 0′ | 0′ | 0′ | 0′ | 0′ | 0′ | 0′ | 0′ | 0′ | 0′ | 0′ | 0h 0m |
| 10 | 0·7 | 0·7 | 0·7 | 0·6 | 0·6 | 0·6 | 0·6 | 0·5 | 0·5 | 0·5 | 0·4 | 0·4 | 0·3 | 0·3 | 0·3 | 0·2 | 0·2 | 0·2 | 0·1 | 0 40 |
| 20 | 1·3 | 1·3 | 1·3 | 1·3 | 1·2 | 1·2 | 1·1 | 1·0 | 1·0 | 0·9 | 0·9 | 0·8 | 0·7 | 0·6 | 0·6 | 0·5 | 0·4 | 0·3 | 0·2 | 1 20 |
| 30 | 2·0 | 2·0 | 1·9 | 1·9 | 1·8 | 1·8 | 1·7 | 1·6 | 1·5 | 1·4 | 1·3 | 1·2 | 1·0 | 0·9 | 0·8 | 0·7 | 0·6 | 0·4 | 0·3 | 2 0 |
| 40 | 2·6 | 2·6 | 2·6 | 2·5 | 2·5 | 2·4 | 2·3 | 2·1 | 2·0 | 1·8 | 1·7 | 1·6 | 1·4 | 1·2 | 1·0 | 0·9 | 0·8 | 0·5 | 0·4 | 2 40 |
| 50 | 3·3 | 3·3 | 3·3 | 3·2 | 3·1 | 3·0 | 2·8 | 2·7 | 2·4 | 2·3 | 2·1 | 2·0 | 1·7 | 1·5 | 1·3 | 1·1 | 1·0 | 0·6 | 0·4 | 3 20 |
| 60 | 3·9 | 3·9 | 3·9 | 3·8 | 3·7 | 3·6 | 3·4 | 3·2 | 2·9 | 2·8 | 2·6 | 2·4 | 2·1 | 1·8 | 1·6 | 1·4 | 1·2 | 0·8 | 0·5 | 4 0 |
| 70 | 4·6 | 4·6 | 4·5 | 4·5 | 4·3 | 4·2 | 4·0 | 3·7 | 3·4 | 3·2 | 3·0 | 2·8 | 2·4 | 2·1 | 1·8 | 1·6 | 1·4 | 0·9 | 0·6 | 4 40 |
| 80 | 5·2 | 5·2 | 5·1 | 5·1 | 5·0 | 4·8 | 4·5 | 4·2 | 3·9 | 3·7 | 3·4 | 3·2 | 2·8 | 2·4 | 2·1 | 1·9 | 1·6 | 1·0 | 0·7 | 5 20 |
| 90 | 5·9 | 5·9 | 5·8 | 5·7 | 5·6 | 5·4 | 5·1 | 4·8 | 4·4 | 4·1 | 3·9 | 3·6 | 3·2 | 2·7 | 2·4 | 2·1 | 1·8 | 1·1 | 0·8 | 6 0 |
| 100 | 6·5 | 6·5 | 6·4 | 6·3 | 6·2 | 6·0 | 5·7 | 5·3 | 4·8 | 4·6 | 4·3 | 3·9 | 3·6 | 3·0 | 2·7 | 2·3 | 2·0 | 1·3 | 0·9 | 6 40 |
| 110 | 7·2 | 7·2 | 7·1 | 7·0 | 6·8 | 6·6 | 6·3 | 5·9 | 5·3 | 5·0 | 4·8 | 4·3 | 3·9 | 3·3 | 3·0 | 2·5 | 2·2 | 1·4 | 0·9 | 7 20 |
| 120 | 7·8 | 7·8 | 7·7 | 7·6 | 7·4 | 7·2 | 6·8 | 6·4 | 5·8 | 5·5 | 5·2 | 4·7 | 4·3 | 3·6 | 3·2 | 2·8 | 2·4 | 1·5 | 1·0 | 8 0 |
| 130 | 8·5 | 8·5 | 8·4 | 8·3 | 8·0 | 7·8 | 7·4 | 7·0 | 6·2 | 5·9 | 5·6 | 5·1 | 4·6 | 3·9 | 3·5 | 3·0 | 2·6 | 1·6 | 1·1 | 8 40 |
| 140 | 9·1 | 9·1 | 9·0 | 8·9 | 8·7 | 8·3 | 8·0 | 7·5 | 6·7 | 6·4 | 6·0 | 5·5 | 5·0 | 4·2 | 3·8 | 3·3 | 2·8 | ·8 | 1·2 | 9 20 |
| 150 | 9·8 | 9·8 | 9·7 | 9·5 | 9·3 | 9·0 | 8·5 | 8·0 | 7·2 | 6·8 | 6·5 | 5·9 | 5·3 | 4·4 | 4·1 | 3·5 | 3·0 | 1·9 | 1·3 | 10 0 |
| 160 | 10·5 | 10·4 | 10·3 | 10·2 | 9·9 | 9·6 | 9·1 | 8·6 | 7·7 | 7·3 | 6·9 | 6·3 | 5·7 | 4·7 | 4·4 | 3·7 | 3·2 | 2·0 | 1·4 | 10 40 |
| 170 | 11·1 | 11·1 | 11·0 | 10·8 | 10·5 | 10·2 | 9·7 | 9·1 | 8·2 | 7·8 | 7·4 | 6·7 | 6·0 | 5·1 | 4·6 | 4·0 | 3·4 | 2·2 | 1·5 | 11 20 |
| 180 | 11·8 | 11·7 | 11·6 | 11·4 | 11·1 | 10·8 | 10·3 | 9·6 | 8·8 | 8·3 | 7·9 | 7·2 | 6·4 | 5·5 | 4·9 | 4·3 | 3·6 | 2·3 | 1·6 | 12 0 |

**In W. Long**
When the Declin. is { *increasing*, add. / *decreasing*, sub.

**In E. Long.**
When the Declin. is { *increasing*, sub. / *decreasing*, add.

For Time, when the Declin. is *increasing*, add , when the Declin. is *decreasing*, sub.

# TABLE 20

## CORRECTION OF THE EQUATION OF TIME, AT NOON, AT SEA,

### FOR LONGITUDE AND FOR TIME

| Long. | Daily Variation | | | | | | | | | | | | | | | | Time from Noon |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0s | 2s | 4s | 6s | 8s | 10s | 12s | 14s | 16s | 18s | 20s | 22s | 24s | 26s | 28s | 30s | |
| 0° | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0h 0m |
| 10 | 0 | 0·1 | 0·1 | 0·2 | 0·2 | 0·3 | 0·3 | 0·4 | 0·4 | 0·5 | 0·6 | 0·6 | 0·7 | 0·7 | 0·8 | 0·8 | 0 40 |
| 20 | 0 | 0·1 | 0·2 | 0·3 | 0·4 | 0·6 | 0·7 | 0·8 | 0·9 | 1·0 | 1·1 | 1·2 | 1·3 | 1·4 | 1·5 | 1·7 | 1 20 |
| 30 | 0 | 0·2 | 0·3 | 0·5 | 0·7 | 0·8 | 1·0 | 1·2 | 1·3 | 1·5 | 1·7 | 1·8 | 2·0 | 2·2 | 2·3 | 2·5 | 2 0 |
| 40 | 0 | 0·2 | 0·4 | 0·7 | 0·9 | 1·1 | 1·3 | 1·6 | 1·8 | 2·0 | 2·2 | 2·4 | 2·7 | 2·9 | 3·1 | 3·3 | 2 40 |
| 50 | 0 | 0·3 | 0·6 | 0·8 | 1·1 | 1·4 | 1·7 | 1·9 | 2·2 | 2·5 | 2·8 | 3·1 | 3·3 | 3·6 | 3·9 | 4·2 | 3 20 |
| 60 | 0 | 0·3 | 0·7 | 1·0 | 1·3 | 1·7 | 2·0 | 2·3 | 2·7 | 3·0 | 3·3 | 3·7 | 4·0 | 4·3 | 4·7 | 5·0 | 4 0 |
| 70 | 0 | 0·4 | 0·8 | 1·2 | 1·6 | 1·9 | 2·3 | 2·7 | 3·1 | 3·5 | 3·9 | 4·3 | 4·7 | 5·1 | 5·4 | 5·8 | 4 40 |
| 80 | 0 | 0·4 | 0·9 | 1·3 | 1·8 | 2·2 | 2·7 | 3·1 | 3·6 | 4·0 | 4·4 | 4·9 | 5·3 | 5·8 | 6·2 | 6·7 | 5 20 |
| 90 | 0 | 0·5 | 1·0 | 1·5 | 2·0 | 2·5 | 3·0 | 3·5 | 4·0 | 4·5 | 5·0 | 5·5 | 6·0 | 6·5 | 7·0 | 7·4 | 6 0 |
| 100 | 0 | 0·6 | 1·1 | 1·7 | 2·2 | 2·8 | 3·3 | 3·9 | 4·4 | 5·0 | 5·6 | 6·1 | 6·7 | 7·2 | 7·8 | 8·3 | 6 40 |
| 110 | 0 | 0·6 | 1·2 | 1·8 | 2·4 | 3·1 | 3·7 | 4·3 | 4·9 | 5·5 | 6·1 | 6·7 | 7·3 | 7·9 | 8·6 | 9·2 | 7 20 |
| 120 | 0 | 0·7 | 1·3 | 2·0 | 2·7 | 3·3 | 4·0 | 4·7 | 5·3 | 6·0 | 6·7 | 7·3 | 8·0 | 8·7 | 9·3 | 10·0 | 8 0 |
| 130 | 0 | 0·7 | 1·4 | 2·2 | 2·9 | 3·6 | 4·3 | 5·1 | 5·8 | 6·5 | 7·2 | 7·9 | 8·7 | 9·4 | 10·1 | 10·8 | 8 40 |
| 140 | 0 | 0·8 | 1·6 | 2·3 | 3·1 | 3·9 | 4·7 | 5·4 | 6·2 | 7·0 | 7·8 | 8·6 | 9·3 | 10·1 | 10·9 | 11·7 | 9 20 |
| 150 | 0 | 0·8 | 1·7 | 2·5 | 3·3 | 4·2 | 5·0 | 5·8 | 6·7 | 7·5 | 8·3 | 9·2 | 10·0 | 10·8 | 11·7 | 12·5 | 10 10 |
| 160 | 0 | 0·9 | 1·8 | 2·7 | 3·6 | 4·4 | 5·3 | 6·2 | 7·1 | 8·0 | 8·9 | 9·8 | 10·7 | 11·6 | 12·4 | 13·3 | 10 40 |
| 170 | 0 | 0·9 | 1·9 | 2·8 | 3·8 | 4·7 | 5·7 | 6·6 | 7·6 | 8·5 | 9·4 | 10·4 | 11·3 | 12·3 | 13·2 | 14·2 | 11 20 |
| 180 | 0 | 1·0 | 2·0 | 3·0 | 4·0 | 5·0 | 6·0 | 7·0 | 8·0 | 9·0 | 10·0 | 11·0 | 12·0 | 13·0 | 14·0 | 15·0 | 12 0 |

**In W. Long.**
When the Equat. is { *increasing*, add. / *decreasing*, sub.

**In E. Long.**
When the Equat. is { *increasing*, sub. / *decreasing*, add.

For Time, when the Equat. is *increasing*, add , when the Equat. is *decreasing*, sub.

## FOR REDUCING DAILY AND TWELVE-HOURLY VARIATIONS

| Interval 24ʰ | Interval 12ʰ | Variation in 24ʰ or in 12ʰ: 1′ 0″ | 1′ 30″ | 2′ 0″ | 2′ 30″ | 3′ 0″ | 3′ 30″ | 4′ 0″ | 4′ 30″ | 5′ 0″ | 5′ 30″ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0ʰ 0ᵐ | 0ʰ 0ᵐ | 0′ 0″ | 0′ 0″ | 0′ 0″ | 0′ 0″ | 0′ 0″ | 0′ 0″ | 0′ 0″ | 0′ 0″ | 0′ 0″ | 0′ 0″ |
| 30 | 15 | 0 1·2 | 0 1·9 | 0 2·5 | 0 3·1 | 0 3·7 | 0 4·4 | 0 5 | 0 5·6 | 0 6·2 | 0 6·9 |
| 1 0 | 30 | 0 2·5 | 0 3·7 | 0 5 | 0 6·2 | 0 7·5 | 0 8·7 | 0 10 | 0 11·2 | 0 12·5 | 0 13·7 |
| 30 | 45 | 0 3·7 | 0 5·6 | 0 7·5 | 0 9·4 | 0 11·2 | 0 13·1 | 0 15 | 0 16·9 | 0 18·7 | 0 20·6 |
| 2 0 | 1 0 | 0 5 | 0 7·5 | 0 10 | 0 12·5 | 0 15 | 0 17·5 | 0 20 | 0 22·5 | 0 25 | 0 27·5 |
| 30 | 15 | 0 6·2 | 0 9·3 | 0 12·5 | 0 15·6 | 0 18·7 | 0 21·9 | 0 25 | 0 28·1 | 0 31·2 | 0 34·4 |
| 3 0 | 30 | 0 7·5 | 0 11·2 | 0 15 | 0 18·7 | 0 22·5 | 0 26·2 | 0 30 | 0 33·7 | 0 37·5 | 0 41·2 |
| 30 | 45 | 0 8·7 | 0 13·1 | 0 17·5 | 0 21·9 | 0 26·2 | 0 30·6 | 0 35 | 0 39·4 | 0 43·7 | 0 48·1 |
| 4 0 | 2 0 | 0 10 | 0 15 | 0 20 | 0 25 | 0 30 | 0 35 | 0 40 | 0 45 | 0 50 | 0 55 |
| 30 | 15 | 0 11·2 | 0 16·8 | 0 22·5 | 0 28·1 | 0 33·7 | 0 39·4 | 0 45 | 0 50·6 | 0 56·2 | 1 1·9 |
| 5 0 | 30 | 0 12·5 | 0 18·7 | 0 25 | 0 31·2 | 0 37·5 | 0 43·7 | 0 50 | 0 56·2 | 1 2·5 | 1 8·7 |
| 30 | 45 | 0 13·7 | 0 20·6 | 0 27·5 | 0 34·4 | 0 41·2 | 0 48·1 | 0 55 | 1 1·9 | 1 8·7 | 1 15·6 |
| 6 0 | 3 0 | 0 15 | 0 22·5 | 0 30 | 0 37·5 | 0 45 | 0 52·5 | 1 0 | 1 7·5 | 1 15 | 1 22·5 |
| 30 | 15 | 0 16·2 | 0 24·4 | 0 32·5 | 0 40·6 | 0 48·7 | 0 56·9 | 1 5 | 1 13·1 | 1 21·2 | 1 29·4 |
| 7 0 | 30 | 0 17·5 | 0 26·2 | 0 35 | 0 43·7 | 0 52·5 | 1 1·2 | 1 10 | 1 18·7 | 1 27·5 | 1 36·2 |
| 30 | 45 | 0 18·7 | 0 28·1 | 0 37·5 | 0 46·9 | 0 56·2 | 1 5·6 | 1 15 | 1 24·4 | 1 33·7 | 1 43·1 |
| 8 0 | 4 0 | 0 20 | 0 30 | 0 40 | 0 50 | 1 0 | 1 10 | 1 20 | 1 30 | 1 40 | 1 50 |
| 30 | 15 | 0 21·2 | 0 31·9 | 0 42·5 | 0 53·1 | 1 3·7 | 1 14·4 | 1 25 | 1 35·6 | 1 46·2 | 1 56·9 |
| 9 0 | 30 | 0 22·5 | 0 33·7 | 0 45 | 0 56·2 | 1 7·5 | 1 18·7 | 1 30 | 1 41·2 | 1 52·5 | 2 3·7 |
| 30 | 45 | 0 23·7 | 0 35·6 | 0 47·5 | 0 59·3 | 1 11·2 | 1 23·1 | 1 35 | 1 46·9 | 1 58·7 | 2 10·6 |
| 10 0 | 5 0 | 0 25 | 0 37·5 | 0 50 | 1 2·4 | 1 15 | 1 27·5 | 1 40 | 1 52·5 | 2 5 | 2 17·5 |
| 30 | 15 | 0 26·2 | 0 39·4 | 0 52·5 | 1 5·6 | 1 18·7 | 1 31·9 | 1 45 | 1 58·1 | 2 11·2 | 2 24·4 |
| 11 0 | 30 | 0 27·5 | 0 41·2 | 0 55 | 1 8·7 | 1 22·5 | 1 36·2 | 1 50 | 2 3·7 | 2 17·5 | 2 31·2 |
| 30 | 45 | 0 28·7 | 0 43·1 | 0 57·5 | 1 11·8 | 1 26·2 | 1 40·6 | 1 55 | 2 9·4 | 2 23·7 | 2 38·1 |
| 12 0 | 6 0 | 0 30 | 0 45 | 1 0 | 1 15 | 1 30 | 1 45 | 2 0 | 2 15 | 2 30 | 2 45 |
| 30 | 15 | 0 31·2 | 0 46·9 | 1 2·5 | 1 18·1 | 1 33·7 | 1 49·4 | 2 5 | 2 20·6 | 2 36·2 | 2 51·9 |
| 13 0 | 30 | 0 32·5 | 0 48·7 | 1 5 | 1 21·4 | 1 37·5 | 1 53·7 | 2 10 | 2 26·2 | 2 42·5 | 2 58·7 |
| 30 | 45 | 0 33·7 | 0 50·6 | 1 7·5 | 1 24·4 | 1 41·2 | 1 58·1 | 2 15 | 2 31·9 | 2 48·7 | 3 5·6 |
| 14 0 | 7 0 | 0 35 | 0 52·5 | 1 10 | 1 27·5 | 1 45 | 2 2·5 | 2 20 | 2 37·5 | 2 55 | 3 12·5 |
| 30 | 15 | 0 36·2 | 0 54·4 | 1 12·5 | 1 30·6 | 1 48·7 | 2 6·9 | 2 25 | 2 43·1 | 3 1·2 | 3 19·4 |
| 15 0 | 30 | 0 37·5 | 0 56·2 | 1 15 | 1 33·7 | 1 52·5 | 2 11·2 | 2 30 | 2 48·7 | 3 7·5 | 3 26·2 |
| 30 | 45 | 0 38·7 | 0 58·1 | 1 17·5 | 1 36·8 | 1 56·2 | 2 15·6 | 2 35 | 2 54·4 | 3 13·7 | 3 33·1 |
| 16 0 | 8 0 | 0 40 | 1 0 | 1 20 | 1 40 | 2 0 | 2 20 | 2 40 | 3 0 | 3 20 | 3 40 |
| 30 | 15 | 0 41·2 | 1 1·9 | 1 22·5 | 1 43·1 | 2 3·7 | 2 24·4 | 2 45 | 3 5·6 | 3 26·2 | 3 46·9 |
| 17 0 | 30 | 0 42·5 | 1 3·7 | 1 25 | 1 46·2 | 2 7·5 | 2 28·7 | 2 50 | 3 11·2 | 3 32·5 | 3 53·7 |
| 30 | 45 | 0 43·7 | 1 5·6 | 1 27·5 | 1 49·3 | 2 11·2 | 2 33·1 | 2 55 | 3 16·9 | 3 38·7 | 4 0·6 |
| 18 0 | 9 0 | 0 45 | 1 7·5 | 1 30 | 1 52·5 | 2 15 | 2 37·5 | 3 0 | 3 22·5 | 3 45 | 4 7·5 |
| 30 | 15 | 0 46·2 | 1 9·3 | 1 32·5 | 1 55·6 | 2 18·7 | 2 41·9 | 3 5 | 3 28·1 | 3 51·2 | 4 14·4 |
| 19 0 | 30 | 0 47·5 | 1 11·2 | 1 35 | 1 58·7 | 2 22·5 | 2 46·2 | 3 10 | 3 33·7 | 3 57·5 | 4 21·2 |
| 30 | 45 | 0 48·7 | 1 13·1 | 1 37·5 | 2 1·9 | 2 26·2 | 2 50·6 | 3 15 | 3 39·4 | 4 3·7 | 4 28·1 |
| 20 0 | 10 0 | 0 50 | 1 15 | 1 40 | 2 5 | 2 30 | 2 55 | 3 20 | 3 45 | 4 10 | 4 35 |
| 30 | 15 | 0 51·2 | 1 16·8 | 1 42·5 | 2 8·1 | 2 33·7 | 2 59·4 | 3 25 | 3 50·6 | 4 16·2 | 4 41·9 |
| 21 0 | 30 | 0 52·5 | 1 18·7 | 1 45 | 2 11·2 | 2 37·5 | 3 3·7 | 3 30 | 3 56·2 | 4 22·5 | 4 48·7 |
| 30 | 45 | 0 53·7 | 1 20·6 | 1 47·5 | 2 14·3 | 2 41·2 | 3 8·1 | 3 35 | 4 1·9 | 4 28·7 | 4 55·6 |
| 22 0 | 11 0 | 0 55 | 1 22·5 | 1 50 | 2 17·4 | 2 45 | 3 12·5 | 3 40 | 4 7·5 | 4 35 | 5 2·5 |
| 30 | 15 | 0 56·2 | 1 24·4 | 1 52·5 | 2 20·6 | 2 48·7 | 3 16·9 | 3 45 | 4 13·1 | 4 41·2 | 5 9·4 |
| 23 0 | 30 | 0 57·5 | 1 26·2 | 1 55 | 2 23·7 | 2 52·5 | 3 21·2 | 3 50 | 4 18·7 | 4 47·5 | 5 16·2 |
| 30 | 45 | 0 58·7 | 1 28·1 | 1 57·5 | 2 26·8 | 2 56·2 | 3 25·6 | 3 55 | 4 24·4 | 4 53·7 | 5 23·1 |
| 24 0 | 12 0 | 1 0 | 1 30 | 2 0 | 2 30 | 3 0 | 3 30 | 4 0 | 4 30 | 5 0 | 5 30 |
| 30 | 15 | 1 1·2 | 1 31·9 | 2 2·5 | 2 33·1 | 3 3·7 | 3 34·4 | 4 5 | 4 35·6 | 5 6·2 | 5 36·9 |
| 25 0 | 30 | 1 2·5 | 1 33·7 | 2 5 | 2 36·2 | 3 7·5 | 3 38·7 | 4 10 | 4 41·2 | 5 12·5 | 5 43·7 |
| 30 | 45 | 1 3·7 | 1 35·6 | 2 7·5 | 2 39·4 | 3 11·2 | 3 43·1 | 4 15 | 4 46·9 | 5 18·7 | 5 50·6 |
| 26 0 | 13 0 | 1 5 | 1 37·5 | 2 10 | 2 42·5 | 3 15 | 3 47·5 | 4 20 | 4 52·5 | 5 25 | 5 57·5 |
| 30 | 15 | 1 6·2 | 1 39·4 | 2 12·5 | 2 45·6 | 3 18·7 | 3 51·9 | 4 25 | 4 58·1 | 5 31·2 | 6 4·4 |
| 27 0 | 30 | 1 7·5 | 1 41·2 | 2 15 | 2 48·7 | 3 22·5 | 3 56·2 | 4 30 | 5 3·7 | 5 37·5 | 6 11·2 |
| 30 | 45 | 1 8·7 | 1 43·1 | 2 17·5 | 2 51·9 | 3 26·2 | 4 0·6 | 4 35 | 5 9·4 | 5 43·7 | 6 18·1 |
| 28 0 | 14 0 | 1 10 | 1 45 | 2 20 | 2 55 | 3 30 | 4 5 | 4 40 | 5 15 | 5 50 | 6 25 |
| 30 | 15 | 1 11·2 | 1 46·9 | 2 22·5 | 2 58·1 | 3 33·7 | 4 9·4 | 4 45 | 5 20·6 | 5 56·2 | 6 31·9 |
| 29 0 | 30 | 1 12·5 | 1 48·7 | 2 25 | 3 1·2 | 3 37·5 | 4 13·7 | 4 50 | 5 26·2 | 6 2·5 | 6 38·7 |
| 30 | 45 | 1 13·7 | 1 50·6 | 2 27·5 | 3 4·3 | 3 41·2 | 4 18·1 | 4 55 | 5 31·9 | 6 8·7 | 6 45·6 |
| 30 0 | 15 0 | 1 15 | 1 52·5 | 2 30 | 3 7·5 | 3 45 | 4 22·5 | 5 0 | 5 37·5 | 6 15 | 6 52·5 |

## FOR REDUCING DAILY AND TWELVE-HOURLY VARIATIONS

| Interval 24ʰ | Interval 12ʰ | Variation in 24ʰ or in 12ʰ: 6′ 0″ | 6′ 30″ | 7′ 0″ | 7′ 30″ | 8′ 0″ | 8′ 30″ | 9′ 0″ | 9′ 30″ | 10′ 0″ | 10′ 30″ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0ʰ 0ᵐ | 0ʰ 0ᵐ | 0′ 0″ | 0′ 0″ | 0′ 0″ | 0′ 0″ | 0′ 0″ | 0′ 0″ | 0′ 0″ | 0′ 0″ | 0′ 0″ | 0′ 0″ |
| 30 | 15 | 0 7·5 | 0 8·1 | 0 8·7 | 0 9·4 | 0 10 | 0 10·6 | 0 11·2 | 0 11·9 | 0 12·5 | 0 13·1 |
| 1 0 | 30 | 0 15 | 0 16·2 | 0 17·5 | 0 18·7 | 0 20 | 0 21·2 | 0 22·5 | 0 23·7 | 0 25 | 0 26·2 |
| 30 | 45 | 0 22·5 | 0 24·4 | 0 26·2 | 0 28·1 | 0 30 | 0 31·9 | 0 33·7 | 0 35·6 | 0 37·5 | 0 39·4 |
| 2 0 | 1 0 | 0 30 | 0 32·5 | 0 35 | 0 37·5 | 0 40 | 0 42·5 | 0 45 | 0 47·5 | 0 50 | 0 52·5 |
| 30 | 15 | 0 37·5 | 0 40·6 | 0 43·7 | 0 46·9 | 0 50 | 0 53·1 | 0 56·2 | 0 59·4 | 1 2·5 | 1 5·6 |
| 3 0 | 30 | 0 45 | 0 48·7 | 0 52·5 | 0 56·2 | 1 0 | 1 3·7 | 1 7·5 | 1 11·2 | 1 15 | 1 18·7 |
| 30 | 45 | 0 52·5 | 0 56·9 | 1 1·2 | 1 5·6 | 1 10 | 1 14·4 | 1 18·7 | 1 23·1 | 1 27·5 | 1 31·9 |
| 4 0 | 2 0 | 1 0 | 1 5 | 1 10 | 1 15 | 1 20 | 1 25 | 1 30 | 1 35 | 1 40 | 1 45 |
| 30 | 15 | 1 7·5 | 1 13·1 | 1 18·7 | 1 24·4 | 1 30 | 1 35·6 | 1 41·2 | 1 46·9 | 1 52·5 | 1 58·1 |
| 5 0 | 30 | 1 15 | 1 21·2 | 1 27·5 | 1 33·7 | 1 40 | 1 46·2 | 1 52·5 | 1 58·7 | 2 5 | 2 11·2 |
| 30 | 45 | 1 22·5 | 1 29·4 | 1 36·2 | 1 43·1 | 1 50 | 1 56·9 | 2 3·7 | 2 10·6 | 2 17·5 | 2 24·4 |
| 6 0 | 3 0 | 1 30 | 1 37·5 | 1 45 | 1 52·5 | 2 0 | 2 7·5 | 2 15 | 2 22·5 | 2 30 | 2 37·5 |
| 30 | 15 | 1 37·5 | 1 45·6 | 1 53·7 | 2 1·9 | 2 10 | 2 18·1 | 2 26·2 | 2 34·4 | 2 42·5 | 2 50·6 |
| 7 0 | 30 | 1 45 | 1 53·7 | 2 2·5 | 2 11·2 | 2 20 | 2 28·7 | 2 37·5 | 2 46·2 | 2 55 | 3 3·7 |
| 30 | 45 | 1 52·5 | 2 1·9 | 2 11·2 | 2 20·6 | 2 30 | 2 39·4 | 2 48·7 | 2 58·1 | 3 7·5 | 3 16·9 |
| 8 0 | 4 0 | 2 0 | 2 10 | 2 20 | 2 30 | 2 40 | 2 50 | 3 0 | 3 10 | 3 20 | 3 30 |
| 30 | 15 | 2 7·5 | 2 18·1 | 2 28·7 | 2 39·4 | 2 50 | 3 0·6 | 3 11·2 | 3 21·9 | 3 32·5 | 3 43·1 |
| 9 0 | 30 | 2 15 | 2 26·2 | 2 37·5 | 2 48·7 | 3 0 | 3 11·2 | 3 22·5 | 3 33·7 | 3 44 | 3 56·2 |
| 30 | 45 | 2 22·5 | 2 34·4 | 2 46·2 | 2 58·1 | 3 10 | 3 21·9 | 3 33·7 | 3 45·6 | 3 57·5 | 4 9·4 |
| 10 0 | 5 0 | 2 30 | 2 42·5 | 2 55 | 3 7·5 | 3 20 | 3 32·5 | 3 45 | 3 57·5 | 4 10 | 4 22·5 |
| 30 | 15 | 2 37·5 | 2 50·6 | 3 3·7 | 3 16·9 | 3 30 | 3 43·1 | 3 56·2 | 4 9·4 | 4 22·5 | 4 35·6 |
| 11 0 | 30 | 2 45 | 2 58·7 | 3 12·5 | 3 26·2 | 3 40 | 3 53·7 | 4 7·5 | 4 21·2 | 4 35 | 4 48·7 |
| 30 | 45 | 2 52·5 | 3 6·9 | 3 21·2 | 3 35·6 | 5 50 | 4 4·4 | 4 18·7 | 4 33·1 | 4 47·5 | 5 1·9 |
| 12 0 | 6 0 | 3 0 | 3 15 | 3 30 | 3 45 | 4 0 | 4 15 | 4 30 | 4 45 | 5 0 | 5 15 |
| 30 | 15 | 3 7·5 | 3 23·1 | 3 38·7 | 3 54·4 | 4 10 | 4 25·6 | 4 41·2 | 4 56·9 | 5 12·5 | 5 28·1 |
| 13 0 | 30 | 3 15 | 3 31·2 | 3 47·5 | 4 3·7 | 4 20 | 4 36·2 | 4 52·5 | 5 8·7 | 5 25 | 5 41·2 |
| 30 | 45 | 3 22·5 | 3 39·4 | 3 56·2 | 4 13·1 | 4 30 | 4 46·9 | 5 3·7 | 5 20·6 | 5 37 5 | 5 54·4 |
| 14 0 | 7 0 | 3 30 | 3 47·5 | 4 5 | 4 22·5 | 4 40 | 4 57·5 | 5 15 | 5 32·5 | 5 50 | 6 7·5 |
| 30 | 15 | 3 37·5 | 3 55·6 | 4 13·7 | 4 31·9 | 4 50 | 5 8·1 | 5 26·2 | 5 44·4 | 6 2·5 | 6 20·6 |
| 15 0 | 30 | 3 45 | 4 3·7 | 4 22·5 | 4 41·2 | 5 0 | 5 18·7 | 5 37·5 | 5 56·2 | 6 15 | 6 33·7 |
| 30 | 45 | 3 52·5 | 4 11·9 | 4 31·2 | 4 50·6 | 5 10 | 5 29·4 | 5 48·7 | 6 8·1 | 6 27·5 | 6 46·9 |
| 16 0 | 8 0 | 4 0 | 4 20 | 4 40 | 5 0 | 5 20 | 5 40 | 6 0 | 6 20 | 6 40 | 7 0 |
| 30 | 15 | 4 7·5 | 4 28·1 | 4 48·7 | 5 9·4 | 5 30 | 5 50·6 | 6 11·2 | 6 31·9 | 6 52·5 | 7 13·1 |
| 17 0 | 30 | 4 15 | 4 36·2 | 4 57·5 | 5 18·7 | 5 40 | 6 1·2 | 6 22·5 | 6 43·7 | 7 5 | 7 26·2 |
| 30 | 45 | 4 22·5 | 4 44·4 | 5 6·2 | 5 28·1 | 5 50 | 6 11·9 | 6 33·7 | 6 55·6 | 7 17·5 | 7 39·4 |
| 18 0 | 9 0 | 4 30 | 4 52·5 | 5 15 | 5 37·5 | 6 0 | 6 22·5 | 6 45 | 7 7·5 | 7 30 | 7 52·5 |
| 30 | 15 | 4 37·5 | 5 0·6 | 5 23·7 | 5 46·9 | 6 10 | 6 33·1 | 6 56·2 | 7 19·4 | 7 42·5 | 8 5·6 |
| 19 0 | 30 | 4 45 | 5 8·7 | 5 32·5 | 5 56·2 | 6 20 | 6 43·7 | 7 7·5 | 7 31·2 | 7 55 | 8 18·7 |
| 30 | 45 | 4 52·5 | 5 16·9 | 5 41·2 | 6 5·6 | 6 30 | 6 54·4 | 7 18·7 | 7 43·1 | 8 7·5 | 8 31·9 |
| 20 0 | 10 0 | 5 0 | 5 25 | 5 50 | 6 15 | 6 40 | 7 5 | 7 30 | 7 55 | 8 20 | 8 45 |
| 30 | 15 | 5 7·5 | 5 33·1 | 5 58·7 | 6 24·4 | 6 50 | 7 15·6 | 7 41·2 | 8 7·9 | 8 32·5 | 8 58·1 |
| 21 0 | 30 | 5 15 | 5 41·2 | 6 7·5 | 6 33·7 | 7 0 | 7 26·2 | 7 52·5 | 8 18·7 | 8 44 | 9 11·2 |
| 30 | 45 | 5 22·5 | 5 49·4 | 6 16·2 | 6 43·1 | 7 10 | 7 36·9 | 8 3·7 | 8 30·6 | 8 57·5 | 9 24·4 |
| 22 0 | 11 0 | 5 30 | 5 57·5 | 6 25 | 6 52·5 | 7 20 | 7 47·5 | 8 15 | 8 42·5 | 9 10 | 9 37·5 |
| 30 | 15 | 5 37·5 | 6 5·6 | 6 33·7 | 7 1·9 | 7 30 | 7 58·1 | 8 26·2 | 8 54·4 | 9 22·5 | 9 50·6 |
| 23 0 | 30 | 5 45 | 6 13·7 | 6 42·5 | 7 11·2 | 7 40 | 8 8·7 | 8 37·5 | 9 6·2 | 9 35 | 10 3·7 |
| 30 | 45 | 5 52·5 | 6 21·9 | 6 51·2 | 7 20·6 | 7 50 | 8 19·4 | 8 48·7 | 9 18·1 | 9 47·5 | 10 16·9 |
| 24 0 | 12 0 | 6 0 | 6 30·5 | 7 0 | 7 30 | 8 0 | 8 30 | 9 0 | 9 30 | 10 0 | 10 30 |
| 30 | 15 | 6 7·5 | 6 38·1 | 7 8·7 | 7 39·4 | 8 10 | 8 40·6 | 9 11·2 | 9 41·9 | 10 12·5 | 10 43·1 |
| 25 0 | 30 | 6 15 | 6 46·2 | 7 17·5 | 7 48·7 | 8 20 | 8 51·2 | 9 28·5 | 9 53·7 | 10 25 | 10 56·2 |
| 30 | 45 | 6 22·5 | 6 54·4 | 7 26·2 | 7 58·1 | 8 30 | 9 1·9 | 9 33·7 | 10 5·6 | 10 37·5 | 11 9·4 |
| 26 0 | 13 0 | 6 30 | 7 2·5 | 7 35 | 8 7·5 | 8 40 | 9 12·5 | 9 45 | 10 17·5 | 10 50 | 11 22·5 |
| 30 | 15 | 6 37·5 | 7 10·6 | 7 43·7 | 8 16·9 | 8 50 | 9 23·1 | 9 56·2 | 10 29·4 | 11 2·5 | 11 35·6 |
| 27 0 | 30 | 6 45 | 7 18·7 | 7 52·5 | 8 26·2 | 9 0 | 9 33·7 | 10 7·5 | 10 41·2 | 11 15 | 11 48·7 |
| 30 | 45 | 6 52·5 | 7 26·9 | 8 ·2 | 8 35·6 | 9 10 | 9 44·4 | 10 18·7 | 10 53·1 | 11 27·5 | 12 1·9 |
| 28 0 | 14 0 | 7 0 | 7 35 | 8 10 | 8 45 | 9 20 | 9 55 | 10 30 | 11 5 | 11 40 | 12 15 |
| 30 | 15 | 7 7·5 | 7 43·1 | 8 18·7 | 8 54·4 | 9 30 | 10 5·6 | 10 41·2 | 11 16·9 | 11 52·5 | 12 28·1 |
| 29 0 | 30 | 7 15 | 7 51·2 | 8 27·5 | 9 3·7 | 9 40 | 10 16·2 | 10 52·5 | 11 28·7 | 12 5 | 12 41·2 |
| 30 | 45 | 7 22·5 | 7 59·4 | 8 36·2 | 9 13·1 | 9 50 | 10 26·9 | 11 3·7 | 11 40·6 | 12 17·5 | 12 54·4 |
| 30 0 | 15 0 | 7 30 | 8 7·5 | 8 45 | 9 22·5 | 10 0 | 10 37·5 | 11 15 | 11 52·5 | 12 30 | 13 7·5 |

## FOR REDUCING DAILY AND TWELVE-HOURLY VARIATIONS

| Interval 24ʰ | Interval 12ʰ | 11′ 0″ | 11′ 30″ | 12′ 0″ | 12′ 30″ | 13′ 0″ | 13′ 30″ | 14′ 0″ | 14′ 30″ | 15′ 0″ | 15′ 30″ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0ʰ 0ᵐ | 0ʰ 0ᵐ | 0′ 0″ | 0′ 0″ | 0′ 0″ | 0′ 0″ | 0′ 0″ | 0′ 0″ | 0′ 0″ | 0′ 0″ | 0′ 0″ | 0′ 0″ |
| 30 | 15 | 0 13·7 | 0 14·4 | 0 15 | 0 15·6 | 0 16·2 | 0 16·9 | 0 17·5 | 0 18·1 | 0 18·7 | 0 19·4 |
| 1 0 | 30 | 0 27·5 | 0 28·7 | 0 30 | 0 31·2 | 0 32·5 | 0 33·7 | 0 35 | 0 36·2 | 0 37·5 | 0 38·7 |
| 30 | 45 | 0 41·2 | 0 43·1 | 0 45 | 0 46·9 | 0 48·7 | 0 50·6 | 0 52·5 | 0 54·4 | 0 56·2 | 0 58·1 |
| 2 0 | 1 0 | 0 55 | 0 57·5 | 1 0 | 1 2·5 | 1 5 | 1 7·5 | 1 10 | 1 12·5 | 1 15 | 1 17·5 |
| 30 | 15 | 1 8·7 | 1 11·9 | 1 15 | 1 18·1 | 1 21·2 | 1 24·4 | 1 27·5 | 1 30·6 | 1 33·7 | 1 36·9 |
| 3 0 | 30 | 1 22·5 | 1 26·2 | 1 30 | 1 33·7 | 1 37·5 | 1 41·2 | 1 45 | 1 48·7 | 1 52·5 | 1 56·2 |
| 30 | 45 | 1 36·2 | 1 40·6 | 1 45 | 1 49·4 | 1 53·7 | 1 58·1 | 2 2·5 | 1 36·9 | 2 11·2 | 2 15·6 |
| 4 0 | 2 0 | 1 50 | 1 55 | 2 0 | 2 5 | 2 10 | 2 15 | 2 20 | 2 25 | 2 30 | 2 35 |
| 30 | 15 | 2 3·7 | 2 9·4 | 2 15 | 2 20·6 | 2 26·2 | 2 31·9 | 2 37·5 | 2 48·1 | 2 48·7 | 2 54·4 |
| 5 0 | 30 | 2 17·5 | 2 23·7 | 2 30 | 2 36·2 | 2 42·5 | 2 48·7 | 2 55 | 3 1·2 | 3 7·5 | 3 13·7 |
| 30 | 45 | 2 31·2 | 2 38·1 | 2 45 | 2 51·9 | 2 58·7 | 3 5·6 | 3 12·5 | 3 19·4 | 3 26·2 | 3 33·1 |
| 6 0 | 3 0 | 2 45 | 2 52·5 | 3 0 | 3 7·5 | 3 15 | 3 22·5 | 3 30 | 3 37·5 | 3 45 | 3 52·5 |
| 30 | 15 | 2 58·7 | 3 6·9 | 3 15 | 3 23·1 | 3 31·2 | 3 39·4 | 3 47·5 | 3 55·6 | 4 3·7 | 4 11·9 |
| 7 0 | 30 | 3 12·5 | 3 21·2 | 3 30 | 3 38·7 | 3 47·5 | 3 56·2 | 4 5 | 4 13·7 | 4 22·5 | 4 31·2 |
| 30 | 45 | 3 26·2 | 3 35·6 | 3 45 | 3 54·4 | 4 3·7 | 4 13·1 | 4 23·5 | 4 31·9 | 4 41·2 | 4 50·6 |
| 8 0 | 4 0 | 3 40 | 3 50 | 4 0 | 4 10 | 4 20 | 4 30 | 4 40 | 4 50 | 5 0 | 5 10 |
| 30 | 15 | 3 53·7 | 4 4·4 | 4 15 | 4 25·6 | 4 36·2 | 4 46·9 | 4 57·5 | 5 8·1 | 5 18·7 | 5 29·4 |
| 9 0 | 30 | 4 7·5 | 4 18·7 | 4 30 | 4 41·2 | 4 52·5 | 5 3·7 | 5 15 | 5 26·2 | 5 37·5 | 5 48·7 |
| 30 | 45 | 4 21·2 | 4 33·1 | 4 45 | 4 56·9 | 5 8·7 | 5 20·6 | 5 32·5 | 5 44·4 | 5 56·2 | 6 8·1 |
| 10 0 | 5 0 | 4 35 | 4 47·5 | 5 0 | 5 12·5 | 5 25 | 5 37·5 | 5 50 | 6 2·5 | 6 15 | 6 27·5 |
| 30 | 15 | 4 48·7 | 5 1·9 | 5 15 | 5 28·1 | 5 41·2 | 5 54·4 | 6 7·5 | 6 20·6 | 6 33·7 | 6 46·9 |
| 11 0 | 30 | 5 2·5 | 5 26·2 | 5 30 | 5 43·7 | 5 57·5 | 6 11·2 | 6 25 | 6 38·7 | 6 52·5 | 7 6·2 |
| 30 | 45 | 5 16·2 | 5 40·6 | 5 45 | 5 59·4 | 6 13·7 | 6 28·1 | 6 42·5 | 6 56·9 | 7 11·2 | 7 25·6 |
| 12 0 | 6 0 | 5 30 | 5 45 | 6 0 | 6 15 | 6 30 | 6 45 | 7 0 | 7 15 | 7 30 | 7 45 |
| 30 | 15 | 5 43·7 | 5 59·4 | 6 15 | 6 30·6 | 6 46·2 | 7 1·9 | 7 17·5 | 7 33·1 | 7 48·7 | 8 4·4 |
| 13 0 | 30 | 5 57·5 | 6 13·7 | 6 30 | 6 46·2 | 7 2·5 | 7 18·7 | 7 35 | 7 51·2 | 8 7·5 | 8 23·7 |
| 30 | 45 | 6 11·2 | 6 28·1 | 6 45 | 7 1·9 | 7 18·7 | 7 35·6 | 7 52·5 | 8 9·4 | 8 26·2 | 8 43·1 |
| 14 0 | 7 0 | 6 25 | 6 42·5 | 7 0 | 7 17·5 | 7 35 | 7 52·5 | 8 10 | 8 27·5 | 8 45 | 9 2·5 |
| 30 | 15 | 6 38·7 | 6 56·9 | 7 15 | 7 33·1 | 7 51·2 | 8 9·4 | 8 27·5 | 8 45·6 | 9 3·7 | 9 21·9 |
| 15 0 | 30 | 6 52·5 | 7 11·2 | 7 30 | 7 48·7 | 8 7·5 | 8 26·2 | 8 45 | 9 3·7 | 9 22·5 | 9 41·2 |
| 30 | 45 | 7 6·2 | 7 25·6 | 7 45 | 8 4·4 | 8 23·7 | 8 43·1 | 9 2·5 | 9 21·9 | 9 41·2 | 10 0·6 |
| 16 0 | 8 0 | 7 20 | 7 40 | 8 0 | 8 20 | 8 40 | 9 0 | 9 20 | 9 40 | 10 0 | 10 20 |
| 30 | 15 | 7 33·7 | 7 54·4 | 8 15 | 8 35·6 | 8 56·2 | 9 16·9 | 9 37·5 | 9 58·1 | 10 18·7 | 10 39·4 |
| 17 0 | 30 | 7 47·5 | 8 8·7 | 8 30 | 8 51·2 | 9 12·5 | 9 33·7 | 9 55 | 10 16·2 | 10 37·5 | 10 58·7 |
| 30 | 45 | 8 1·2 | 8 23·1 | 8 45 | 9 6·9 | 9 28·7 | 9 50·6 | 10 12·5 | 10 34·4 | 10 56·2 | 11 18·1 |
| 18 0 | 9 0 | 8 15 | 8 37·5 | 9 0 | 9 22·5 | 9 45 | 10 7·5 | 10 30 | 10 52·5 | 11 15 | 11 37·5 |
| 30 | 15 | 8 28·7 | 8 51·9 | 9 15 | 9 38·1 | 10 1·2 | 10 24·4 | 10 47·5 | 11 10·6 | 11 33·7 | 11 56·9 |
| 19 0 | 30 | 8 42·5 | 9 6·2 | 9 30 | 9 53·7 | 10 17·5 | 10 41·2 | 11 5 | 11 28·7 | 11 52·5 | 12 16·2 |
| 30 | 45 | 8 56·2 | 9 20·6 | 9 45 | 10 9·4 | 10 33·7 | 10 58·1 | 11 23·5 | 11 46·9 | 12 11·2 | 12 35·6 |
| 20 0 | 10 0 | 9 10 | 9 35 | 10 0 | 10 25 | 10 50 | 11 15 | 11 40 | 12 5 | 12 30 | 12 55 |
| 30 | 15 | 9 23·7 | 9 49·4 | 10 15 | 10 40·6 | 11 6·2 | 11 31·9 | 11 57·5 | 12 23·1 | 12 48·7 | 13 14·4 |
| 21 0 | 30 | 9 37·5 | 10 3·7 | 10 30 | 10 56·2 | 11 22·5 | 11 48·7 | 12 15 | 12 41·2 | 13 7·5 | 13 33·7 |
| 30 | 45 | 9 51·2 | 10 18·1 | 10 45 | 11 11·9 | 11 38·7 | 12 5·6 | 12 32·5 | 12 59·4 | 13 26·2 | 13 53·1 |
| 22 0 | 11 0 | 10 5 | 10 32·5 | 11 0 | 11 27·5 | 11 55 | 12 22·5 | 12 50 | 13 17·5 | 13 45 | 14 12·5 |
| 30 | 15 | 10 18·7 | 10 46·9 | 11 15 | 11 43·1 | 12 11·2 | 12 39·4 | 13 7·5 | 13 35·6 | 14 3·7 | 14 31·9 |
| 23 0 | 30 | 10 32·5 | 11 1·2 | 11 30 | 11 58·7 | 12 27·5 | 12 56·2 | 13 25 | 13 53·7 | 14 22·5 | 14 51·2 |
| 30 | 45 | 10 46·2 | 11 15·6 | 11 45 | 12 14·4 | 12 43·7 | 13 13·1 | 13 42·5 | 14 11·9 | 14 41·2 | 15 10·6 |
| 24 0 | 12 0 | 11 0 | 11 30 | 12 0 | 12 30 | 13 0 | 13 30 | 14 0 | 14 30 | 15 0 | 15 30 |
| 30 | 15 | 11 13·7 | 11 44·4 | 12 15 | 12 45·6 | 13 16·2 | 13 46·9 | 14 17·5 | 14 48·1 | 15 18·7 | 15 49·4 |
| 25 0 | 30 | 11 27·5 | 11 58·7 | 12 30 | 13 1·2 | 13 32·5 | 14 3·7 | 14 35 | 15 6·2 | 15 37·5 | 16 8·7 |
| 30 | 45 | 11 41·2 | 12 13·1 | 12 45 | 13 16·9 | 13 48·7 | 14 20·6 | 14 52·5 | 15 24·4 | 15 56·2 | 16 28·1 |
| 26 0 | 13 0 | 11 55 | 12 27·5 | 13 0 | 13 32·5 | 14 5 | 14 37·5 | 15 10 | 15 42·5 | 16 15 | 16 47·5 |
| 30 | 15 | 12 8·7 | 12 41·9 | 13 15 | 13 48·1 | 14 21·2 | 14 54·4 | 15 27·5 | 16 0·6 | 16 33·7 | 17 6·9 |
| 27 0 | 30 | 12 22·5 | 12 56·2 | 13 30 | 14 3·7 | 14 37·5 | 15 11·2 | 15 45 | 16 18·7 | 16 52·5 | 17 26·2 |
| 30 | 45 | 12 36·2 | 13 10·6 | 13 45 | 14 19·4 | 14 53·7 | 15 28·1 | 16 2·5 | 16 36·9 | 17 11·2 | 17 45·6 |
| 28 0 | 14 0 | 12 50 | 13 25 | 14 0 | 14 35 | 15 10 | 15 45 | 16 20 | 16 55 | 17 30 | 18 5 |
| 30 | 15 | 13 3·7 | 13 39·4 | 14 15 | 14 50·6 | 15 26·2 | 16 1·9 | 16 37·5 | 17 13·1 | 17 48·7 | 18 24·4 |
| 29 0 | 30 | 13 17·5 | 13 53·7 | 14 30 | 15 6·2 | 15 42·5 | 16 18·7 | 16 55 | 17 31·2 | 18 7·5 | 18 43·7 |
| 30 | 45 | 13 31·2 | 14 8·1 | 14 45 | 15 21·9 | 15 58·7 | 16 35·6 | 17 12·5 | 17 49·4 | 18 26·2 | 19 3·1 |
| 30 0 | 15 0 | 13 45 | 14 22·5 | 15 0 | 15 37·5 | 16 15 | 16 52·5 | 17 30 | 18 7·5 | 18 45 | 19 22·5 |

## FOR REDUCING DAILY AND TWELVE-HOURLY VARIATIONS

| Interval 24ʰ | Interval 12ʰ | Variation in 24ʰ or in 12ʰ: 16′ 0″ | 16′ 30″ | 17′ 0″ | 17′ 30″ | 18′ 0″ | 18′ 30″ | 19′ 0″ | 19′ 30″ | 20′ 0″ | 20′ 30″ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0ʰ 0ᵐ | 0ʰ 0ᵐ | 0′ 0″ | 0′ 0″ | 0′ 0″ | 0′ 0″ | 0′ 0″ | 0′ 0″ | 0′ 0″ | 0′ 0″ | 0 0″ | 0′ 0″ |
| 30 | 15 | 0 20 | 0 20·6 | 0 21·2 | 0 21·9 | 0 22·5 | 0 23·1 | 0 23·7 | 0 24·4 | 0 25 | 0 25·6 |
| 1 0 | 30 | 0 40 | 0 41·2 | 0 42·5 | 0 43·7 | 0 45 | 0 46·2 | 0 47·5 | 0 48·7 | 0 50 | 0 51·2 |
| 30 | 45 | 1 0 | 1 1·9 | 1 3·7 | 1 5·6 | 1 7·5 | 1 9·4 | 1 11·2 | 1 13·1 | 1 15 | 1 16·9 |
| 2 0 | 1 0 | 1 20 | 1 22·5 | 1 25 | 1 27·5 | 1 30 | 1 32·5 | 1 35 | 1 37·5 | 1 40 | 1 42·5 |
| 30 | 15 | 1 40 | 1 43·1 | 1 46·2 | 1 49·4 | 1 52·5 | 1 55·6 | 1 58·7 | 2 1·9 | 2 5 | 2 8·1 |
| 3 0 | 30 | 2 0 | 2 3·7 | 2 7·5 | 2 11·2 | 2 15 | 2 18·7 | 2 22·5 | 2 26·2 | 2 30 | 2 33·7 |
| 30 | 45 | 2 20 | 2 24·4 | 2 28·7 | 2 33·1 | 2 37·5 | 2 41·9 | 2 46·2 | 2 50·6 | 2 55 | 2 59·4 |
| 4 0 | 2 0 | 2 40 | 2 45 | 2 50 | 2 55 | 3 0 | 3 5 | 3 10 | 3 15 | 3 20 | 3 25 |
| 30 | 15 | 3 0 | 3 5·6 | 3 11·2 | 3 16·9 | 3 22·5 | 3 28·1 | 3 33·7 | 3 39·4 | 3 45 | 3 50·6 |
| 5 0 | 30 | 3 20 | 3 26·2 | 3 32·5 | 3 38·7 | 3 45 | 3 51·2 | 3 57·5 | 4 3·7 | 4 10 | 4 16·2 |
| 30 | 45 | 3 40 | 3 46·9 | 3 53·7 | 4 10·6 | 4 7·5 | 4 14·4 | 4 21·2 | 4 28·1 | 4 35 | 4 41·9 |
| 6 0 | 3 0 | 4 0 | 4 7·5 | 4 15 | 4 22·5 | 4 30 | 4 37·5 | 4 45 | 4 52·5 | 5 0 | 5 7·5 |
| 30 | 15 | 4 20 | 4 28·1 | 4 36·2 | 4 44·4 | 4 52·5 | 5 0·6 | 5 8·7 | 5 16·9 | 5 25 | 5 33·1 |
| 7 0 | 30 | 4 40 | 4 48·7 | 4 57·5 | 5 6·2 | 5 15 | 5 23·7 | 5 32·5 | 5 41·2 | 5 50 | 5 58·7 |
| 30 | 45 | 5 0 | 5 9·4 | 5 18·7 | 5 28·1 | 5 37·5 | 5 46·9 | 5 56·2 | 6 5·6 | 6 15 | 6 24·4 |
| 8 0 | 4 0 | 5 20 | 5 30 | 5 40 | 5 50 | 6 0 | 6 10 | 6 20 | 6 30 | 6 40 | 6 50 |
| 30 | 15 | 5 40 | 5 50·6 | 6 1·2 | 6 11·9 | 6 22·5 | 6 33·1 | 6 43·7 | 6 54·4 | 7 5 | 7 15·6 |
| 9 0 | 30 | 6 0 | 6 11·2 | 6 22·5 | 6 33·7 | 6 45 | 6 56·2 | 7 7·5 | 7 18·7 | 7 30 | 7 41·2 |
| 30 | 45 | 6 20 | 6 31·9 | 6 43·7 | 6 55·6 | 7 7·5 | 7 19·4 | 7 31·2 | 7 43·1 | 7 55 | 8 6·9 |
| 10 0 | 5 0 | 6 40 | 6 52·5 | 7 5 | 7 17·5 | 7 30 | 7 42·5 | 7 55 | 8 7·5 | 8 20 | 8 32·5 |
| 30 | 15 | 7 0 | 7 13·1 | 7 26·2 | 7 39·4 | 7 52·5 | 8 5·6 | 8 18·7 | 8 31·9 | 8 45 | 8 58·1 |
| 11 0 | 30 | 7 20 | 7 33·7 | 7 47·5 | 8 11·2 | 8 15 | 8 28·7 | 8 42·5 | 8 56·2 | 9 10 | 9 23·7 |
| 30 | 45 | 7 40 | 7 54·4 | 8 8·7 | 8 23·1 | 8 37·5 | 8 51·9 | 9 6·2 | 9 20·6 | 9 35 | 9 49·4 |
| 12 0 | 6 0 | 8 0 | 8 15 | 8 30 | 8 45 | 9 0 | 9 15 | 9 30 | 9 45 | 10 0 | 10 15 |
| 30 | 15 | 8 20 | 8 35·6 | 8 51·2 | 9 6·9 | 9 22·5 | 9 38·1 | 9 53·7 | 10 9·4 | 10 25 | 10 40·6 |
| 13 0 | 30 | 8 40 | 8 56·2 | 9 12·5 | 9 28·7 | 9 45 | 10 1·2 | 10 17·5 | 10 33·7 | 10 50 | 11 6·2 |
| 30 | 45 | 9 0 | 9 16·9 | 9 33·7 | 9 50·6 | 10 7·5 | 10 24·4 | 10 41·2 | 10 58·1 | 11 15 | 11 31·9 |
| 14 0 | 7 0 | 9 20 | 9 37·5 | 9 55 | 10 12·5 | 10 30 | 10 47·5 | 11 5 | 11 22·5 | 11 40 | 11 57·5 |
| 30 | 15 | 9 40 | 9 58·1 | 10 16·2 | 10 54·4 | 10 52·5 | 11 10·6 | 11 28·7 | 11 46·9 | 12 5 | 12 23·1 |
| 15 0 | 30 | 10 0 | 10 18·7 | 10 37·5 | 10 56·2 | 11 15 | 11 33·7 | 11 52·5 | 12 11·2 | 12 30 | 12 48·7 |
| 30 | 45 | 10 20 | 10 39·4 | 10 58·7 | 11 18·1 | 11 37·5 | 11 56·9 | 12 16·2 | 12 35·6 | 12 55 | 13 14·4 |
| 16 0 | 8 0 | 10 40 | 11 0 | 11 20 | 11 40 | 12 0 | 12 20 | 12 40 | 13 0 | 13 20 | 13 40 |
| 30 | 15 | 11 0 | 11 20·6 | 11 41·2 | 12 1·9 | 12 22·5 | 12 43·1 | 13 3·7 | 13 24·4 | 13 45 | 14 5·6 |
| 17 0 | 30 | 11 20 | 11 41·2 | 12 2·5 | 12 23·7 | 12 45 | 13 6·2 | 13 27·5 | 13 48·7 | 14 10 | 14 31·2 |
| 30 | 45 | 11 40 | 12 1·9 | 12 23·7 | 12 45·6 | 13 7·5 | 13 29·4 | 13 51·2 | 14 13·1 | 14 35 | 14 56·9 |
| 18 0 | 9 0 | 12 0 | 12 22·5 | 12 45 | 13 7·5 | 13 30 | 13 52·5 | 14 15 | 14 37·5 | 15 0 | 15 22·5 |
| 30 | 15 | 12 20 | 12 43·1 | 13 6·2 | 13 29·4 | 13 52·5 | 14 15·6 | 14 38·7 | 15 1·9 | 15 25 | 15 48·1 |
| 19 0 | 30 | 12 40 | 13 3·7 | 13 27·5 | 13 51·2 | 14 15 | 14 38·7 | 15 2·5 | 15 26·2 | 15 50 | 16 13·7 |
| 30 | 45 | 13 0 | 13 24·4 | 13 48·7 | 14 13·1 | 14 37·5 | 15 1·9 | 15 26·2 | 15 50·6 | 16 15 | 16 39·4 |
| 20 0 | 10 0 | 13 20 | 13 45 | 14 10 | 14 35 | 15 0 | 15 25 | 15 50 | 16 15 | 16 40 | 17 5 |
| 30 | 15 | 13 40 | 14 5·6 | 14 31·2 | 14 56·9 | 15 22·5 | 15 48·1 | 16 13·7 | 16 39·4 | 17 5 | 17 30·6 |
| 21 0 | 30 | 14 0 | 14 26·2 | 14 52·5 | 15 18·7 | 15 45 | 16 11·2 | 16 37·5 | 17 3·7 | 17 30 | 17 56·2 |
| 30 | 45 | 14 20 | 14 46·9 | 15 13·7 | 15 40·6 | 16 7·5 | 16 34·4 | 17 1·2 | 17 28·1 | 17 55 | 18 21·9 |
| 22 0 | 11 0 | 14 40 | 15 7·5 | 15 35 | 16 2·5 | 16 30 | 16 57·5 | 17 25 | 17 52·5 | 18 20 | 18 47·5 |
| 30 | 15 | 15 0 | 15 28·1 | 15 56·2 | 16 24·4 | 16 52·5 | 17 20·6 | 17 48·7 | 18 16·9 | 18 45 | 19 13·1 |
| 23 0 | 30 | 15 20 | 15 48·7 | 16 17·5 | 16 46·2 | 17 15 | 17 43·7 | 18 12·5 | 18 41·2 | 19 10 | 19 38·7 |
| 30 | 45 | 15 40 | 16 9·4 | 16 38·7 | 17 8·1 | 17 37·5 | 18 6·9 | 18 36·2 | 19 5·6 | 19 35 | 20 4·4 |
| 24 0 | 12 0 | 16 0 | 16 30 | 17 0 | 17 30 | 18 0 | 18 30 | 19 0 | 19 30 | 20 0 | 20 30 |
| 30 | 15 | 16 20 | 16 50·6 | 17 21·2 | 17 51·9 | 18 22·5 | 18 53·1 | 19 23·7 | 19 54·4 | 20 25 | 20 55·6 |
| 25 0 | 30 | 16 40 | 17 11·2 | 17 42·5 | 18 13·7 | 18 45 | 19 16·2 | 19 47·5 | 20 18·7 | 20 50 | 21 21·2 |
| 30 | 45 | 17 0 | 17 31·9 | 18 3·7 | 18 35·6 | 19 7·5 | 19 39·4 | 20 11·2 | 20 43·1 | 21 15 | 21 46·9 |
| 26 0 | 13 0 | 17 20 | 17 52·5 | 18 25 | 18 57·5 | 19 30 | 20 2·5 | 20 35 | 21 7·5 | 21 40 | 22 12·5 |
| 30 | 15 | 17 40 | 18 13·1 | 18 46·2 | 19 19·4 | 19 52·5 | 20 15·6 | 20 58·7 | 21 31·9 | 22 5 | 22 38·1 |
| 27 0 | 30 | 18 0 | 18 33·7 | 19 7·5 | 19 41·2 | 20 15 | 20 48·7 | 21 22·5 | 21 56·2 | 22 30 | 23 3·7 |
| 30 | 45 | 18 20 | 18 54·4 | 19 28·7 | 20 3·1 | 20 37·5 | 21 11·9 | 21 46·2 | 22 20·6 | 22 55 | 23 29·4 |
| 28 0 | 14 0 | 18 40 | 19 15 | 19 50 | 20 25 | 21 0 | 21 35 | 22 10 | 22 45 | 23 20 | 23 55 |
| 30 | 15 | 19 0 | 19 35·6 | 20 11·2 | 20 46·9 | 21 22·5 | 21 58·1 | 22 33·7 | 23 9·4 | 23 45 | 24 20·6 |
| 29 0 | 30 | 19 20 | 19 56·2 | 20 32·5 | 21 8·7 | 21 45 | 22 21·2 | 22 57· | 23 33·7 | 24 10 | 24 46·2 |
| 30 | 45 | 19 40 | 20 16·9 | 20 53·7 | 21 30·6 | 22 7·5 | 22 44·4 | 23 21·2 | 23 58·1 | 24 35 | 25 11·9 |
| 30 0 | 15 0 | 20 0 | 20 37·5 | 21 15 | 21 52·5 | 22 30 | 23 7·5 | 23 45 | 24 22·5 | 25 0 | 25 37·5 |

## FOR REDUCING DAILY AND TWELVE-HOURLY VARIATIONS

| Interval 24h | Interval 12h | Variation in 24h or in 12h: 21′ 0″ | 21′ 30″ | 22′ 0″ | 22′ 30″ | 23′ 0″ | 23′ 30″ | 24′ 0″ | 24′ 30″ | 25′ 0″ | 25′ 30″ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0h 0m | 0h 0m | 0′ 0″ | 0′ 0″ | 0′ 0″ | 0′ 0″ | 0′ 0″ | 0′ 0″ | 0′ 0″ | 0′ 0″ | 0′ 0″ | 0′ 0″ |
| 30 | 15 | 0 26.2 | 0 26.9 | 0 27.5 | 0 28.1 | 0 28.7 | 0 29.4 | 0 30 | 0 30.6 | 0 31.2 | 0 31.9 |
| 1 0 | 30 | 0 52.5 | 0 53.7 | 0 55 | 0 56.2 | 0 57.5 | 0 58.7 | 1 0 | 1 1.2 | 1 2.5 | 1 3.7 |
| 30 | 45 | 1 18.7 | 1 20.6 | 1 22.5 | 1 24.4 | 1 26.2 | 1 28.1 | 1 30 | 1 31.9 | 1 33.7 | 1 35.6 |
| 2 0 | 1 0 | 1 45 | 1 47.5 | 1 50 | 1 52.5 | 1 55 | 1 57.5 | 2 0 | 2 2.5 | 2 5 | 2 7.5 |
| 30 | 15 | 2 11.2 | 2 14.4 | 2 17.5 | 2 20.6 | 2 23.7 | 2 26.9 | 2 30 | 2 33.1 | 2 36.2 | 2 39.4 |
| 3 0 | 30 | 2 37.5 | 2 41.2 | 2 45 | 2 48.7 | 2 52.5 | 2 56.2 | 3 0 | 3 3.7 | 3 7.5 | 3 11.2 |
| 30 | 45 | 3 3.7 | 3 8.1 | 3 12.5 | 3 16.9 | 3 21.2 | 3 25.6 | 3 30 | 3 34.4 | 3 38.7 | 3 43.1 |
| 4 0 | 2 0 | 3 30 | 3 35 | 3 40 | 3 45 | 3 50 | 3 55 | 4 0 | 4 5 | 4 10 | 4 15 |
| 30 | 15 | 3 56.2 | 4 1.9 | 4 7.5 | 4 13.1 | 4 18.7 | 4 24.4 | 4 30 | 4 35.6 | 4 41.2 | 4 46.9 |
| 5 0 | 30 | 4 22.5 | 4 28.7 | 4 35 | 4 41.2 | 4 47.5 | 4 53.7 | 5 0 | 5 6.2 | 5 12.5 | 5 18.7 |
| 30 | 45 | 4 48.7 | 4 55.6 | 5 2.5 | 5 9.4 | 5 16.2 | 5 23.1 | 5 30 | 5 36.9 | 5 43.7 | 5 50.6 |
| 6 0 | 3 0 | 5 15 | 5 22.5 | 5 30 | 5 37.5 | 5 45 | 5 52.5 | 6 0 | 6 7.5 | 6 15 | 6 22.5 |
| 30 | 15 | 5 41.2 | 5 49.4 | 5 57.5 | 6 5.6 | 6 13.7 | 6 21.9 | 6 30 | 6 38.1 | 6 46.2 | 6 54.4 |
| 7 0 | 30 | 6 7.5 | 6 16.2 | 6 25 | 6 33.7 | 6 42.5 | 6 51.2 | 7 0 | 7 8.7 | 7 17.5 | 7 26.2 |
| 30 | 45 | 6 33.7 | 6 43.1 | 6 52.5 | 7 1.9 | 7 11.2 | 7 20.6 | 7 30 | 7 39.4 | 7 48.7 | 7 58.1 |
| 8 0 | 4 0 | 7 0 | 7 10 | 7 20 | 7 30 | 7 40 | 7 50 | 8 0 | 8 10 | 8 20 | 8 30 |
| 30 | 15 | 7 26.2 | 7 36.9 | 7 47.5 | 7 58.1 | 8 8.7 | 8 19.4 | 8 30 | 8 40.6 | 8 51.2 | 9 1.9 |
| 9 0 | 30 | 7 52.5 | 8 3.7 | 8 15 | 8 26.2 | 8 37.5 | 8 48.7 | 9 0 | 9 11.2 | 9 22.5 | 9 33.7 |
| 30 | 45 | 8 18.7 | 8 30.6 | 8 42.5 | 8 54.4 | 9 6.2 | 9 18.1 | 9 30 | 9 41.9 | 9 53.7 | 10 5.6 |
| 10 0 | 5 0 | 8 45 | 8 57.5 | 9 10 | 9 22.5 | 9 35 | 9 47.5 | 10 0 | 10 12.5 | 10 25 | 10 37.5 |
| 30 | 15 | 9 11.2 | 9 24.4 | 9 37.5 | 9 50.6 | 10 3.7 | 10 16.9 | 10 30 | 10 43.1 | 10 56.2 | 11 9.4 |
| 11 0 | 30 | 9 37.5 | 9 51.2 | 10 5 | 10 18.7 | 10 32.5 | 10 46.2 | 11 0 | 11 13.7 | 11 27.5 | 11 41.2 |
| 30 | 45 | 10 3.7 | 10 18.1 | 10 32.5 | 10 46.9 | 11 1.2 | 11 15.6 | 11 30 | 11 44.4 | 11 58.7 | 12 13.1 |
| 12 0 | 6 0 | 10 30 | 10 45 | 11 0 | 11 15 | 11 30 | 11 45 | 12 0 | 12 15 | 12 30 | 12 45 |
| 30 | 15 | 10 56.2 | 11 11.9 | 11 27.5 | 11 43.1 | 11 58.7 | 12 14.4 | 12 30 | 12 45.6 | 13 1.2 | 13 16.9 |
| 13 0 | 30 | 11 22.5 | 11 38.7 | 11 55 | 12 11.2 | 12 27.5 | 12 43.7 | 13 0 | 13 16.2 | 13 32.5 | 13 48.7 |
| 30 | 45 | 11 48.7 | 12 5.6 | 12 22.5 | 12 39.4 | 12 56.2 | 13 13.1 | 13 30 | 13 46.9 | 14 3.7 | 14 20.6 |
| 14 0 | 7 0 | 12 15 | 12 32.5 | 12 50 | 13 7.5 | 13 25 | 13 42.5 | 14 0 | 14 17.5 | 14 35 | 14 52.5 |
| 30 | 15 | 12 41.2 | 12 59.4 | 13 17.5 | 13 35.6 | 13 53.7 | 14 11.9 | 14 30 | 14 48.1 | 15 6.2 | 15 24.4 |
| 15 0 | 30 | 13 7.5 | 13 26.2 | 13 45 | 14 3.7 | 14 22.5 | 14 41.2 | 15 0 | 15 18.7 | 15 37.5 | 15 56.2 |
| 30 | 45 | 13 33.7 | 13 53.1 | 14 12.5 | 14 31.9 | 14 51.2 | 15 10.6 | 15 30 | 16 49.4 | 16 8.7 | 16 27.1 |
| 16 0 | 8 0 | 14 0 | 14 20 | 14 40 | 15 0 | 15 20 | 15 40 | 16 0 | 16 20 | 16 40 | 17 0 |
| 30 | 5 | 14 26.2 | 14 46.9 | 15 7.5 | 15 28.1 | 15 48.7 | 16 9.4 | 16 30 | 16 50.6 | 17 11.2 | 17 31.9 |
| 17 0 | 30 | 14 52.5 | 15 13.7 | 15 35 | 15 56.2 | 16 7.5 | 16 38.7 | 17 0 | 17 21.2 | 17 42.5 | 18 3.7 |
| 30 | 45 | 15 18.7 | 15 40.6 | 16 2.5 | 16 24.4 | 16 46.2 | 17 8.1 | 17 30 | 17 51.9 | 18 13.7 | 18 35.6 |
| 18 0 | 9 0 | 15 45 | 16 7.5 | 16 30 | 16 52.5 | 17 15 | 17 37.5 | 18 0 | 18 22.5 | 18 45 | 19 7.5 |
| 30 | 15 | 16 11.2 | 16 34.4 | 16 57.5 | 17 20.6 | 17 43.7 | 18 6.9 | 18 30 | 18 53.1 | 19 16.2 | 19 39.4 |
| 19 0 | 30 | 16 37.5 | 17 1.2 | 17 25 | 17 48.7 | 18 12.5 | 18 36.2 | 19 0 | 19 23.7 | 19 47.5 | 20 11.2 |
| 30 | 45 | 17 3.7 | 17 28.1 | 17 52.5 | 18 16.9 | 18 41.2 | 19 5.6 | 19 30 | 19 54.4 | 20 18.7 | 20 43.1 |
| 20 0 | 10 0 | 17 30 | 17 55 | 18 20 | 18 45 | 19 10 | 19 35 | 20 0 | 20 25 | 20 50 | 21 15 |
| 30 | 15 | 17 56.2 | 18 21.9 | 18 47.5 | 19 13.1 | 19 38.7 | 20 4.4 | 20 30 | 20 55.6 | 21 21.2 | 21 46.9 |
| 21 0 | 30 | 18 22.5 | 18 48.7 | 19 15 | 19 41.2 | 20 7.5 | 20 33.7 | 21 0 | 21 26.2 | 21 52.5 | 22 18.7 |
| 30 | 45 | 18 48.7 | 19 15.6 | 19 42.5 | 20 9.4 | 20 36.2 | 21 3.1 | 21 30 | 21 56.9 | 22 23.7 | 22 50.6 |
| 22 0 | 11 0 | 19 15 | 19 42.5 | 20 10 | 20 37.5 | 21 5 | 21 32.5 | 22 0 | 22 27.5 | 22 55 | 23 22.5 |
| 30 | 15 | 19 41.2 | 20 9.4 | 20 37.5 | 21 5.6 | 21 33.7 | 22 1.9 | 22 30 | 22 58.1 | 23 26.2 | 23 54.4 |
| 23 0 | 30 | 20 7.5 | 20 36.2 | 21 5 | 21 33.7 | 22 2.5 | 22 31.2 | 23 0 | 23 28.7 | 23 57.5 | 24 26.2 |
| 30 | 45 | 20 33.7 | 21 3.1 | 21 32.5 | 22 1.9 | 22 31.2 | 23 0.6 | 23 30 | 23 59.4 | 24 28.7 | 24 58.1 |
| 24 0 | 12 0 | 21 0 | 21 30 | 22 0 | 22 30 | 23 0 | 23 30 | 24 0 | 24 30 | 25 0 | 25 30 |
| 30 | 15 | 21 26.2 | 21 56.9 | 22 27.5 | 22 58.1 | 23 28.7 | 23 59.4 | 24 30 | 25 0.6 | 25 31.2 | 26 1.9 |
| 25 0 | 30 | 21 52.5 | 22 23.7 | 22 55 | 23 26.2 | 23 57.5 | 24 28.7 | 25 0 | 25 31.2 | 26 2.5 | 26 33.7 |
| 30 | 45 | 22 18.7 | 22 50.6 | 23 22.5 | 23 54.4 | 24 26.2 | 24 58.1 | 25 30 | 26 1.9 | 26 33.7 | 27 5.6 |
| 26 0 | 13 0 | 22 45 | 23 17.5 | 23 50 | 24 22.5 | 24 55 | 25 27.5 | 26 0 | 26 32.5 | 27 5 | 27 37.5 |
| 30 | 15 | 23 11.2 | 23 44.4 | 24 17.5 | 24 50.6 | 25 23.7 | 25 56.9 | 26 30 | 27 3.1 | 27 36.2 | 28 9.4 |
| 27 0 | 30 | 23 37.5 | 24 11.2 | 24 45 | 25 18.7 | 25 52.5 | 26 26.2 | 27 0 | 27 33.7 | 28 7.5 | 28 41.2 |
| 30 | 45 | 24 3.7 | 24 38.1 | 25 12.5 | 25 46.9 | 26 21.2 | 26 55.6 | 27 30 | 28 4.4 | 28 38.7 | 29 13.1 |
| 28 0 | 14 0 | 24 30 | 25 5 | 25 40 | 26 15 | 26 50 | 27 25 | 28 0 | 28 35 | 29 10 | 29 45 |
| 30 | 15 | 24 56.2 | 25 31.9 | 26 7.5 | 26 43.1 | 27 18.7 | 27 54.4 | 28 30 | 29 5.6 | 29 41.2 | 30 16.9 |
| 29 0 | 30 | 25 22.5 | 25 58. | 26 35 | 27 11.2 | 27 47.5 | 28 23.7 | 29 0 | 29 36.2 | 30 12.5 | 30 48.7 |
| 30 | 45 | 25 48.7 | 26 25.6 | 27 2.5 | 27 39.4 | 28 16.2 | 28 53.1 | 29 30 | 30 6.9 | 30 43.7 | 31 20.6 |
| 30 0 | 15 0 | 26 15 | 26 52.5 | 27 30 | 28 7.5 | 28 45 | 29 22.5 | 30 0 | 30 37.5 | 31 15 | 31 52.5 |

## FOR REDUCING DAILY AND TWELVE-HOURLY VARIATIONS

| Interval 24h | Interval 12h | 26′ 0″ | 26′ 30″ | 27′ 0″ | 27′ 30″ | 28′ 0″ | 28′ 30″ | 29′ 0″ | 29′ 30″ | 30′ 0″ | 30′ 30″ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0h 0m | 0h 0m | 0′ 0″ | 0′ 0″ | 0′ 0″ | 0′ 0″ | 0′ 0″ | 0′ 0″ | 0′ 0″ | 0′ 0″ | 0′ 0″ | 0′ 0″ |
| 30 | 15 | 0 32.5 | 0 33.1 | 0 33.7 | 0 34.4 | 0 35 | 0 35.6 | 0 36.2 | 0 36.9 | 0 37.5 | 0 38.1 |
| 1 0 | 30 | 1 5 | 1 6.2 | 1 7.5 | 1 8.7 | 1 10 | 1 11.2 | 1 12.5 | 1 13.7 | 1 15 | 1 16.2 |
| 30 | 45 | 1 37.5 | 1 39.4 | 1 41.2 | 1 43.1 | 1 45 | 1 46.9 | 1 48.7 | 1 50.6 | 1 52.5 | 1 54.4 |
| 2 0 | 1 0 | 2 10 | 2 12.5 | 2 15 | 2 17.5 | 2 20 | 2 22.5 | 2 25 | 2 27.5 | 2 30 | 2 32.5 |
| 30 | 15 | 2 42.5 | 2 45.6 | 2 48.7 | 2 51.9 | 2 55 | 2 58.1 | 3 1.2 | 3 4.4 | 3 7.5 | 3 10.6 |
| 3 0 | 30 | 3 15 | 3 18.7 | 3 22.5 | 3 26.2 | 3 30 | 3 33.7 | 3 37.5 | 3 41.2 | 3 45 | 3 48.7 |
| 30 | 45 | 3 47.5 | 3 51.9 | 3 56.2 | 4 0.6 | 4 5 | 4 9.4 | 4 13.7 | 4 18.1 | 4 22.5 | 4 26.9 |
| 4 0 | 2 0 | 4 20 | 4 25 | 4 30 | 4 35 | 4 40 | 4 45 | 4 50 | 4 55 | 5 0 | 5 5 |
| 30 | 15 | 4 52.5 | 4 58.1 | 5 3.7 | 5 9.4 | 5 15 | 5 20.6 | 5 26.2 | 5 31.9 | 5 37.5 | 5 43.1 |
| 5 0 | 30 | 5 25 | 5 31.2 | 5 37.5 | 5 43.7 | 5 50 | 5 56.2 | 6 2.5 | 6 8.7 | 6 15 | 6 21.2 |
| 30 | 45 | 5 57.5 | 6 4.4 | 6 11.2 | 6 18.1 | 6 25 | 6 31.9 | 6 38.7 | 6 45.6 | 6 52.5 | 6 59.4 |
| 6 0 | 3 0 | 6 30 | 6 37.5 | 6 45 | 6 52.5 | 7 0 | 7 7.5 | 7 15 | 7 22.5 | 7 30 | 7 37.5 |
| 30 | 15 | 7 2.5 | 7 10.6 | 7 18.7 | 7 26.9 | 7 35 | 7 43.1 | 7 51.2 | 7 59.4 | 8 7.5 | 8 15.6 |
| 7 0 | 30 | 7 35 | 7 43.7 | 7 52.5 | 8 1.2 | 8 10 | 8 18.7 | 8 27.5 | 8 36.2 | 8 45 | 8 53.7 |
| 30 | 45 | 8 7.5 | 8 16.9 | 8 26.2 | 8 35.6 | 8 45 | 8 54.4 | 9 3.7 | 9 13.1 | 9 22.5 | 9 31.9 |
| 8 0 | 4 0 | 8 40 | 8 50 | 9 0 | 9 10 | 9 20 | 9 30 | 9 40 | 9 50 | 10 0 | 10 10 |
| 30 | 15 | 9 12.5 | 9 23.1 | 9 33.7 | 9 44.4 | 9 55 | 10 5.6 | 10 16.2 | 10 26.9 | 10 37.5 | 10 48.1 |
| 9 0 | 30 | 9 45 | 9 56.2 | 10 7.5 | 10 18.7 | 10 30 | 10 41.2 | 10 52.5 | 11 3.7 | 11 15 | 11 26.2 |
| 30 | 45 | 10 17.5 | 10 29.4 | 10 41.2 | 10 53.1 | 11 5 | 11 16.9 | 11 28.7 | 11 40.6 | 11 52.5 | 12 4.4 |
| 10 0 | 5 0 | 10 50 | 11 2.5 | 11 15 | 11 27.5 | 11 40 | 11 52.5 | 12 5 | 12 17.5 | 12 30 | 12 42.5 |
| 30 | 15 | 11 22.5 | 11 35.6 | 11 48.7 | 12 1.9 | 12 15 | 12 28.1 | 12 41.2 | 12 54.4 | 13 7.5 | 13 20.6 |
| 11 0 | 30 | 11 55 | 12 8.7 | 12 22.5 | 12 36.2 | 12 50 | 13 3.7 | 13 17.5 | 13 31.2 | 13 45 | 13 58.7 |
| 30 | 45 | 12 27.5 | 12 41.9 | 12 56.2 | 13 10.6 | 13 25 | 13 39.4 | 13 53.7 | 14 8.1 | 14 22.5 | 14 36.9 |
| 12 0 | 6 0 | 13 0 | 13 15 | 13 30 | 13 45 | 14 0 | 14 15 | 14 30 | 14 45 | 15 0 | 15 15 |
| 30 | 15 | 13 32.5 | 13 48.1 | 14 3.7 | 14 19.4 | 14 35 | 14 50.6 | 15 6.2 | 15 21.9 | 15 37.5 | 15 53.1 |
| 13 0 | 30 | 14 5 | 14 21.2 | 14 37.5 | 14 53.7 | 15 10 | 15 26.2 | 15 42.5 | 15 58.7 | 16 15 | 16 31.2 |
| 30 | 45 | 14 37.5 | 14 54.4 | 15 11.2 | 15 28.1 | 15 45 | 16 1.9 | 16 18.7 | 16 35.6 | 16 52.5 | 17 9.4 |
| 14 0 | 7 0 | 15 10 | 15 27.5 | 15 45 | 16 2.5 | 16 20 | 16 37.5 | 16 55 | 17 12.5 | 17 30 | 17 47.5 |
| 30 | 15 | 15 42.5 | 16 0.6 | 16 18.7 | 16 36.9 | 16 55 | 17 13.1 | 17 31.2 | 17 49.4 | 18 7.5 | 18 25.6 |
| 15 0 | 30 | 16 15 | 16 33.7 | 16 52.5 | 17 11.2 | 17 30 | 17 48.7 | 18 7.5 | 18 26.2 | 18 45 | 19 3.7 |
| 30 | 45 | 16 47.5 | 17 6.9 | 17 26.2 | 17 45.6 | 18 5 | 18 24.4 | 18 43.7 | 19 3.1 | 19 22.5 | 19 41.9 |
| 16 0 | 8 0 | 17 20 | 17 40 | 18 0 | 18 20 | 18 40 | 19 0 | 19 20 | 19 40 | 20 0 | 20 20 |
| 30 | 15 | 17 52.5 | 18 13.1 | 18 33.7 | 18 54.4 | 19 15 | 19 35.6 | 19 56.2 | 20 16.9 | 20 37.5 | 20 58.1 |
| 17 0 | 30 | 18 25 | 18 46.2 | 19 7.5 | 19 28.7 | 19 50 | 20 11.2 | 20 32.5 | 20 53.7 | 21 15 | 21 36.2 |
| 30 | 45 | 18 57.5 | 19 19.4 | 19 41.2 | 20 3.1 | 20 25 | 20 46.9 | 21 8.7 | 21 30.6 | 21 52.5 | 22 14.4 |
| 18 0 | 9 0 | 19 30 | 19 52.5 | 20 15 | 20 37.5 | 21 0 | 21 22.5 | 21 45 | 22 7.5 | 22 30 | 22 52.5 |
| 30 | 15 | 20 2.5 | 20 25.6 | 20 48.7 | 21 11.9 | 21 35 | 21 58.1 | 22 21.2 | 22 44.4 | 23 7.5 | 23 30.6 |
| 19 0 | 30 | 20 35 | 20 58.7 | 21 22.5 | 21 46.2 | 22 10 | 22 33.7 | 22 57.5 | 23 21.2 | 23 45 | 24 8.7 |
| 30 | 45 | 21 7.5 | 21 31.9 | 21 56.2 | 22 20.6 | 22 45 | 23 9.4 | 23 33.7 | 23 58.1 | 24 22.5 | 24 46.9 |
| 20 0 | 10 0 | 21 40 | 22 5 | 22 30 | 22 55 | 23 20 | 23 45 | 24 10 | 24 35 | 25 0 | 25 25 |
| 30 | 15 | 22 12.5 | 22 38.1 | 23 3.7 | 23 29.4 | 23 55 | 24 20.6 | 24 46.2 | 25 11.9 | 25 37.5 | 26 3.1 |
| 21 0 | 30 | 22 45 | 23 11.2 | 23 37.5 | 24 3.7 | 24 30 | 24 56.2 | 25 22.5 | 25 48.7 | 26 15 | 26 41.2 |
| 30 | 45 | 23 17.5 | 23 44.4 | 24 11.2 | 24 38.1 | 25 5 | 25 31.9 | 25 58.7 | 26 25.6 | 26 52.5 | 27 19.4 |
| 22 0 | 11 0 | 23 50 | 24 17.5 | 24 45 | 25 12.5 | 25 40 | 26 7.5 | 26 35 | 27 2.5 | 27 30 | 27 57.5 |
| 30 | 15 | 24 22.5 | 24 50.6 | 25 18.7 | 25 46.9 | 26 15 | 26 43.1 | 27 11.2 | 27 39.4 | 28 7.5 | 28 35.6 |
| 23 0 | 30 | 24 55 | 25 23.7 | 25 52.5 | 26 21.2 | 26 50 | 27 18.7 | 27 47.5 | 28 16.2 | 28 45 | 29 13.7 |
| 30 | 45 | 25 27.5 | 25 56.9 | 26 26.2 | 26 55.6 | 27 25 | 27 54.4 | 28 23.7 | 28 53.1 | 29 22.5 | 29 51.9 |
| 24 0 | 12 0 | 26 0 | 26 30 | 27 0 | 27 30 | 28 0 | 28 30 | 29 0 | 29 30 | 30 0 | 30 30 |
| 30 | 15 | 26 32.5 | 27 3.1 | 27 33.7 | 28 4.4 | 28 35 | 29 5.6 | 29 36.2 | 30 6.9 | 30 37.5 | 31 8.1 |
| 25 0 | 30 | 27 5 | 27 36.2 | 28 7.5 | 28 38.7 | 29 10 | 29 41.2 | 30 12.5 | 30 43.7 | 31 15 | 31 46.2 |
| 30 | 45 | 27 37.5 | 28 9.4 | 28 41.2 | 29 13.1 | 29 45 | 30 16.9 | 30 48.7 | 31 20.6 | 31 52.5 | 32 24.4 |
| 26 0 | 13 0 | 28 10 | 28 42.5 | 29 15 | 29 47.5 | 30 20 | 30 52.5 | 31 25 | 31 57.5 | 32 30 | 33 2.5 |
| 30 | 15 | 28 42.5 | 29 5.6 | 29 48.7 | 30 21.9 | 30 55 | 31 28.1 | 32 1.2 | 32 34.4 | 33 7.5 | 33 40.6 |
| 27 0 | 30 | 29 15 | 29 48.7 | 30 22.5 | 30 56.2 | 31 30 | 32 3.7 | 32 37.5 | 33 11.2 | 33 45 | 34 18.7 |
| 30 | 45 | 29 47.5 | 30 21.9 | 30 56.2 | 31 30.6 | 32 5 | 32 39.4 | 33 13.7 | 33 48.1 | 34 22.5 | 34 56.9 |
| 28 0 | 14 0 | 30 20 | 30 55 | 31 30 | 32 5 | 32 40 | 33 15 | 33 50 | 34 25 | 35 0 | 35 35 |
| 30 | 15 | 30 52.5 | 31 28.1 | 32 3.7 | 32 39.4 | 33 15 | 33 50.6 | 34 26.2 | 35 1.9 | 35 37.5 | 36 13.1 |
| 29 0 | 30 | 31 25 | 32 1.2 | 32 37.5 | 33 13.7 | 33 50 | 34 26.2 | 35 2.5 | 35 38.7 | 36 15 | 36 51.2 |
| 30 | 45 | 31 57.5 | 32 34.4 | 33 11.2 | 33 48.1 | 34 25 | 35 1.9 | 35 38.7 | 36 15.6 | 36 52.5 | 37 29.4 |
| 30 0 | 15 0 | 32 30 | 33 7.5 | 33 45 | 34 22.5 | 35 0 | 35 37.5 | 36 15 | 36 52.5 | 37 30 | 38 7.5 |

Variation in 24h or in 12h (column heads 26′–30′).

## LOGARITHMS FOR REDUCING DAILY VARIATIONS

| Min. or Sec. | Hours, Degrees, or Minutes 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | Min. or Sec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | 1·3802 | 1·0792 | 9031 | 7781 | 6812 | 6021 | 5351 | 4771 | 4260 | 3802 | 3388 | 0 |
| 1 | 3·1584 | 1·3730 | 1·0756 | 9007 | 7763 | 6798 | 6009 | 5341 | 4762 | 4252 | 3795 | 3382 | 1 |
| 2 | 2·8573 | 1·3660 | 1·0720 | 8983 | 7745 | 6784 | 5997 | 5330 | 4753 | 4244 | 3788 | 3375 | 2 |
| 3 | 2·6812 | 1·3590 | 1·0685 | 8959 | 7728 | 6769 | 5985 | 5320 | 4744 | 4236 | 3780 | 3368 | 3 |
| 4 | 2·5563 | 1·3522 | 1·0649 | 8935 | 7710 | 6755 | 5973 | 5310 | 4735 | 4228 | 3773 | 3362 | 4 |
| 5 | 2·4594 | 1·3454 | 1·0614 | 8912 | 7692 | 6741 | 5961 | 5300 | 4726 | 4220 | 3766 | 3355 | 5 |
| 6 | 2·3802 | 1·3388 | 1·0580 | 8888 | 7674 | 6726 | 5949 | 5289 | 4717 | 4212 | 3759 | 3349 | 6 |
| 7 | 2·3133 | 1·3323 | 1·0546 | 8865 | 7657 | 6712 | 5937 | 5279 | 4708 | 4204 | 3752 | 3342 | 7 |
| 8 | 2·2553 | 1·3259 | 1·0512 | 8842 | 7639 | 6698 | 5925 | 5269 | 4699 | 4196 | 3745 | 3336 | 8 |
| 9 | 2·2041 | 1·3195 | 1·0478 | 8819 | 7622 | 6684 | 5913 | 5259 | 4690 | 4188 | 3737 | 3329 | 9 |
| 10 | 2·1584 | 1·3133 | 1·0444 | 8796 | 7604 | 6670 | 5902 | 5249 | 4682 | 4180 | 3730 | 3323 | 10 |
| 11 | 2·1170 | 1·3071 | 1·0411 | 8773 | 7587 | 6656 | 5890 | 5239 | 4673 | 4172 | 3723 | 3316 | 11 |
| 12 | 2·0792 | 1·3010 | 1·0378 | 8751 | 7570 | 6642 | 5878 | 5229 | 4664 | 4164 | 3716 | 3310 | 12 |
| 13 | 2·0444 | 1·2950 | 1·0345 | 8728 | 7552 | 6628 | 5866 | 5219 | 4655 | 4156 | 3709 | 3303 | 13 |
| 14 | 2·0122 | 1·2891 | 1·0313 | 8706 | 7535 | 6614 | 5855 | 5209 | 4646 | 4148 | 3702 | 3297 | 14 |
| 15 | 1·9823 | 1·2833 | 1·0280 | 8683 | 7518 | 6600 | 5843 | 5199 | 4638 | 4141 | 3695 | 3291 | 15 |
| 16 | 1·9542 | 1·2775 | 1·0248 | 8661 | 7501 | 6587 | 5832 | 5189 | 4629 | 4133 | 3688 | 3284 | 16 |
| 17 | 1·9279 | 1·2719 | 1·0216 | 8639 | 7484 | 6573 | 5820 | 5179 | 4620 | 4125 | 3681 | 3278 | 17 |
| 18 | 1·9031 | 1·2663 | 1·0185 | 8617 | 7467 | 6559 | 5809 | 5169 | 4611 | 4117 | 3674 | 3271 | 18 |
| 19 | 1·8796 | 1·2607 | 1·0153 | 8595 | 7451 | 6546 | 5797 | 5159 | 4603 | 4109 | 3667 | 3265 | 19 |
| 20 | 1·8573 | 1·2553 | 1·0122 | 8573 | 7434 | 6532 | 5786 | 5149 | 4594 | 4102 | 3660 | 3258 | 20 |
| 21 | 1·8361 | 1·2499 | 1·0091 | 8552 | 7417 | 6518 | 5774 | 5139 | 4585 | 4094 | 3653 | 3252 | 21 |
| 22 | 1·8159 | 1·2445 | 1·0061 | 8530 | 7401 | 6505 | 5763 | 5129 | 4577 | 4086 | 3646 | 3246 | 22 |
| 23 | 1·7966 | 1·2393 | 1·0030 | 8509 | 7384 | 6492 | 5752 | 5120 | 4568 | 4079 | 3639 | 3239 | 23 |
| 24 | 1·7782 | 1·2341 | 1·0000 | 8487 | 7368 | 6478 | 5740 | 5110 | 4559 | 4071 | 3632 | 3233 | 24 |
| 25 | 1·7604 | 1·2289 | 0·9970 | 8466 | 7351 | 6465 | 5729 | 5100 | 4551 | 4063 | 3625 | 3227 | 25 |
| 26 | 1·7434 | 1·2239 | 0·9940 | 8445 | 7335 | 6451 | 5718 | 5090 | 4542 | 4055 | 3618 | 3220 | 26 |
| 27 | 1·7270 | 1·2188 | 0·9910 | 8424 | 7318 | 6438 | 5706 | 5081 | 4534 | 4048 | 3611 | 3214 | 27 |
| 28 | 1·7112 | 1·2139 | 0·9881 | 8403 | 7302 | 6425 | 5695 | 5071 | 4525 | 4040 | 3604 | 3208 | 28 |
| 29 | 1·6960 | 1·2090 | 0·9852 | 8382 | 7286 | 6412 | 5684 | 5061 | 4516 | 4032 | 3597 | 3201 | 29 |
| 30 | 1·6812 | 1·2041 | 0·9823 | 8361 | 7270 | 6398 | 5673 | 5051 | 4508 | 4025 | 3590 | 3195 | 30 |
| 31 | 1·6670 | 1·1993 | 0·9794 | 8341 | 7254 | 6385 | 5662 | 5042 | 4499 | 4017 | 3583 | 3189 | 31 |
| 32 | 1·6532 | 1·1946 | 0·9765 | 8320 | 7238 | 6372 | 5651 | 5032 | 4491 | 4010 | 3576 | 3183 | 32 |
| 33 | 1·6398 | 1·1899 | 0·9737 | 8300 | 7222 | 6359 | 5640 | 5023 | 4482 | 4002 | 3570 | 3176 | 33 |
| 34 | 1·6269 | 1·1852 | 0·9708 | 8279 | 7206 | 6346 | 5629 | 5013 | 4474 | 3994 | 3563 | 3170 | 34 |
| 35 | 1·6143 | 1·1806 | 0·9680 | 8259 | 7190 | 6333 | 5618 | 5003 | 4466 | 3987 | 3556 | 3164 | 35 |
| 36 | 1·6021 | 1·1761 | 0·9652 | 8239 | 7174 | 6320 | 5607 | 4994 | 4457 | 3979 | 3549 | 3157 | 36 |
| 37 | 1·5902 | 1·1716 | 0·9625 | 8219 | 7159 | 6307 | 5596 | 4984 | 4449 | 3972 | 3542 | 3151 | 37 |
| 38 | 1·5786 | 1·1671 | 0·9597 | 8199 | 7143 | 6294 | 5585 | 4975 | 4440 | 3964 | 3535 | 3145 | 38 |
| 39 | 1·5673 | 1·1627 | 0·9570 | 8179 | 7128 | 6282 | 5574 | 4965 | 4432 | 3957 | 3529 | 3139 | 39 |
| 40 | 1·5563 | 1·1584 | 0·9542 | 8159 | 7112 | 6269 | 5563 | 4956 | 4424 | 3949 | 3522 | 3133 | 40 |
| 41 | 1·5456 | 1·1540 | 0·9515 | 8140 | 7097 | 6256 | 5552 | 4947 | 4415 | 3942 | 3515 | 3126 | 41 |
| 42 | 1·5351 | 1·1498 | 0·9488 | 8120 | 7081 | 6243 | 5541 | 4937 | 4407 | 3934 | 3508 | 3120 | 42 |
| 43 | 1·5249 | 1·1455 | 0·9462 | 8101 | 7066 | 6231 | 5531 | 4928 | 4399 | 3927 | 3501 | 3114 | 43 |
| 44 | 1·5149 | 1·1413 | 0·9435 | 8081 | 7050 | 6218 | 5520 | 4918 | 4390 | 3919 | 3495 | 3108 | 44 |
| 45 | 1·5051 | 1·1372 | 0·9408 | 8062 | 7035 | 6205 | 5509 | 4909 | 4382 | 3912 | 3488 | 3102 | 45 |
| 46 | 1·4956 | 1·1331 | 0·9382 | 8043 | 7020 | 6193 | 5498 | 4900 | 4374 | 3905 | 3481 | 3096 | 46 |
| 47 | 1·4863 | 1·1290 | 0·9356 | 8023 | 7005 | 6180 | 5488 | 4890 | 4365 | 3897 | 3475 | 3089 | 47 |
| 48 | 1·4771 | 1·1249 | 0·9330 | 8004 | 6990 | 6168 | 5477 | 4881 | 4357 | 3890 | 3468 | 3083 | 48 |
| 49 | 1·4682 | 1·1209 | 0·9305 | 7985 | 6975 | 6155 | 5466 | 4872 | 4349 | 3882 | 3461 | 3077 | 49 |
| 50 | 1·4594 | 1·1170 | 0·9279 | 7966 | 6960 | 6143 | 5456 | 4863 | 4341 | 3875 | 3454 | 3071 | 50 |
| 51 | 1·4508 | 1·1130 | 0·9254 | 7947 | 6945 | 6131 | 5445 | 4853 | 4333 | 3868 | 3448 | 3065 | 51 |
| 52 | 1·4424 | 1·1091 | 0·9228 | 7929 | 6930 | 6118 | 5435 | 4844 | 4324 | 3860 | 3441 | 3059 | 52 |
| 53 | 1·4341 | 1·1053 | 0·9203 | 7910 | 6915 | 6106 | 5424 | 4835 | 4316 | 3853 | 3434 | 3053 | 53 |
| 54 | 1·4260 | 1·1015 | 0·9178 | 7891 | 6900 | 6094 | 5414 | 4826 | 4308 | 3846 | 3428 | 3047 | 54 |
| 55 | 1·4180 | 1·0977 | 0·9153 | 7873 | 6885 | 6081 | 5403 | 4817 | 4300 | 3838 | 3421 | 3041 | 55 |
| 56 | 1·4102 | 1·0940 | 0·9128 | 7854 | 6871 | 6069 | 5393 | 4808 | 4292 | 3831 | 3415 | 3034 | 56 |
| 57 | 1·4025 | 1·0902 | 0·9104 | 7836 | 6856 | 6057 | 5382 | 4798 | 4284 | 3824 | 3408 | 3028 | 57 |
| 58 | 1·3949 | 1·0865 | 0·9079 | 7818 | 6841 | 6045 | 5372 | 4789 | 4276 | 3817 | 3401 | 3022 | 58 |
| 59 | 1·3875 | 1·0828 | 0·9055 | 7800 | 6827 | 6033 | 5361 | 4780 | 4268 | 3809 | 3395 | 3016 | 59 |
| 60 | 1·3802 | 1·0792 | 0·9031 | 7781 | 6812 | 6021 | 5351 | 4771 | 4260 | 3802 | 3388 | 3010 | 60 |
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | |

## LOGARITHMS FOR REDUCING DAILY VARIATIONS

| Min. or Sec. | Hours, Degrees, or Minutes 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | Min. or Sec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 3010 | 2663 | 2341 | 2041 | 1761 | 1498 | 1249 | 1015 | 0792 | 0580 | 0378 | 0185 | 0 |
| 1 | 3004 | 2657 | 2336 | 2036 | 1756 | 1493 | 1245 | 1011 | 0788 | 0576 | 0375 | 0182 | 1 |
| 2 | 2998 | 2652 | 2330 | 2031 | 1752 | 1489 | 1241 | 1007 | 0785 | 0573 | 0371 | 0179 | 2 |
| 3 | 2992 | 2646 | 2325 | 2027 | 1747 | 1485 | 1237 | 1003 | 0781 | 0570 | 0368 | 0175 | 3 |
| 4 | 2986 | 2640 | 2320 | 2022 | 1743 | 1481 | 1233 | 0999 | 0777 | 0566 | 0365 | 0172 | 4 |
| 5 | 2980 | 2635 | 2315 | 2017 | 1738 | 1476 | 1229 | 0996 | 0774 | 0563 | 0361 | 0169 | 5 |
| 6 | 2974 | 2629 | 2310 | 2012 | 1734 | 1472 | 1225 | 0992 | 0770 | 0559 | 0358 | 0166 | 6 |
| 7 | 2968 | 2624 | 2305 | 2008 | 1729 | 1468 | 1221 | 0988 | 0767 | 0556 | 0355 | 0163 | 7 |
| 8 | 2962 | 2618 | 2300 | 2003 | 1725 | 1464 | 1217 | 0984 | 0763 | 0552 | 0352 | 0160 | 8 |
| 9 | 2956 | 2613 | 2295 | 1998 | 1720 | 1459 | 1213 | 0980 | 0759 | 0549 | 0348 | 0157 | 9 |
| 10 | 2950 | 2607 | 2289 | 1993 | 1716 | 1455 | 1209 | 0977 | 0756 | 0546 | 0345 | 0153 | 10 |
| 11 | 2944 | 2602 | 2284 | 1988 | 1711 | 1451 | 1205 | 0973 | 0753 | 0542 | 0342 | 0150 | 11 |
| 12 | 2938 | 2596 | 2279 | 1984 | 1707 | 1447 | 1201 | 0969 | 0749 | 0539 | 0339 | 0147 | 12 |
| 13 | 2933 | 2591 | 2274 | 1979 | 1702 | 1443 | 1197 | 0965 | 0745 | 0535 | 0335 | 0144 | 13 |
| 14 | 2927 | 2585 | 2269 | 1974 | 1698 | 1438 | 1193 | 0962 | 0741 | 0532 | 0332 | 0141 | 14 |
| 15 | 2921 | 2580 | 2264 | 1969 | 1694 | 1434 | 1189 | 0958 | 0738 | 0528 | 0329 | 0138 | 15 |
| 16 | 2915 | 2574 | 2259 | 1965 | 1689 | 1430 | 1185 | 0954 | 0734 | 0525 | 0326 | 0135 | 16 |
| 17 | 2909 | 2569 | 2254 | 1960 | 1685 | 1426 | 1181 | 0950 | 0731 | 0522 | 0322 | 0132 | 17 |
| 18 | 2903 | 2564 | 2249 | 1955 | 1680 | 1422 | 1178 | 0947 | 0727 | 0518 | 0319 | 0128 | 18 |
| 19 | 2897 | 2558 | 2244 | 1950 | 1676 | 1417 | 1174 | 0943 | 0724 | 0515 | 0316 | 0125 | 19 |
| 20 | 2891 | 2553 | 2239 | 1946 | 1671 | 1413 | 1170 | 0939 | 0720 | 0511 | 0313 | 0122 | 20 |
| 21 | 2885 | 2547 | 2234 | 1941 | 1667 | 1409 | 1166 | 0935 | 0716 | 0508 | 0309 | 0119 | 21 |
| 22 | 2880 | 2542 | 2229 | 1936 | 1662 | 1405 | 1162 | 0932 | 0713 | 0505 | 0306 | 0116 | 22 |
| 23 | 2874 | 2536 | 2223 | 1932 | 1658 | 1401 | 1158 | 0928 | 0709 | 0501 | 0303 | 0113 | 23 |
| 24 | 2868 | 2531 | 2218 | 1927 | 1654 | 1397 | 1154 | 0924 | 0706 | 0498 | 0300 | 0110 | 24 |
| 25 | 2862 | 2526 | 2213 | 1922 | 1649 | 1392 | 1150 | 0920 | 0702 | 0495 | 0296 | 0107 | 25 |
| 26 | 2856 | 2520 | 2208 | 1917 | 1645 | 1388 | 1146 | 0917 | 0699 | 0491 | 0293 | 0104 | 26 |
| 27 | 2850 | 2515 | 2203 | 1913 | 1640 | 1384 | 1142 | 0913 | 0695 | 0488 | 0290 | 0101 | 27 |
| 28 | 2845 | 2510 | 2198 | 1908 | 1636 | 1380 | 1138 | 0909 | 0692 | 0484 | 0287 | 0098 | 28 |
| 29 | 2839 | 2504 | 2193 | 1903 | 1632 | 1376 | 1134 | 0905 | 0688 | 0481 | 0283 | 0094 | 29 |
| 30 | 2833 | 2499 | 2188 | 1899 | 1627 | 1372 | 1130 | 0902 | 0685 | 0478 | 0280 | 0091 | 30 |
| 31 | 2827 | 2493 | 2183 | 1894 | 1623 | 1368 | 1126 | 0898 | 0681 | 0474 | 0277 | 0088 | 31 |
| 32 | 2821 | 2488 | 2178 | 1889 | 1618 | 1363 | 1123 | 0895 | 0677 | 0471 | 0274 | 0085 | 32 |
| 33 | 2816 | 2483 | 2173 | 1885 | 1614 | 1359 | 1119 | 0891 | 0674 | 0468 | 0271 | 0082 | 33 |
| 34 | 2810 | 2477 | 2168 | 1880 | 1610 | 1355 | 1115 | 0887 | 0670 | 0464 | 0267 | 0079 | 34 |
| 35 | 2804 | 2472 | 2163 | 1875 | 1605 | 1351 | 1111 | 0883 | 0667 | 0461 | 0264 | 0076 | 35 |
| 36 | 2798 | 2467 | 2159 | 1871 | 1601 | 1347 | 1107 | 0880 | 0663 | 0458 | 0261 | 0073 | 36 |
| 37 | 2793 | 2461 | 2154 | 1866 | 1597 | 1343 | 1103 | 0876 | 0660 | 0454 | 0258 | 0070 | 37 |
| 38 | 2787 | 2456 | 2149 | 1862 | 1592 | 1339 | 1099 | 0872 | 0656 | 0451 | 0255 | 0067 | 38 |
| 39 | 2781 | 2451 | 2144 | 1857 | 1588 | 1335 | 1095 | 0868 | 0653 | 0447 | 0251 | 0064 | 39 |
| 40 | 2775 | 2445 | 2139 | 1852 | 1584 | 1331 | 1091 | 0865 | 0649 | 0444 | 0248 | 0061 | 40 |
| 41 | 2770 | 2440 | 2134 | 1848 | 1579 | 1326 | 1088 | 0861 | 0646 | 0441 | 0245 | 0058 | 41 |
| 42 | 2764 | 2435 | 2129 | 1843 | 1575 | 1322 | 1084 | 0858 | 0642 | 0438 | 0242 | 0055 | 42 |
| 43 | 2758 | 2430 | 2124 | 1838 | 1571 | 1318 | 1080 | 0854 | 0639 | 0434 | 0239 | 0052 | 43 |
| 44 | 2753 | 2424 | 2119 | 1834 | 1566 | 1314 | 1076 | 0850 | 0635 | 0431 | 0235 | 0048 | 44 |
| 45 | 2747 | 2419 | 2114 | 1829 | 1562 | 1310 | 1072 | 0846 | 0632 | 0427 | 0232 | 0045 | 45 |
| 46 | 2741 | 2414 | 2109 | 1825 | 1558 | 1306 | 1068 | 0843 | 0628 | 0424 | 0229 | 0042 | 46 |
| 47 | 2736 | 2409 | 2104 | 1820 | 1553 | 1302 | 1064 | 0839 | 0625 | 0421 | 0226 | 0039 | 47 |
| 48 | 2730 | 2403 | 2099 | 1816 | 1549 | 1298 | 1060 | 0835 | 0621 | 0418 | 0223 | 0036 | 48 |
| 49 | 2724 | 2398 | 2095 | 1811 | 1545 | 1294 | 1057 | 0832 | 0618 | 0414 | 0220 | 0033 | 49 |
| 50 | 2719 | 2393 | 2090 | 1806 | 1540 | 1290 | 1053 | 0828 | 0614 | 0411 | 0216 | 0030 | 50 |
| 51 | 2713 | 2388 | 2085 | 1802 | 1536 | 1286 | 1049 | 0824 | 0611 | 0408 | 0213 | 0027 | 51 |
| 52 | 2707 | 2382 | 2080 | 1797 | 1532 | 1282 | 1045 | 0821 | 0608 | 0404 | 0210 | 0024 | 52 |
| 53 | 2702 | 2377 | 2075 | 1793 | 1527 | 1278 | 1041 | 0817 | 0604 | 0401 | 0207 | 0021 | 53 |
| 54 | 2696 | 2372 | 2070 | 1788 | 1523 | 1274 | 1037 | 0814 | 0601 | 0398 | 0204 | 0018 | 54 |
| 55 | 2690 | 2367 | 2065 | 1784 | 1519 | 1270 | 1034 | 0810 | 0597 | 0394 | 0201 | 0015 | 55 |
| 56 | 2685 | 2362 | 2061 | 1779 | 1515 | 1265 | 1030 | 0806 | 0594 | 0391 | 0197 | 0012 | 56 |
| 57 | 2679 | 2356 | 2056 | 1774 | 1510 | 1261 | 1026 | 0803 | 0590 | 0388 | 0194 | 0009 | 57 |
| 58 | 2674 | 2351 | 2051 | 1770 | 1506 | 1257 | 1022 | 0799 | 0587 | 0384 | 0191 | 0006 | 58 |
| 59 | 2668 | 2346 | 2046 | 1765 | 1502 | 1253 | 1018 | 0795 | 0583 | 0381 | 0188 | 0003 | 59 |
| 60 | 2663 | 2341 | 2041 | 1761 | 1498 | 1249 | 1015 | 0792 | 0580 | 0378 | 0185 | 0000 | 60 |
| | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | |

## FOR REDUCING THE MOON'S DECLINATION

| M | Difference for 10m | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10″ | 20″ | 30″ | 40″ | 50″ | 60″ | 70″ | 80″ | 90″ | 100″ | 110″ | 120″ | 130″ |
| 1 | 0′ 1″ | 0′ 2″ | 0′ 3″ | 0′ 4″ | 0′ 5″ | 0′ 6″ | 0′ 7″ | 0′ 8″ | 0′ 9″ | 0′ 10″ | 0′ 11″ | 0′ 12″ | 0′ 13″ |
| 2 | 0 2 | 0 4 | 0 6 | 0 8 | 0 10 | 0 12 | 0 14 | 0 16 | 0 18 | 0 20 | 0 22 | 0 24 | 0 26 |
| 3 | 0 3 | 0 6 | 0 9 | 0 12 | 0 15 | 0 18 | 0 21 | 0 24 | 0 27 | 0 30 | 0 33 | 0 36 | 0 39 |
| 4 | 0 4 | 0 8 | 0 12 | 0 16 | 0 20 | 0 24 | 0 28 | 0 32 | 0 36 | 0 40 | 0 44 | 0 48 | 0 52 |
| 5 | 0 5 | 0 10 | 0 15 | 0 20 | 0 25 | 0 30 | 0 35 | 0 40 | 0 45 | 0 50 | 0 55 | 1 0 | 1 5 |
| 6 | 0 6 | 0 12 | 0 18 | 0 24 | 0 30 | 0 36 | 0 42 | 0 48 | 0 54 | 1 0 | 1 6 | 1 12 | 1 18 |
| 7 | 0 7 | 0 14 | 0 21 | 0 28 | 0 35 | 0 42 | 0 49 | 0 56 | 1 3 | 1 10 | 1 17 | 1 24 | 1 31 |
| 8 | 0 8 | 0 16 | 0 24 | 0 32 | 0 40 | 0 48 | 0 56 | 1 4 | 1 12 | 1 20 | 1 28 | 1 36 | 1 44 |
| 9 | 0 9 | 0 18 | 0 27 | 0 36 | 0 45 | 0 54 | 1 3 | 1 12 | 1 21 | 1 30 | 1 39 | 1 48 | 1 57 |
| 10 | 0 10 | 0 20 | 0 30 | 0 40 | 0 50 | 1 0 | 1 10 | 1 20 | 1 30 | 1 40 | 1 50 | 2 0 | 2 10 |
| 11 | 0 11 | 0 22 | 0 33 | 0 44 | 0 55 | 1 6 | 1 17 | 1 28 | 1 39 | 1 50 | 2 1 | 2 12 | 2 23 |
| 12 | 0 12 | 0 24 | 0 36 | 0 48 | 1 0 | 1 12 | 1 24 | 1 36 | 1 48 | 2 0 | 2 12 | 2 24 | 2 36 |
| 13 | 0 13 | 0 26 | 0 39 | 0 52 | 1 5 | 1 18 | 1 31 | 1 44 | 1 57 | 2 10 | 2 23 | 2 36 | 2 49 |
| 14 | 0 14 | 0 28 | 0 42 | 0 56 | 1 10 | 1 24 | 1 38 | 1 52 | 2 6 | 2 20 | 2 34 | 2 48 | 3 2 |
| 15 | 0 15 | 0 30 | 0 45 | 1 0 | 1 15 | 1 30 | 1 45 | 2 0 | 2 15 | 2 30 | 2 45 | 3 0 | 3 15 |
| 16 | 0 16 | 0 32 | 0 48 | 1 4 | 1 20 | 1 36 | 1 52 | 2 8 | 2 24 | 2 40 | 2 56 | 3 12 | 3 28 |
| 17 | 0 17 | 0 34 | 0 51 | 1 8 | 1 25 | 1 42 | 1 59 | 2 16 | 2 33 | 2 50 | 3 7 | 3 24 | 3 41 |
| 18 | 0 18 | 0 36 | 0 54 | 1 12 | 1 30 | 1 48 | 2 6 | 2 24 | 2 42 | 3 0 | 3 18 | 3 36 | 3 54 |
| 19 | 0 19 | 0 38 | 0 57 | 1 16 | 1 35 | 1 54 | 2 13 | 2 32 | 2 51 | 3 10 | 3 29 | 3 48 | 4 7 |
| 20 | 0 20 | 0 40 | 1 0 | 1 20 | 1 40 | 2 0 | 2 20 | 2 40 | 3 0 | 3 20 | 3 40 | 4 0 | 4 20 |
| 21 | 0 21 | 0 42 | 1 3 | 1 24 | 1 45 | 2 6 | 2 27 | 2 48 | 3 9 | 3 30 | 3 51 | 4 12 | 4 33 |
| 22 | 0 22 | 0 44 | 1 6 | 1 28 | 1 50 | 2 12 | 2 34 | 2 56 | 3 18 | 3 40 | 4 2 | 4 24 | 4 46 |
| 23 | 0 23 | 0 46 | 1 9 | 1 32 | 1 55 | 2 18 | 2 41 | 3 4 | 3 27 | 3 50 | 4 13 | 4 36 | 4 59 |
| 24 | 0 24 | 0 48 | 1 12 | 1 36 | 2 0 | 2 24 | 2 48 | 3 12 | 3 36 | 4 0 | 4 24 | 4 48 | 5 12 |
| 25 | 0 25 | 0 50 | 1 15 | 1 40 | 2 5 | 2 30 | 2 55 | 3 20 | 3 45 | 4 10 | 4 35 | 5 0 | 5 25 |
| 26 | 0 26 | 0 52 | 1 18 | 1 44 | 2 10 | 2 36 | 3 2 | 3 28 | 3 54 | 4 20 | 4 46 | 5 12 | 5 38 |
| 27 | 0 27 | 0 54 | 1 21 | 1 48 | 2 15 | 2 42 | 3 9 | 3 36 | 4 3 | 4 30 | 4 57 | 5 24 | 5 51 |
| 28 | 0 28 | 0 56 | 1 24 | 1 52 | 2 20 | 2 48 | 3 16 | 3 44 | 4 12 | 4 40 | 5 8 | 5 36 | 6 4 |
| 29 | 0 29 | 0 58 | 1 27 | 1 56 | 2 25 | 2 54 | 3 23 | 3 52 | 4 21 | 4 50 | 5 19 | 5 48 | 6 17 |
| 30 | 0 30 | 1 0 | 1 30 | 2 0 | 2 30 | 3 0 | 3 30 | 4 0 | 4 30 | 5 0 | 5 30 | 6 0 | 6 30 |
| 31 | 0 31 | 1 2 | 1 33 | 2 4 | 2 35 | 3 6 | 3 37 | 4 8 | 4 39 | 5 10 | 5 41 | 6 12 | 6 43 |
| 32 | 0 32 | 1 4 | 1 36 | 2 8 | 2 40 | 3 12 | 3 44 | 4 16 | 4 48 | 5 20 | 5 52 | 6 24 | 6 56 |
| 33 | 0 33 | 1 6 | 1 39 | 2 12 | 2 45 | 3 18 | 3 51 | 4 24 | 4 57 | 5 30 | 6 3 | 6 36 | 7 9 |
| 34 | 0 34 | 1 8 | 1 42 | 2 16 | 2 50 | 3 24 | 3 58 | 4 32 | 5 6 | 5 40 | 6 14 | 6 48 | 7 22 |
| 35 | 0 35 | 1 10 | 1 45 | 2 20 | 2 55 | 3 30 | 4 5 | 4 40 | 5 15 | 5 50 | 6 25 | 7 0 | 7 35 |
| 36 | 0 36 | 1 12 | 1 48 | 2 24 | 3 0 | 3 36 | 4 12 | 4 48 | 5 24 | 6 0 | 6 36 | 7 12 | 7 48 |
| 37 | 0 37 | 1 14 | 1 51 | 2 28 | 3 5 | 3 42 | 4 19 | 4 56 | 5 33 | 6 10 | 6 47 | 7 24 | 8 1 |
| 38 | 0 38 | 1 16 | 1 54 | 2 32 | 3 10 | 3 48 | 4 26 | 5 4 | 5 42 | 6 20 | 6 58 | 7 36 | 8 14 |
| 39 | 0 39 | 1 18 | 1 57 | 2 36 | 3 15 | 3 54 | 4 33 | 5 12 | 5 51 | 6 30 | 7 9 | 7 48 | 8 27 |
| 40 | 0 40 | 1 20 | 2 0 | 2 40 | 3 20 | 4 0 | 4 40 | 5 20 | 6 0 | 6 40 | 7 20 | 8 0 | 8 40 |
| 41 | 0 41 | 1 22 | 2 3 | 2 44 | 3 25 | 4 6 | 4 47 | 5 28 | 6 9 | 6 50 | 7 31 | 8 12 | 8 53 |
| 42 | 0 42 | 1 24 | 2 6 | 2 48 | 3 30 | 4 12 | 4 54 | 5 36 | 6 18 | 7 0 | 7 42 | 8 24 | 9 6 |
| 43 | 0 43 | 1 26 | 2 9 | 2 52 | 3 35 | 4 18 | 5 1 | 5 44 | 6 27 | 7 10 | 7 53 | 8 36 | 9 19 |
| 44 | 0 44 | 1 28 | 2 12 | 2 56 | 3 40 | 4 24 | 5 8 | 5 52 | 6 36 | 7 20 | 8 4 | 8 48 | 9 32 |
| 45 | 0 45 | 1 30 | 2 15 | 3 0 | 3 45 | 4 30 | 5 15 | 6 0 | 6 45 | 7 30 | 8 15 | 9 0 | 9 45 |
| 46 | 0 46 | 1 32 | 2 18 | 3 4 | 3 50 | 4 36 | 5 22 | 6 8 | 6 54 | 7 40 | 8 26 | 9 12 | 9 58 |
| 47 | 0 47 | 1 34 | 2 21 | 3 8 | 3 55 | 4 42 | 5 29 | 6 16 | 7 3 | 7 50 | 8 37 | 9 24 | 10 11 |
| 48 | 0 48 | 1 36 | 2 24 | 3 12 | 4 0 | 4 48 | 5 36 | 6 24 | 7 12 | 8 0 | 8 48 | 9 36 | 10 24 |
| 49 | 0 49 | 1 38 | 2 27 | 3 16 | 4 5 | 4 54 | 5 43 | 6 32 | 7 21 | 8 10 | 8 59 | 9 48 | 10 37 |
| 50 | 0 50 | 1 40 | 2 30 | 3 20 | 4 10 | 5 0 | 5 50 | 6 40 | 7 30 | 8 20 | 9 10 | 10 0 | 10 50 |
| 51 | 0 51 | 1 42 | 2 33 | 3 24 | 4 15 | 5 6 | 5 57 | 6 48 | 7 39 | 8 30 | 9 21 | 10 12 | 11 3 |
| 52 | 0 52 | 1 44 | 2 36 | 3 28 | 4 20 | 5 12 | 6 4 | 6 56 | 7 48 | 8 40 | 9 32 | 10 24 | 11 16 |
| 53 | 0 53 | 1 46 | 2 39 | 3 32 | 4 25 | 5 18 | 6 11 | 7 4 | 7 57 | 8 50 | 9 43 | 10 36 | 11 29 |
| 54 | 0 54 | 1 48 | 2 42 | 3 36 | 4 30 | 5 24 | 6 18 | 7 12 | 8 6 | 9 0 | 9 54 | 10 48 | 11 42 |
| 55 | 0 55 | 1 50 | 2 45 | 3 40 | 4 35 | 5 30 | 6 25 | 7 20 | 8 15 | 9 10 | 10 5 | 11 0 | 11 55 |
| 56 | 0 56 | 1 52 | 2 48 | 3 44 | 4 40 | 5 36 | 6 32 | 7 28 | 8 24 | 9 20 | 10 16 | 11 12 | 12 8 |
| 57 | 0 57 | 1 54 | 2 51 | 3 48 | 4 45 | 5 42 | 6 39 | 7 36 | 8 33 | 9 30 | 10 27 | 11 24 | 12 21 |
| 58 | 0 58 | 1 56 | 2 54 | 3 52 | 4 50 | 5 48 | 6 46 | 7 44 | 8 42 | 9 40 | 10 38 | 11 36 | 12 34 |
| 59 | 0 59 | 1 58 | 2 57 | 3 56 | 4 55 | 5 54 | 6 53 | 7 52 | 8 51 | 9 50 | 10 49 | 11 48 | 12 47 |
| 60 | 1 0 | 2 0 | 3 0 | 4 0 | 5 0 | 6 0 | 7 0 | 8 0 | 9 0 | 10 0 | 11 0 | 12 0 | 13 0 |

## FOR REDUCING THE MOON'S DECLINATION

| M | Difference for 10m: 140″ | 150″ | 160″ | 170″ | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0′ 14″ | 0′ 15″ | 0′ 16″ | 0′ 17″ | 0″·1 | 0″·2 | 0″·3 | 0″·4 | 0″·5 | 0″·6 | 0″·7 | 0″·8 | 0″·9 | 1″ |
| 2 | 0 28 | 0 30 | 0 32 | 0 34 | 0·2 | ·4 | ·6 | ·8 | 1·0 | 1·2 | 1·4 | 1·6 | 1·8 | 2 |
| 3 | 0 42 | 0 45 | 0 48 | 0 51 | 0·3 | ·6 | ·9 | 1·2 | 1·5 | 1·8 | 2·1 | 2·4 | 2·7 | 3 |
| 4 | 0 56 | 1 0 | 1 4 | 1 8 | 0·4 | ·8 | 1·2 | 1·6 | 2·0 | 2·4 | 2·8 | 3·2 | 3·6 | 4 |
| 5 | 1 10 | 1 15 | 1 20 | 1 25 | 0·5 | 1·0 | 1·5 | 2·0 | 2·5 | 3·0 | 3·5 | 4·0 | 4·5 | 5 |
| 6 | 1 24 | 1 30 | 1 36 | 1 42 | 0·6 | 1·2 | 1·8 | 2·4 | 3·0 | 3·6 | 4·2 | 4·8 | 5·4 | 6 |
| 7 | 1 38 | 1 45 | 1 52 | 1 59 | 0·7 | 1·4 | 2·1 | 2·8 | 3·5 | 4·2 | 4·9 | 5·6 | 6·3 | 7 |
| 8 | 1 52 | 2 0 | 2 8 | 2 16 | 0·8 | 1·6 | 2·4 | 3·2 | 4·0 | 4·8 | 5·6 | 6·4 | 7·2 | 8 |
| 9 | 2 6 | 2 15 | 2 24 | 2 33 | 0·9 | 1·8 | 2·7 | 3·6 | 4·5 | 5·4 | 6·3 | 7·2 | 8·1 | 9 |
| 10 | 2 20 | 2 30 | 2 40 | 2 50 | 1·0 | 2·0 | 3·0 | 4·0 | 5·0 | 6·0 | 7·0 | 8·0 | 9·0 | 10 |
| 11 | 2 34 | 2 45 | 2 56 | 3 7 | 1·1 | 2·2 | 3·3 | 4·4 | 5·5 | 6·6 | 7·7 | 8·8 | 9·9 | 11 |
| 12 | 2 48 | 3 0 | 3 12 | 3 24 | 1·2 | 2·4 | 3·6 | 4·8 | 6·0 | 7·2 | 8·4 | 9·6 | 10·8 | 12 |
| 13 | 3 2 | 3 15 | 3 28 | 3 41 | 1·3 | 2·6 | 3·9 | 5·2 | 6·5 | 7·8 | 9·1 | 10·4 | 11·7 | 13 |
| 14 | 3 16 | 3 30 | 3 44 | 3 58 | 1·4 | 2·8 | 4·2 | 5·6 | 7·0 | 8·4 | 9·8 | 11·2 | 12·6 | 14 |
| 15 | 3 30 | 3 45 | 4 0 | 4 15 | 1·5 | 3·0 | 4·5 | 6·0 | 7·5 | 9·0 | 10·5 | 12·0 | 13·5 | 15 |
| 16 | 3 44 | 4 0 | 4 16 | 4 32 | 1·6 | 3·2 | 4·8 | 6·4 | 8·0 | 9·6 | 11·2 | 12·8 | 14·4 | 16 |
| 17 | 3 58 | 4 15 | 4 32 | 4 49 | 1·7 | 3·4 | 5·1 | 6·8 | 8·5 | 10·2 | 11·9 | 13·6 | 15·3 | 17 |
| 18 | 4 12 | 4 30 | 4 48 | 5 6 | 1·8 | 3·6 | 5·4 | 7·2 | 9·0 | 10·8 | 12·6 | 14·4 | 16·2 | 18 |
| 19 | 4 26 | 4 45 | 5 4 | 5 23 | 1·9 | 3·8 | 5·7 | 7·6 | 9·5 | 11·4 | 13·3 | 15·2 | 17·1 | 19 |
| 20 | 4 40 | 5 0 | 5 20 | 5 40 | 2·0 | 4·0 | 6·0 | 8·0 | 10·0 | 12·0 | 14·0 | 16·0 | 18·0 | 20 |
| 21 | 4 54 | 5 15 | 5 36 | 5 57 | 2·1 | 4·2 | 6·3 | 8·4 | 10·5 | 12·6 | 14·7 | 16·8 | 18·9 | 21 |
| 22 | 5 8 | 5 30 | 5 52 | 6 14 | 2·2 | 4·4 | 6·6 | 8·8 | 11·0 | 13·2 | 15·4 | 17·6 | 19·8 | 22 |
| 23 | 5 22 | 5 45 | 6 8 | 6 31 | 2·3 | 4·6 | 6·9 | 9·2 | 11·5 | 13·8 | 16·1 | 18·4 | 20·7 | 23 |
| 24 | 5 36 | 6 0 | 6 24 | 6 48 | 2·4 | 4·8 | 7·2 | 9·6 | 12·0 | 14·4 | 16·8 | 19·2 | 21·6 | 24 |
| 25 | 5 50 | 6 15 | 6 40 | 7 5 | 2·5 | 5·0 | 7·5 | 10·0 | 12·5 | 15·0 | 17·5 | 20·0 | 22·5 | 25 |
| 26 | 6 4 | 6 30 | 6 56 | 7 22 | 2·6 | 5·2 | 7·8 | 10·4 | 13·0 | 15·6 | 18·2 | 20·8 | 23·4 | 26 |
| 27 | 6 18 | 6 45 | 7 12 | 7 39 | 2·7 | 5·4 | 8·1 | 10·8 | 13·5 | 16·2 | 18·9 | 21·6 | 24·3 | 27 |
| 28 | 6 32 | 7 0 | 7 28 | 7 56 | 2·8 | 5·6 | 8·4 | 11·2 | 14·0 | 16·8 | 19·6 | 22·4 | 25·2 | 28 |
| 29 | 6 46 | 7 15 | 7 44 | 8 13 | 2·9 | 5·8 | 8·7 | 11·6 | 14·5 | 17·4 | 20·3 | 23·2 | 26·1 | 29 |
| 30 | 7 0 | 7 30 | 8 0 | 8 30 | 3·0 | 6·0 | 9·0 | 12·0 | 15·0 | 18·0 | 21·0 | 24·0 | 27·0 | 30 |
| 31 | 7 14 | 7 45 | 8 16 | 8 47 | 3·1 | 6·2 | 9·3 | 12·4 | 15·5 | 18·6 | 21·7 | 24·8 | 27·9 | 31 |
| 32 | 7 28 | 8 0 | 8 32 | 9 4 | 3·2 | 6·4 | 9·6 | 12·8 | 16·0 | 19·2 | 22·4 | 25·6 | 28·8 | 32 |
| 33 | 7 42 | 8 15 | 8 48 | 9 21 | 3·3 | 6·6 | 9·9 | 13·2 | 16·5 | 19·8 | 23·1 | 26·4 | 29·7 | 33 |
| 34 | 7 56 | 8 30 | 9 4 | 9 38 | 3·4 | 6·8 | 10·2 | 13·6 | 17·0 | 20·4 | 23·8 | 27·2 | 30·6 | 34 |
| 35 | 8 10 | 8 45 | 9 20 | 9 55 | 3·5 | 7·0 | 10·5 | 14·0 | 17·5 | 21·0 | 24·5 | 28·0 | 31·5 | 35 |
| 36 | 8 24 | 9 0 | 9 36 | 10 12 | 3·6 | 7·2 | 10·8 | 14·4 | 18·0 | 21·6 | 25·2 | 28·8 | 32·4 | 36 |
| 37 | 8 38 | 9 15 | 9 52 | 10 29 | 3·7 | 7·4 | 11·1 | 14·8 | 18·5 | 22·2 | 25·9 | 29·6 | 33·3 | 37 |
| 38 | 8 52 | 9 30 | 10 8 | 10 46 | 3·8 | 7·6 | 11·4 | 15·2 | 19·0 | 22·8 | 26·6 | 30·4 | 34·2 | 38 |
| 39 | 9 6 | 9 45 | 10 24 | 11 3 | 3·9 | 7·8 | 11·7 | 15·6 | 19·5 | 23·4 | 27·3 | 31·2 | 35·1 | 39 |
| 40 | 9 20 | 10 0 | 10 40 | 11 20 | 4·0 | 8·0 | 12·0 | 16·0 | 20·0 | 24·0 | 28·0 | 32·0 | 36·0 | 40 |
| 41 | 9 34 | 10 15 | 10 56 | 11 37 | 4·1 | 8·2 | 12·3 | 16·4 | 20·5 | 24·6 | 28·7 | 32·8 | 36·9 | 41 |
| 42 | 9 48 | 10 30 | 11 12 | 11 54 | 4·2 | 8·4 | 12·6 | 16·8 | 21·0 | 25·2 | 29·4 | 33·6 | 37·8 | 42 |
| 43 | 10 2 | 10 45 | 11 28 | 12 11 | 4·3 | 8·6 | 12·9 | 17·2 | 21·5 | 25·8 | 30·1 | 34·4 | 38·7 | 43 |
| 44 | 10 16 | 11 0 | 11 44 | 12 28 | 4·4 | 8·8 | 13·2 | 17·6 | 22·0 | 26·4 | 30·8 | 35·2 | 39·6 | 44 |
| 45 | 10 30 | 11 15 | 12 0 | 12 45 | 4·5 | 9·0 | 13·5 | 18·0 | 22·5 | 27·0 | 31·5 | 36·0 | 40·5 | 45 |
| 46 | 10 44 | 11 30 | 12 16 | 13 2 | 4·6 | 9·2 | 13·8 | 18·4 | 23·0 | 27·6 | 32·2 | 36·8 | 41·4 | 46 |
| 47 | 10 58 | 11 45 | 12 32 | 13 19 | 4·7 | 9·4 | 14·1 | 18·8 | 23·5 | 28·2 | 32·9 | 37·6 | 42·3 | 47 |
| 48 | 11 12 | 12 0 | 12 48 | 13 36 | 4·8 | 9·6 | 14·4 | 19·2 | 24·0 | 28·8 | 33·6 | 38·4 | 43·2 | 48 |
| 49 | 11 26 | 12 15 | 13 4 | 13 53 | 4·9 | 9·8 | 14·7 | 19·6 | 24·5 | 29·4 | 34·3 | 39·2 | 44·1 | 49 |
| 50 | 11 40 | 12 30 | 13 20 | 14 10 | 5·0 | 10·0 | 15·0 | 20·0 | 25·0 | 30·0 | 35·0 | 40·0 | 45·0 | 50 |
| 51 | 11 54 | 12 45 | 13 36 | 14 27 | 5·1 | 10·2 | 15·3 | 20·4 | 25·5 | 30·6 | 35·7 | 40·8 | 45·9 | 51 |
| 52 | 12 8 | 13 0 | 13 52 | 14 44 | 5·2 | 10·4 | 15·6 | 20·8 | 26·0 | 31·2 | 36·4 | 41·6 | 46·8 | 52 |
| 53 | 12 22 | 13 15 | 14 8 | 15 1 | 5·3 | 10·6 | 15·9 | 21·2 | 26·5 | 31·8 | 37·1 | 42·4 | 47·7 | 53 |
| 54 | 12 36 | 13 30 | 14 24 | 15 18 | 5·4 | 10·8 | 16·2 | 21·6 | 27·0 | 32·4 | 37·8 | 43·2 | 48·6 | 54 |
| 55 | 12 50 | 13 45 | 14 40 | 15 35 | 5·5 | 11·0 | 16·5 | 22·0 | 27·5 | 33·0 | 38·5 | 44·0 | 49·5 | 55 |
| 56 | 13 4 | 14 0 | 14 56 | 15 52 | 5·6 | 11·2 | 16·8 | 22·4 | 28·0 | 33·6 | 39·2 | 44·8 | 50·4 | 56 |
| 57 | 13 18 | 14 15 | 15 12 | 16 9 | 5·7 | 11·4 | 17·1 | 22·8 | 28·5 | 34·2 | 39·9 | 45·6 | 51·3 | 57 |
| 58 | 13 32 | 14 30 | 15 28 | 16 26 | 5·8 | 11·6 | 17·4 | 23·2 | 29·0 | 34·8 | 40·6 | 46·4 | 52·2 | 58 |
| 59 | 13 46 | 14 45 | 15 44 | 16 43 | 5·9 | 11·8 | 17·7 | 23·6 | 29·5 | 35·4 | 41·3 | 47·2 | 53·1 | 59 |
| 60 | 14 0 | 15 0 | 16 0 | 17 0 | 6·0 | 12·0 | 18·0 | 24·0 | 30·0 | 36·0 | 42·0 | 48·0 | 54·0 | 60 |

## TABLE 23

**ACCELERATION**

| H | M | S | M | S | S | Dec. |
|---|---|---|---|---|---|---|
| 1 | 0 | 9.86 | 1 | 0.16 | 1 | .00 |
| 2 | 0 | 19.71 | 2 | 0.33 | 2 | .00 |
| 3 | 0 | 29.57 | 3 | 0.49 | 3 | .01 |
| 4 | 0 | 39.43 | 4 | 0.66 | 4 | .01 |
| 5 | 0 | 49.28 | 5 | 0.82 | 5 | .01 |
| 6 | 0 | 59.14 | 6 | 0.98 | 6 | .02 |
| 7 | 1 | 9.00 | 7 | 1.15 | 7 | .02 |
| 8 | 1 | 18.85 | 8 | 1.31 | 8 | .02 |
| 9 | 1 | 28.71 | 9 | 1.48 | 9 | .02 |
| 10 | 1 | 38.56 | 10 | 1.64 | 10 | .03 |
| 11 | 1 | 48.42 | 11 | 1.81 | 11 | .03 |
| 12 | 1 | 58.28 | 12 | 1.97 | 12 | .03 |
| 13 | 2 | 8.13 | 13 | 2.13 | 13 | .04 |
| 14 | 2 | 17.99 | 14 | 2.30 | 14 | .04 |
| 15 | 2 | 27.85 | 15 | 2.46 | 15 | .04 |
| 16 | 2 | 37.70 | 16 | 2.63 | 16 | .04 |
| 17 | 2 | 47.56 | 17 | 2.79 | 17 | .05 |
| 18 | 2 | 57.42 | 18 | 2.96 | 18 | .05 |
| 19 | 3 | 7.27 | 19 | 3.12 | 19 | .05 |
| 20 | 3 | 17.13 | 20 | 3.29 | 20 | .05 |
| 21 | 3 | 26.99 | 21 | 3.45 | 21 | .06 |
| 22 | 3 | 36.84 | 22 | 3.61 | 22 | .06 |
| 23 | 3 | 46.70 | 23 | 3.78 | 23 | .06 |
| 24 | 3 | 56.56 | 24 | 3.94 | 24 | .07 |
| | | | 25 | 4.11 | 25 | .07 |
| | | | 26 | 4.27 | 26 | .07 |
| | | | 27 | 4.44 | 27 | .07 |
| | | | 28 | 4.60 | 28 | .08 |
| | | | 29 | 4.76 | 29 | .08 |
| | | | 30 | 4.93 | 30 | .08 |
| | | | 31 | 5.09 | 31 | .08 |
| | | | 32 | 5.26 | 32 | .09 |
| | | | 33 | 5.42 | 33 | .09 |
| | | | 34 | 5.59 | 34 | .09 |
| | | | 35 | 5.75 | 35 | .10 |
| | | | 36 | 5.91 | 36 | .10 |
| | | | 37 | 6.08 | 37 | .10 |
| | | | 38 | 6.24 | 38 | .11 |
| | | | 39 | 6.40 | 39 | .11 |
| | | | 40 | 6.57 | 40 | .11 |
| | | | 41 | 6.74 | 41 | .11 |
| | | | 42 | 6.90 | 42 | .12 |
| | | | 43 | 7.06 | 43 | .12 |
| | | | 44 | 7.23 | 44 | .12 |
| | | | 45 | 7.39 | 45 | .12 |
| | | | 46 | 7.56 | 46 | .13 |
| | | | 47 | 7.72 | 47 | .13 |
| | | | 48 | 7.89 | 48 | .13 |
| | | | 49 | 8.05 | 49 | .14 |
| | | | 50 | 8.21 | 50 | .14 |
| | | | 51 | 8.38 | 51 | .14 |
| | | | 52 | 8.54 | 52 | .14 |
| | | | 53 | 8.71 | 53 | .15 |
| | | | 54 | 8.87 | 54 | .15 |
| | | | 55 | 9.04 | 55 | .15 |
| | | | 56 | 9.20 | 56 | .13 |
| | | | 57 | 9.36 | 57 | .16 |
| | | | 58 | 9.53 | 58 | .16 |
| | | | 59 | 9.69 | 59 | .16 |
| | | | 60 | 9.86 | 60 | .16 |

## TABLE 24

**RETARDATION**

| H | M | S | M | S | S | Dec. |
|---|---|---|---|---|---|---|
| 1 | 0 | 9.83 | 1 | 0.16 | 1 | .00 |
| 2 | 0 | 19.66 | 2 | 0.33 | 2 | .00 |
| 3 | 0 | 29.49 | 3 | 0.49 | 3 | .01 |
| 4 | 0 | 39.32 | 4 | 0.66 | 4 | .01 |
| 5 | 0 | 49.15 | 5 | 0.82 | 5 | .01 |
| 6 | 0 | 58.98 | 6 | 0.98 | 6 | .02 |
| 7 | 1 | 8.81 | 7 | 1.15 | 7 | .02 |
| 8 | 1 | 18.64 | 8 | 1.31 | 8 | .02 |
| 9 | 1 | 28.47 | 9 | 1.47 | 9 | .02 |
| 10 | 1 | 38.30 | 10 | 1.64 | 10 | .03 |
| 11 | 1 | 48.13 | 11 | 1.80 | 11 | .03 |
| 12 | 1 | 57.95 | 12 | 1.97 | 12 | .03 |
| 13 | 2 | 7.78 | 13 | 2.13 | 13 | .04 |
| 14 | 2 | 17.61 | 14 | 2.29 | 14 | .04 |
| 15 | 2 | 27.44 | 15 | 2.46 | 15 | .04 |
| 16 | 2 | 37.27 | 16 | 2.62 | 16 | .04 |
| 17 | 2 | 47.10 | 17 | 2.78 | 17 | .05 |
| 18 | 2 | 56.93 | 18 | 2.95 | 18 | .05 |
| 19 | 3 | 6.76 | 19 | 3.11 | 19 | .05 |
| 20 | 3 | 16.59 | 20 | 3.28 | 20 | .05 |
| 21 | 3 | 26.42 | 21 | 3.44 | 21 | .06 |
| 22 | 3 | 36.25 | 22 | 3.60 | 22 | .06 |
| 23 | 3 | 46.08 | 23 | 3.77 | 23 | .06 |
| 24 | 3 | 55.91 | 24 | 3.93 | 24 | .07 |
| | | | 25 | 4.10 | 25 | .07 |
| | | | 26 | 4.26 | 26 | .07 |
| | | | 27 | 4.42 | 27 | .07 |
| | | | 28 | 4.59 | 28 | .08 |
| | | | 29 | 4.75 | 29 | .08 |
| | | | 30 | 4.91 | 30 | .08 |
| | | | 31 | 5.08 | 31 | .08 |
| | | | 32 | 5.24 | 32 | .09 |
| | | | 33 | 5.41 | 33 | .09 |
| | | | 34 | 5.57 | 34 | .09 |
| | | | 35 | 5.73 | 35 | .10 |
| | | | 36 | 5.90 | 36 | .10 |
| | | | 37 | 6.06 | 37 | .10 |
| | | | 38 | 6.23 | 38 | .11 |
| | | | 39 | 6.39 | 39 | .11 |
| | | | 40 | 6.55 | 40 | .11 |
| | | | 41 | 6.72 | 41 | .11 |
| | | | 42 | 6.88 | 42 | .12 |
| | | | 43 | 7.04 | 43 | .12 |
| | | | 44 | 7.21 | 44 | .12 |
| | | | 45 | 7.37 | 45 | .12 |
| | | | 46 | 7.54 | 46 | .13 |
| | | | 47 | 7.70 | 47 | .13 |
| | | | 48 | 7.86 | 48 | .13 |
| | | | 49 | 8.03 | 49 | .14 |
| | | | 50 | 8.19 | 50 | .14 |
| | | | 51 | 8.36 | 51 | .14 |
| | | | 52 | 8.52 | 52 | .14 |
| | | | 53 | 8.68 | 53 | .15 |
| | | | 54 | 8.85 | 54 | .15 |
| | | | 55 | 9.01 | 55 | .15 |
| | | | 56 | 9.17 | 56 | .15 |
| | | | 57 | 9.34 | 57 | .16 |
| | | | 58 | 9.50 | 58 | .16 |
| | | | 59 | 9.67 | 59 | .16 |
| | | | 60 | 9.83 | 60 | .16 |

## FOR FINDING THE EQUATION OF SECOND DIFFERENCES

| Tabular Interval | | | | | | | | Multi-plier. | Logarit. |
|---|---|---|---|---|---|---|---|---|---|
| 24 Hours | | 12 Hours | | 3 Hours | | 1 Hour | | | |
| 0h 12m | 23h 48m | 0h 6m | 11h 54m | 0h 1m·5 | 2h 58m·5 | | | ·0041 | 7·61615 |
| 0 24 | 23 36 | 0 12 | 11 48 | 0 3 | 2 57 | 1m | 59m | ·0082 | 7·91352 |
| 0 36 | 23 24 | 0 18 | 11 42 | 0 4·5 | 2 55·5 | | | ·0122 | 8·08591 |
| 0 48 | 23 12 | 0 24 | 11 36 | 0 6 | 2 54 | 2 | 58 | ·0161 | 8·20713 |
| 1 0 | 23 0 | 0 30 | 11 30 | 0 7·5 | 2 52·5 | | | ·0200 | 8·30028 |
| 1 12 | 22 48 | 0 36 | 11 24 | 0 9 | 2 51 | 3 | 57 | ·0238 | 8·37566 |
| 1 24 | 22 36 | 0 42 | 11 18 | 0 10·5 | 2 49·5 | | | ·0275 | 8·43878 |
| 1 36 | 22 24 | 0 48 | 11 12 | 0 12 | 2 48 | 4 | 56 | ·0311 | 8·49292 |
| 1 48 | 22 12 | 0 54 | 11 6 | 0 13·5 | 2 46·5 | | | ·0347 | 8·54017 |
| 2 0 | 22 0 | 1 0 | 11 0 | 0 15 | 2 45 | 5 | 55 | ·0382 | 8·58200 |
| 2 12 | 21 48 | 1 6 | 10 54 | 0 16·5 | 2 43·5 | | | ·0416 | 8·61943 |
| 2 24 | 21 36 | 1 12 | 10 48 | 0 18 | 2 42 | 6 | 54 | ·0450 | 8·65321 |
| 2 36 | 21 24 | 1 18 | 10 42 | 0 19·5 | 2 40·5 | | | ·0483 | 8·68393 |
| 2 48 | 21 12 | 1 24 | 10 36 | 0 21 | 2 39 | 7 | 53 | ·0515 | 8·71204 |
| 3 0 | 21 0 | 1 30 | 10 30 | 0 22·5 | 2 37·5 | | | ·0547 | 8·73789 |
| 3 12 | 21 48 | 1 36 | 10 24 | 0 24 | 2 36 | 8 | 52 | ·0578 | 8·76176 |
| 3 24 | 20 36 | 1 42 | 10 18 | 0 25·5 | 2 34·5 | | | ·0608 | 8·78389 |
| 3 36 | 20 24 | 1 48 | 10 12 | 0 27 | 2 33 | 9 | 51 | ·0637 | 8·80448 |
| 3 48 | 20 12 | 1 54 | 10 6 | 0 28·5 | 2 31·5 | | | ·0666 | 8·82368 |
| 4 0 | 20 0 | 2 0 | 10 0 | 0 30 | 2 30 | 10 | 50 | ·0694 | 8·84164 |
| 4 12 | 19 48 | 2 6 | 9 54 | 0 31·5 | 2 28·5 | | | ·0722 | 8·85846 |
| 4 24 | 19 36 | 2 12 | 9 48 | 0 33 | 2 27 | 11 | 49 | ·0749 | 8·87426 |
| 4 36 | 19 24 | 2 18 | 9 42 | 0 34·5 | 2 25·5 | | | ·0775 | 8·88911 |
| 4 48 | 19 12 | 2 24 | 9 36 | 0 36 | 2 24 | 12 | 48 | ·0800 | 8·90309 |
| 5 0 | 19 0 | 2 30 | 9 30 | 0 37·5 | 2 22·5 | | | ·0825 | 8·91627 |
| 5 12 | 18 48 | 2 36 | 9 24 | 0 39 | 2 21 | 13 | 47 | ·0849 | 8·92871 |
| 5 24 | 18 36 | 2 42 | 9 18 | 0 40·5 | 2 19·5 | | | ·0872 | 8·94045 |
| 5 36 | 18 24 | 2 48 | 9 12 | 0 42 | 2 18 | 14 | 46 | ·0894 | 8·95195 |
| 5 48 | 18 12 | 2 54 | 9 6 | 0 43·5 | 2 16·5 | | | ·0916 | 8·96205 |
| 6 0 | 18 0 | 3 0 | 9 0 | 0 45 | 2 15 | 15 | 45 | ·0937 | 8·97197 |
| 6 12 | 17 48 | 3 6 | 8 54 | 0 46·5 | 2 13·5 | | | ·0958 | 8·98136 |
| 6 24 | 17 36 | 3 12 | 8 48 | 0 48 | 2 12 | 16 | 44 | ·0978 | 8·99024 |
| 6 36 | 17 24 | 3 18 | 8 42 | 0 49·5 | 2 10·5 | | | ·0997 | 8·99864 |
| 6 48 | 17 12 | 3 24 | 8 36 | 0 51 | 2 9 | 17 | 43 | ·1015 | 9·00658 |
| 7 0 | 17 0 | 3 30 | 8 30 | 0 52·5 | 2 7·5 | | | ·1033 | 9·01409 |
| 7 12 | 16 48 | 3 36 | 8 24 | 0 54 | 2 6 | 18 | 42 | ·1050 | 9·02119 |
| 7 24 | 16 36 | 3 42 | 8 18 | 0 55·5 | 2 4·5 | | | ·1066 | 9·02789 |
| 7 36 | 16 24 | 3 48 | 8 12 | 0 57 | 2 3 | 19 | 41 | ·1082 | 9·03421 |
| 7 48 | 16 12 | 3 54 | 8 6 | 0 58·5 | 2 1·5 | | | ·1097 | 9·04016 |
| 8 0 | 16 0 | 4 0 | 8 0 | 1 0 | 2 0 | 20 | 40 | ·1111 | 9·04576 |
| 8 12 | 15 48 | 4 6 | 7 54 | 1 1·5 | 1 58·5 | | | ·1125 | 9·05102 |
| 8 24 | 15 36 | 4 12 | 7 48 | 1 3 | 1 57 | 21 | 39 | ·1138 | 9·05595 |
| 8 36 | 15 24 | 4 18 | 7 42 | 1 4·5 | 1 55·5 | | | ·1150 | 9·06057 |
| 8 48 | 15 12 | 4 24 | 7 36 | 1 6 | 1 54 | 22 | 38 | ·1161 | 9·06487 |
| 9 0 | 15 0 | 4 30 | 7 30 | 1 7·5 | 1 52·5 | | | ·1172 | 9·06888 |
| 9 12 | 14 48 | 4 36 | 7 24 | 1 9 | 1 51 | 23 | 37 | ·1182 | 9·07260 |
| 9 24 | 14 36 | 4 42 | 7 18 | 1 10·5 | 1 49·5 | | | ·1191 | 9·07603 |
| 9 36 | 14 24 | 4 48 | 7 12 | 1 12 | 1 48 | 24 | 36 | ·1200 | 9·07918 |
| 9 48 | 14 12 | 4 54 | 7 6 | 1 13·5 | 1 46·5 | | | ·1208 | 9·08206 |
| 10 0 | 14 0 | 5 0 | 7 0 | 1 15 | 1 45 | 25 | 35 | ·1215 | 9·08468 |
| 10 12 | 13 48 | 5 6 | 6 54 | 1 16·5 | 1 43·5 | | | ·1222 | 9·08703 |
| 10 24 | 13 36 | 5 12 | 6 48 | 1 18 | 1 42 | 26 | 34 | ·1228 | 9·08912 |
| 10 36 | 13 24 | 5 18 | 6 42 | 1 19·5 | 1 40·5 | | | ·1233 | 9·09096 |
| 10 48 | 13 12 | 5 24 | 6 36 | 1 21 | 1 39 | 27 | 33 | ·1237 | 9·09255 |
| 11 0 | 13 0 | 5 30 | 6 30 | 1 22·5 | 1 37·5 | | | ·1241 | 9·09388 |
| 11 12 | 12 48 | 5 36 | 6 24 | 1 24 | 1 36 | 28 | 32 | ·1244 | 9·09498 |
| 11 24 | 12 36 | 5 42 | 6 18 | 1 25·5 | 1 34·5 | | | ·1247 | 9·09582 |
| 11 36 | 12 24 | 5 48 | 6 12 | 1 27 | 1 33 | 29 | 31 | ·1249 | 9·09643 |
| 11 48 | 12 12 | 5 54 | 6 6 | 1 28·5 | 1 31·5 | | | ·1250 | 9·09679 |
| 12 0 | 12 0 | 6 0 | 6 0 | 1 30 | 1 30 | 30 | 30 | ·1250 | 9·09691 |

## APPARENT TIME OF THE SUN'S RISING AND SETTING

Declination, of the *same* Name as the Latitude

| Lat. | 0° | | 2° | | 4° | | 6° | | 8° | | 9° | | 10° | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ris. | Sett. | Ris. | Sett. | Ris. | Sett. | Ris. | Sett. | Ris. | Sett. | Ris. | Sett. | Ris. | Sett. |
| 0° | 6h 0m | 6h 0m | 6h 0m | 6h 0m | 6h 0m | 6h 0m | 6h 0m | 6h 0m | 6h 0m | 6h 0m | 6h 0m | 6h 0m | 6h 0m | 6h 0m |
| 2 | 6 0 | 6 0 | 6 0 | 6 0 | 6 0 | 6 0 | 6 0 | 6 0 | 5 59 | 6 1 | 5 59 | 6 1 | 5 59 | 6 1 |
| 4 | 6 0 | 6 0 | 6 0 | 6 0 | 5 59 | 6 1 | 5 59 | 6 1 | 5 58 | 6 2 | 5 58 | 6 2 | 5 57 | 6 3 |
| 6 | 6 0 | 6 0 | 6 0 | 6 0 | 5 58 | 6 2 | 5 58 | 6 2 | 5 57 | 6 3 | 5 57 | 6 3 | 5 56 | 0 4 |
| 8 | 6 0 | 6 0 | 5 59 | 6 1 | 5 58 | 6 2 | 5 57 | 6 3 | 5 56 | 6 4 | 5 55 | 6 5 | 5 55 | 6 5 |
| 10 | 6 0 | 6 0 | 5 59 | 6 1 | 5 57 | 6 3 | 5 56 | 6 4 | 5 54 | 6 6 | 5 54 | 6 6 | 5 53 | 6 7 |
| 12 | 5 0 | 6 0 | 5 58 | 6 2 | 5 57 | 6 3 | 5 55 | 6 5 | 5 53 | 6 7 | 5 53 | 6 7 | 5 52 | 6 9 |
| 14 | 6 0 | 6 0 | 5 58 | 6 2 | 5 56 | 6 4 | 5 54 | 6 6 | 5 52 | 6 8 | 5 51 | 6 8 | 5 51 | 6 10 |
| 16 | 6 0 | 6 0 | 5 58 | 6 2 | 5 55 | 6 5 | 5 53 | 6 7 | 5 51 | 6 9 | 5 50 | 6 10 | 5 48 | 6 12 |
| 18 | 6 0 | 6 0 | 5 58 | 6 2 | 5 55 | 6 5 | 5 52 | 6 8 | 5 50 | 6 10 | 5 48 | 6 12 | 5 47 | 6 13 |
| 20 | 6 0 | 6 0 | 5 57 | 6 3 | 5 54 | 6 6 | 5 51 | 6 9 | 5 48 | 6 12 | 5 47 | 6 13 | 5 45 | 6 15 |
| 21 | 6 0 | 6 0 | 5 57 | 6 3 | 5 54 | 6 6 | 5 51 | 6 9 | 5 48 | 6 12 | 5 46 | 6 14 | 5 44 | 6 16 |
| 22 | 6 0 | 6 0 | 5 57 | 6 3 | 5 54 | 6 6 | 5 50 | 6 10 | 5 47 | 6 13 | 5 45 | 6 15 | 5 44 | 6 16 |
| 23 | 6 0 | 6 0 | 5 57 | 6 3 | 5 53 | 6 7 | 5 50 | 6 10 | 5 46 | 6 14 | 5 45 | 6 15 | 5 43 | 6 17 |
| 24 | 6 0 | 6 0 | 5 57 | 6 3 | 5 53 | 6 7 | 5 49 | 6 11 | 5 46 | 6 14 | 5 44 | 6 16 | 5 42 | 6 18 |
| 25 | 6 0 | 6 0 | 5 56 | 6 4 | 5 53 | 6 7 | 5 49 | 6 11 | 5 45 | 6 15 | 5 43 | 6 17 | 5 41 | 6 19 |
| 26 | 6 0 | 6 0 | 5 56 | 6 4 | 5 52 | 6 8 | 5 48 | 6 12 | 5 44 | 6 16 | 5 42 | 6 18 | 5 40 | 6 20 |
| 27 | 6 0 | 6 0 | 5 56 | 6 4 | 5 52 | 6 8 | 5 48 | 6 12 | 5 44 | 6 16 | 5 41 | 6 19 | 5 39 | 6 21 |
| 28 | 6 0 | 6 0 | 5 56 | 6 4 | 5 51 | 6 9 | 5 47 | 6 13 | 5 43 | 6 17 | 5 41 | 6 19 | 5 38 | 6 22 |
| 29 | 6 0 | 6 0 | 5 56 | 6 4 | 5 51 | 6 9 | 5 47 | 6 13 | 5 42 | 6 18 | 5 40 | 6 20 | 5 38 | 6 22 |
| 30 | 6 0 | 6 0 | 5 55 | 6 5 | 5 51 | 6 9 | 5 46 | 6 14 | 5 41 | 6 19 | 5 39 | 6 21 | 5 37 | 6 23 |
| 31 | 6 0 | 6 0 | 5 55 | 6 5 | 5 50 | 6 10 | 5 46 | 6 14 | 5 41 | 6 19 | 5 38 | 6 22 | 5 36 | 6 24 |
| 32 | 6 0 | 6 0 | 5 55 | 6 5 | 5 50 | 6 10 | 5 45 | 6 15 | 5 40 | 6 20 | 5 37 | 6 23 | 5 35 | 6 25 |
| 33 | 6 0 | 6 0 | 5 55 | 6 5 | 5 50 | 6 10 | 5 44 | 6 16 | 5 39 | 6 21 | 5 36 | 6 24 | 5 34 | 6 26 |
| 34 | 6 0 | 6 0 | 5 55 | 6 5 | 5 49 | 6 11 | 5 44 | 6 16 | 5 38 | 6 22 | 5 35 | 6 25 | 5 33 | 6 27 |
| 35 | 6 0 | 6 0 | 5 55 | 6 5 | 5 49 | 6 11 | 5 43 | 6 17 | 5 37 | 6 23 | 5 35 | 6 25 | 5 32 | 6 28 |
| 36 | 6 0 | 6 0 | 5 55 | 6 5 | 5 48 | 6 12 | 5 42 | 6 18 | 5 37 | 6 23 | 5 34 | 6 26 | 5 31 | 6 29 |
| 37 | 6 0 | 6 0 | 5 55 | 6 5 | 5 48 | 6 12 | 5 42 | 6 18 | 5 36 | 6 24 | 5 33 | 6 27 | 5 29 | 6 31 |
| 38 | 6 0 | 6 0 | 5 55 | 6 5 | 5 47 | 6 13 | 5 41 | 6 19 | 5 35 | 6 25 | 5 32 | 6 29 | 5 28 | 6 32 |
| 39 | 6 0 | 6 0 | 5 55 | 6 5 | 5 47 | 6 13 | 5 40 | 6 20 | 5 34 | 6 26 | 5 31 | 6 29 | 5 27 | 6 33 |
| 40 | 6 0 | 6 0 | 5 54 | 6 6 | 5 47 | 6 13 | 5 40 | 6 20 | 5 33 | 6 27 | 5 29 | 6 31 | 5 26 | 6 34 |
| 41 | 6 0 | 6 0 | 5 54 | 6 6 | 5 46 | 6 14 | 5 39 | 6 21 | 5 32 | 6 28 | 5 28 | 6 32 | 5 25 | 6 35 |
| 42 | 6 0 | 6 0 | 5 54 | 6 6 | 5 46 | 6 14 | 5 38 | 6 22 | 5 31 | 6 29 | 5 27 | 6 33 | 5 23 | 6 37 |
| 43 | 6 0 | 6 0 | 5 53 | 6 7 | 5 45 | 6 15 | 5 38 | 6 22 | 5 30 | 6 30 | 5 26 | 6 34 | 5 22 | 6 38 |
| 44 | 6 0 | 6 0 | 5 53 | 6 7 | 5 45 | 6 15 | 5 37 | 6 23 | 5 29 | 6 31 | 5 25 | 6 35 | 5 21 | 6 39 |
| 45 | 6 0 | 6 0 | 5 52 | 6 8 | 5 44 | 6 16 | 5 36 | 6 24 | 5 28 | 6 32 | 5 24 | 6 36 | 5 19 | 6 41 |
| 46 | 6 0 | 6 0 | 5 52 | 6 8 | 5 43 | 6 17 | 5 35 | 6 25 | 5 27 | 6 33 | 5 22 | 6 38 | 5 18 | 6 42 |
| 47 | 6 0 | 6 0 | 5 51 | 6 9 | 5 43 | 6 17 | 5 34 | 6 26 | 5 25 | 6 35 | 5 21 | 6 39 | 5 16 | 6 44 |
| 48 | 6 0 | 6 0 | 5 51 | 6 9 | 5 42 | 6 18 | 5 33 | 6 27 | 5 24 | 6 36 | 5 19 | 6 41 | 5 15 | 6 45 |
| 49 | 6 0 | 6 0 | 5 51 | 6 9 | 5 42 | 6 18 | 5 32 | 6 28 | 5 23 | 6 37 | 5 18 | 6 42 | 5 13 | 6 47 |
| 50 | 6 0 | 6 0 | 5 50 | 6 10 | 5 41 | 6 19 | 5 31 | 6 29 | 5 21 | 6 39 | 5 16 | 6 44 | 5 11 | 6 49 |
| 51 | 6 0 | 6 0 | 5 50 | 6 10 | 5 40 | 6 20 | 5 30 | 6 30 | 5 20 | 6 40 | 5 15 | 6 45 | 5 10 | 6 50 |
| 52 | 6 0 | 6 0 | 5 50 | 6 10 | 5 39 | 6 21 | 5 29 | 6 31 | 5 19 | 6 41 | 5 13 | 6 47 | 5 8 | 6 52 |
| 53 | 6 0 | 6 0 | 5 49 | 6 11 | 5 39 | 6 21 | 5 28 | 6 32 | 5 17 | 6 43 | 5 11 | 6 49 | 5 6 | 6 54 |
| 54 | 6 0 | 6 0 | 5 49 | 6 11 | 5 38 | 6 22 | 5 27 | 6 33 | 5 15 | 6 45 | 5 10 | 6 50 | 5 4 | 6 56 |
| 55 | 6 0 | 6 0 | 5 49 | 6 11 | 5 37 | 6 23 | 5 25 | 6 35 | 5 14 | 6 46 | 5 8 | 6 52 | 5 2 | 6 58 |
| 56 | 6 0 | 6 0 | 5 48 | 6 12 | 5 36 | 6 24 | 5 24 | 6 36 | 5 12 | 6 48 | 5 6 | 6 54 | 4 59 | 7 1 |
| 57 | 6 0 | 6 0 | 5 48 | 6 12 | 5 35 | 6 25 | 5 23 | 6 37 | 5 10 | 6 50 | 5 4 | 6 56 | 4 57 | 7 3 |
| 58 | 6 0 | 6 0 | 5 47 | 6 13 | 5 34 | 6 26 | 5 21 | 6 39 | 5 8 | 6 52 | 5 1 | 6 59 | 4 54 | 7 6 |
| 59 | 6 0 | 6 0 | 5 47 | 6 13 | 5 33 | 6 27 | 5 20 | 6 40 | 5 6 | 6 54 | 4 59 | 7 1 | 4 52 | 7 8 |
| 60 | 6 0 | 6 0 | 5 46 | 6 14 | 5 32 | 6 28 | 5 18 | 6 42 | 5 4 | 6 56 | 4 56 | 7 4 | 4 49 | 7 11 |
| 61 | 6 0 | 6 0 | 5 46 | 6 14 | 5 31 | 6 29 | 5 16 | 6 44 | 5 1 | 6 59 | 4 54 | 7 6 | 4 46 | 7 14 |
| 62 | 6 0 | 6 0 | 5 45 | 6 15 | 5 30 | 6 30 | 5 14 | 6 46 | 4 59 | 7 1 | 4 51 | 7 9 | 4 43 | 7 17 |
| 63 | 6 0 | 6 0 | 5 44 | 6 16 | 5 28 | 6 32 | 5 12 | 6 48 | 4 56 | 7 4 | 4 48 | 7 12 | 4 39 | 7 21 |
| 64 | 6 0 | 6 0 | 5 44 | 6 16 | 5 27 | 6 33 | 5 10 | 6 50 | 4 53 | 7 7 | 4 44 | 7 16 | 4 35 | 7 25 |
| 65 | 6 0 | 6 0 | 5 43 | 6 17 | 5 26 | 6 34 | 5 8 | 6 52 | 4 50 | 7 10 | 4 41 | 7 19 | 4 31 | 7 29 |
| 66 | 6 0 | 6 0 | 5 42 | 6 18 | 5 24 | 6 35 | 5 5 | 6 54 | 4 46 | 7 13 | 4 37 | 7 23 | 4 27 | 7 33 |
| 66½ | 6 0 | 6 0 | 5 42 | 6 18 | 5 23 | 6 36 | 5 4 | 6 56 | 4 44 | 7 16 | 4 34 | 7 26 | 4 24 | 7 36 |
| Lat. | Sett. | Ris. | Sett. | Ris. | Sett. | Ris. | Sett. | Ris. | Sett. | Ris. | Sett. | Ris. | Sett. | Ris. |

Latitude and Declination of *contrary* Names

## APPARENT TIMES OF THE SUN'S RISING AND SETTING

**Declination, of the *same* Name as the Latitude**

| Lat. | 11° | | 12° | | 13° | | 14° | | 15° | | 16° | | 7° | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ris. | Sett. | Ris. | Sett. | Ris. | Sett. | Ris. | Sett. | Ris. | Sett. | Ris. | Sett. | Ris. | Sett. |
| 0° | 6$^h$ 0$^m$ | 6$^h$ 0$^m$ | 6$^h$ 0$^m$ | 6$^h$ 0$^m$ | 6$^h$ 0$^m$ | 6$^h$ 0$^m$ | 6$^h$ 0$^m$ | 6$^h$ 0$^m$ | 6$^h$ 0$^m$ | 6$^h$ 0$^m$ | 6$^h$ 0$^m$ | 6$^h$ 0$^m$ | 6$^h$ 0$^m$ | 6$^h$ 0$^m$ |
| 2 | 5 59 | 6 1 | 5 58 | 6 1 | 5 58 | 6 2 | 5 58 | 6 2 | 5 58 | 6 2 | 5 58 | 6 2 | 5 58 | 6 2 |
| 4 | 5 57 | 6 3 | 5 57 | 6 3 | 5 56 | 6 4 | 5 56 | 6 4 | 5 56 | 6 4 | 5 56 | 6 4 | 5 55 | 6 5 |
| 6 | 5 56 | 6 4 | 5 55 | 6 5 | 5 55 | 6 5 | 5 54 | 6 6 | 5 54 | 6 6 | 5 53 | 6 7 | 5 53 | 6 7 |
| 8 | 5 54 | 6 6 | 5 53 | 6 8 | 5 53 | 6 7 | 5 52 | 6 8 | 5 51 | 6 9 | 5 51 | 6 9 | 5 50 | 6 10 |
| 10 | 5 52 | 6 8 | 5 52 | 6 9 | 5 51 | 6 9 | 5 50 | 6 10 | 5 49 | 6 11 | 5 49 | 6 12 | 5 48 | 6 12 |
| 12 | 5 51 | 6 9 | 5 50 | 6 10 | 5 49 | 6 11 | 5 48 | 6 12 | 5 47 | 6 13 | 5 46 | 6 14 | 5 45 | 6 15 |
| 14 | 5 50 | 6 11 | 5 48 | 6 12 | 5 48 | 6 13 | 5 46 | 6 14 | 5 45 | 6 15 | 5 44 | 6 16 | 5 43 | 6 17 |
| 16 | 5 47 | 6 13 | 5 46 | 6 14 | 5 45 | 6 15 | 5 44 | 6 16 | 5 42 | 6 18 | 5 41 | 6 19 | 5 40 | 6 20 |
| 18 | 5 46 | 6 14 | 5 44 | 6 16 | 5 43 | 6 17 | 5 41 | 6 19 | 5 40 | 6 20 | 5 39 | 6 21 | 5 37 | 6 23 |
| 20 | 5 44 | 6 16 | 5 42 | 6 18 | 5 41 | 6 19 | 5 39 | 6 21 | 5 38 | 6 22 | 5 36 | 6 24 | 5 34 | 6 26 |
| 21 | 5 43 | 6 17 | 5 41 | 6 19 | 5 40 | 6 20 | 5 38 | 6 22 | 5 36 | 6 24 | 5 35 | 6 25 | 5 33 | 6 27 |
| 22 | 5 42 | 6 18 | 5 40 | 6 20 | 5 39 | 6 21 | 5 37 | 6 23 | 5 35 | 6 25 | 5 33 | 6 27 | 5 32 | 6 28 |
| 23 | 5 41 | 6 19 | 5 39 | 6 21 | 5 38 | 6 22 | 5 36 | 6 24 | 5 34 | 6 26 | 5 32 | 6 28 | 5 30 | 6 30 |
| 24 | 5 40 | 6 20 | 5 38 | 6 22 | 5 36 | 6 24 | 5 34 | 6 26 | 5 33 | 6 27 | 5 31 | 6 29 | 5 29 | 6 31 |
| 25 | 5 39 | 6 21 | 5 37 | 6 23 | 5 35 | 6 25 | 5 33 | 6 27 | 5 31 | 6 29 | 5 29 | 6 31 | 5 27 | 6 33 |
| 26 | 5 38 | 6 22 | 5 36 | 6 24 | 5 34 | 6 26 | 5 32 | 6 28 | 5 30 | 6 30 | 5 28 | 6 32 | 5 26 | 6 34 |
| 27 | 5 37 | 6 23 | 5 35 | 6 25 | 5 33 | 6 27 | 5 31 | 6 29 | 5 29 | 6 31 | 5 26 | 6 34 | 5 24 | 6 36 |
| 28 | 5 36 | 6 24 | 5 34 | 6 26 | 5 32 | 6 28 | 5 30 | 6 30 | 5 27 | 6 33 | 5 25 | 6 35 | 5 23 | 6 37 |
| 29 | 5 35 | 6 25 | 5 33 | 6 27 | 5 31 | 6 29 | 5 28 | 6 32 | 5 26 | 6 34 | 5 23 | 6 37 | 5 21 | 6 39 |
| 30 | 5 34 | 6 26 | 5 32 | 6 28 | 5 29 | 6 31 | 5 27 | 6 33 | 5 24 | 6 36 | 5 22 | 6 38 | 5 19 | 6 41 |
| 31 | 5 33 | 6 27 | 5 31 | 6 29 | 5 28 | 6 32 | 5 26 | 6 34 | 5 23 | 6 37 | 5 20 | 6 40 | 5 18 | 6 42 |
| 32 | 5 32 | 6 28 | 5 29 | 6 31 | 5 27 | 6 33 | 5 24 | 6 36 | 5 21 | 6 39 | 5 19 | 6 41 | 5 16 | 6 44 |
| 33 | 5 31 | 6 29 | 5 28 | 6 32 | 5 26 | 6 34 | 5 23 | 6 37 | 5 20 | 6 40 | 5 17 | 6 43 | 5 14 | 6 46 |
| 34 | 5 30 | 6 30 | 5 27 | 6 33 | 5 24 | 6 36 | 5 21 | 6 39 | 5 18 | 6 42 | 5 15 | 6 45 | 5 12 | 6 48 |
| 35 | 5 29 | 6 31 | 5 26 | 6 34 | 5 23 | 6 37 | 5 20 | 6 40 | 5 17 | 6 43 | 5 14 | 6 46 | 5 11 | 6 49 |
| 36 | 5 28 | 6 32 | 5 24 | 6 36 | 5 21 | 6 39 | 5 18 | 6 42 | 5 15 | 6 45 | 5 12 | 6 48 | 5 9 | 6 51 |
| 37 | 5 26 | 6 34 | 5 23 | 6 37 | 5 20 | 6 40 | 5 17 | 6 43 | 5 13 | 6 47 | 5 10 | 6 50 | 5 7 | 6 53 |
| 38 | 5 25 | 6 35 | 5 22 | 6 38 | 5 18 | 6 42 | 5 15 | 6 45 | 5 12 | 6 48 | 5 8 | 6 52 | 5 5 | 6 55 |
| 39 | 5 24 | 6 36 | 5 20 | 6 40 | 5 17 | 6 43 | 5 13 | 6 47 | 5 10 | 6 50 | 5 6 | 6 54 | 5 3 | 6 57 |
| 40 | 5 22 | 6 38 | 5 19 | 6 41 | 5 15 | 6 45 | 5 12 | 6 48 | 5 8 | 6 52 | 5 4 | 6 56 | 5 1 | 6 59 |
| 41 | 5 21 | 6 39 | 5 17 | 6 43 | 5 14 | 6 46 | 5 10 | 6 50 | 5 6 | 6 54 | 5 2 | 6 58 | 4 58 | 7 2 |
| 42 | 5 20 | 6 40 | 5 16 | 6 44 | 5 12 | 6 48 | 5 8 | 6 52 | 5 4 | 6 56 | 5 0 | 7 0 | 4 56 | 7 4 |
| 43 | 5 18 | 6 42 | 5 14 | 6 46 | 5 10 | 6 50 | 5 6 | 6 54 | 5 2 | 6 58 | 4 58 | 7 2 | 4 54 | 7 6 |
| 44 | 5 17 | 6 43 | 5 13 | 6 47 | 5 8 | 6 52 | 5 4 | 6 56 | 5 0 | 7 0 | 4 56 | 7 4 | 4 51 | 7 9 |
| 45 | 5 15 | 6 45 | 5 11 | 6 49 | 5 7 | 6 53 | 5 2 | 6 58 | 4 58 | 7 2 | 4 53 | 7 7 | 4 49 | 7 11 |
| 46 | 5 14 | 6 46 | 5 9 | 6 51 | 5 5 | 6 55 | 5 0 | 7 0 | 4 56 | 7 4 | 4 51 | 7 9 | 4 46 | 7 14 |
| 47 | 5 12 | 6 48 | 5 7 | 6 53 | 5 3 | 6 57 | 4 58 | 7 2 | 4 53 | 7 7 | 4 48 | 7 12 | 4 43 | 7 17 |
| 48 | 5 10 | 6 50 | 5 5 | 6 55 | 5 1 | 6 59 | 4 56 | 7 4 | 4 51 | 7 9 | 4 46 | 7 14 | 4 41 | 7 19 |
| 49 | 5 8 | 6 52 | 5 3 | 6 57 | 4 58 | 7 2 | 4 53 | 7 7 | 4 48 | 7 12 | 4 43 | 7 17 | 4 38 | 7 22 |
| 50 | 5 6 | 6 54 | 5 1 | 6 59 | 4 56 | 7 4 | 4 51 | 7 9 | 4 46 | 7 14 | 4 40 | 7 20 | 4 35 | 7 25 |
| 51 | 5 4 | 6 56 | 4 59 | 7 1 | 4 54 | 7 6 | 4 48 | 7 12 | 4 43 | 7 17 | 4 37 | 7 23 | 4 31 | 7 29 |
| 52 | 5 2 | 6 58 | 4 57 | 7 3 | 4 51 | 7 9 | 4 46 | 7 14 | 4 40 | 7 20 | 4 34 | 7 26 | 4 28 | 7 32 |
| 53 | 5 0 | 7 0 | 4 54 | 7 6 | 4 49 | 7 11 | 4 43 | 7 17 | 4 37 | 7 23 | 4 31 | 7 29 | 4 24 | 7 36 |
| 54 | 4 58 | 7 2 | 4 52 | 7 8 | 4 46 | 7 14 | 4 40 | 7 20 | 4 33 | 7 27 | 4 27 | 7 33 | 4 20 | 7 40 |
| 55 | 4 56 | 7 4 | 4 49 | 7 11 | 4 43 | 7 17 | 4 37 | 7 23 | 4 30 | 7 30 | 4 23 | 7 37 | 4 16 | 7 44 |
| 56 | 4 53 | 7 7 | 4 47 | 7 13 | 4 40 | 7 20 | 4 33 | 7 27 | 4 26 | 7 34 | 4 19 | 7 41 | 4 12 | 7 48 |
| 57 | 4 50 | 7 10 | 4 44 | 7 16 | 4 37 | 7 23 | 4 30 | 7 30 | 4 23 | 7 37 | 4 15 | 7 45 | 4 8 | 7 52 |
| 58 | 4 47 | 7 13 | 4 40 | 7 20 | 4 33 | 7 27 | 4 26 | 7 34 | 4 18 | 7 42 | 4 11 | 7 49 | 4 3 | 7 57 |
| 59 | 4 44 | 7 16 | 4 37 | 7 23 | 4 30 | 7 30 | 4 22 | 7 38 | 4 14 | 7 46 | 4 6 | 7 54 | 3 58 | 8 2 |
| 60 | 4 41 | 7 19 | 4 34 | 7 26 | 4 26 | 7 34 | 4 18 | 7 42 | 4 9 | 7 51 | 4 1 | 7 59 | 3 52 | 8 8 |
| 61 | 4 38 | 7 22 | 4 30 | 7 30 | 4 22 | 7 38 | 4 13 | 7 47 | 4 4 | 7 56 | 3 55 | 8 5 | 3 46 | 8 14 |
| 62 | 4 34 | 7 26 | 4 26 | 7 34 | 4 17 | 7 43 | 4 8 | 7 52 | 3 59 | 8 1 | 3 49 | 8 11 | 3 40 | 8 20 |
| 63 | 4 30 | 7 30 | 4 21 | 7 39 | 4 12 | 7 48 | 4 3 | 7 57 | 3 53 | 8 7 | 3 43 | 8 17 | 3 33 | 8 27 |
| 64 | 4 26 | 7 34 | 4 17 | 7 43 | 4 7 | 7 53 | 3 57 | 8 3 | 3 47 | 8 13 | 3 36 | 8 24 | 3 25 | 8 35 |
| 65 | 4 21 | 7 39 | 4 12 | 7 48 | 4 1 | 7 59 | 3 51 | 8 9 | 3 40 | 8 20 | 3 28 | 8 32 | 3 16 | 8 44 |
| 66 | 4 18 | 7 42 | 4 6 | 7 54 | 3 55 | 8 5 | 3 44 | 8 16 | 3 32 | 8 28 | 3 20 | 8 40 | 3 7 | 8 53 |
| 66½ | 4 14 | 7 46 | 4 3 | 7 57 | 3 52 | 8 8 | 3 40 | 8 20 | 3 28 | 8 32 | 3 15 | 8 45 | 3 1 | 8 59 |
| Lat. | Sett. | Ris. | Sett. | Ris. | Sett. | Ris. | Sett. | Ris. | Sett. | Ris. | Sett. | Ris | Sett. | Ris |

Latitude and Declination of *contrary* Names.

## APPARENT TIME OF THE SUN'S RISING AND SETTING

Declination, of the same Name as the Latitude

| Lat. | 18° | | 19° | | 20° | | 21° | | 22° | | 23° | | 23½° | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ris. | Sett. | Ris. | Sett. | Ris. | Sett. | Ris. | Sett. | Ris. | Sett. | Ris. | Sett. | Ris. | Sett. |
| 0° | 6h 0m | 6h 0m | 6h 0m | 6h 0m | 6h 0m | 6h 0m | 6h 0m | 6h 0m | 6h 0m | 6h 0m | 6h 0m | 6h 0m | 6h 0m | 6h 0m |
| 2 | 5 58 | 6 2 | 5 58 | 6 2 | 5 58 | 6 2 | 5 57 | 6 3 | 5 57 | 6 3 | 5 57 | 6 3 | 5 57 | 6 3 |
| 4 | 5 55 | 6 5 | 5 55 | 6 5 | 5 55 | 6 5 | 5 54 | 6 6 | 5 54 | 6 6 | 5 53 | 6 7 | 5 53 | 6 7 |
| 6 | 5 52 | 6 8 | 5 52 | 6 8 | 5 52 | 6 8 | 5 51 | 6 9 | 5 51 | 6 9 | 5 50 | 6 10 | 5 50 | 6 10 |
| 8 | 5 50 | 6 10 | 5 49 | 6 11 | 5 49 | 6 12 | 5 48 | 6 12 | 5 47 | 6 12 | 5 47 | 6 13 | 5 46 | 6 14 |
| 10 | 5 47 | 6 13 | 5 46 | 6 14 | 5 46 | 6 15 | 5 45 | 6 16 | 5 44 | 6 16 | 5 43 | 6 17 | 5 43 | 6 17 |
| 12 | 5 44 | 6 16 | 5 44 | 6 17 | 5 43 | 6 18 | 5 42 | 6 19 | 5 41 | 6 20 | 5 40 | 6 21 | 5 39 | 6 21 |
| 14 | 5 41 | 6 19 | 5 40 | 6 20 | 5 39 | 6 21 | 5 38 | 6 22 | 5 37 | 6 23 | 5 36 | 6 24 | 5 35 | 6 25 |
| 16 | 5 39 | 6 21 | 5 37 | 6 23 | 5 36 | 6 24 | 5 35 | 6 25 | 5 33 | 6 27 | 5 32 | 6 28 | 5 31 | 6 29 |
| 18 | 5 36 | 6 24 | 5 34 | 6 26 | 5 33 | 6 27 | 5 31 | 6 29 | 5 30 | 6 30 | 5 28 | 6 32 | 5 28 | 6 32 |
| 20 | 5 33 | 6 27 | 5 31 | 6 29 | 5 30 | 6 30 | 5 28 | 6 32 | 5 26 | 6 34 | 5 24 | 6 36 | 5 24 | 6 30 |
| 21 | 5 31 | 6 29 | 5 30 | 6 30 | 5 28 | 6 32 | 5 26 | 6 34 | 5 24 | 6 36 | 5 22 | 6 38 | 5 22 | 6 38 |
| 22 | 5 30 | 6 30 | 5 28 | 6 32 | 5 26 | 6 34 | 5 24 | 6 36 | 5 22 | 6 38 | 5 21 | 6 39 | 5 20 | 6 40 |
| 23 | 5 28 | 6 32 | 5 26 | 6 34 | 5 24 | 6 36 | 5 22 | 6 38 | 5 21 | 6 39 | 5 19 | 6 41 | 5 18 | 6 42 |
| 24 | 5 27 | 6 33 | 5 25 | 6 35 | 5 23 | 6 37 | 5 21 | 6 39 | 5 19 | 6 41 | 5 16 | 6 44 | 5 15 | 6 45 |
| 25 | 5 25 | 6 35 | 5 23 | 6 37 | 5 21 | 6 39 | 5 19 | 6 41 | 5 17 | 6 43 | 5 14 | 6 46 | 5 13 | 6 47 |
| 26 | 5 24 | 6 36 | 5 21 | 6 39 | 5 19 | 6 41 | 5 17 | 6 43 | 5 15 | 6 45 | 5 12 | 6 48 | 5 11 | 6 49 |
| 27 | 5 22 | 6 38 | 5 20 | 6 40 | 5 17 | 6 43 | 5 15 | 6 45 | 5 12 | 6 48 | 5 10 | 6 50 | 5 9 | 6 51 |
| 28 | 5 20 | 6 40 | 5 18 | 6 42 | 5 15 | 6 45 | 5 13 | 6 47 | 5 10 | 6 50 | 5 8 | 6 52 | 5 7 | 6 53 |
| 29 | 5 18 | 6 42 | 5 16 | 6 44 | 5 13 | 6 47 | 5 11 | 6 49 | 5 8 | 6 52 | 5 6 | 6 54 | 5 4 | 6 56 |
| 30 | 5 17 | 6 43 | 5 14 | 6 46 | 5 11 | 6 49 | 5 9 | 6 51 | 5 6 | 6 54 | 5 3 | 6 57 | 5 2 | 6 58 |
| 31 | 5 15 | 6 45 | 5 12 | 6 48 | 5 9 | 6 51 | 5 7 | 6 53 | 5 4 | 6 56 | 5 1 | 6 59 | 5 0 | 7 0 |
| 32 | 5 13 | 6 47 | 5 10 | 6 50 | 5 7 | 6 53 | 5 4 | 6 56 | 5 2 | 6 58 | 4 59 | 7 1 | 4 57 | 7 3 |
| 33 | 5 11 | 6 49 | 5 8 | 6 52 | 5 5 | 6 55 | 5 2 | 6 58 | 4 59 | 7 1 | 4 56 | 7 4 | 4 55 | 7 5 |
| 34 | 5 9 | 6 51 | 5 6 | 6 54 | 5 3 | 6 57 | 5 0 | 7 0 | 4 57 | 7 3 | 4 53 | 7 7 | 4 52 | 7 8 |
| 35 | 5 7 | 6 53 | 5 4 | 6 56 | 5 1 | 6 59 | 4 58 | 7 2 | 4 54 | 7 6 | 4 51 | 7 9 | 4 49 | 7 11 |
| 36 | 5 5 | 6 55 | 5 2 | 6 58 | 4 59 | 7 1 | 4 55 | 7 5 | 4 52 | 7 8 | 4 48 | 7 12 | 4 46 | 7 14 |
| 37 | 5 3 | 6 58 | 5 0 | 7 0 | 4 56 | 7 4 | 4 53 | 7 7 | 4 49 | 7 11 | 4 45 | 7 15 | 4 44 | 7 16 |
| 38 | 5 1 | 6 59 | 4 58 | 7 2 | 4 53 | 7 7 | 4 50 | 7 10 | 4 46 | 7 14 | 4 43 | 7 17 | 4 41 | 7 19 |
| 39 | 4 59 | 7 1 | 4 55 | 7 5 | 4 51 | 7 9 | 4 48 | 7 12 | 4 44 | 7 16 | 4 40 | 7 20 | 4 38 | 7 22 |
| 40 | 4 57 | 7 3 | 4 53 | 7 7 | 4 49 | 7 11 | 4 45 | 7 15 | 4 41 | 7 19 | 4 37 | 7 23 | 4 35 | 7 25 |
| 41 | 4 54 | 7 6 | 4 50 | 7 10 | 4 46 | 7 14 | 4 42 | 7 18 | 4 38 | 7 22 | 4 33 | 7 27 | 4 31 | 7 29 |
| 42 | 4 52 | 7 8 | 4 48 | 7 12 | 4 43 | 7 17 | 4 39 | 7 21 | 4 35 | 7 25 | 4 30 | 7 30 | 4 28 | 7 32 |
| 43 | 4 49 | 7 11 | 4 45 | 7 15 | 4 41 | 7 19 | 4 36 | 7 24 | 4 31 | 7 29 | 4 27 | 7 33 | 4 24 | 7 36 |
| 44 | 4 47 | 7 13 | 4 42 | 7 18 | 4 38 | 7 22 | 4 33 | 7 27 | 4 28 | 7 32 | 4 23 | 7 37 | 4 21 | 7 39 |
| 45 | 4 44 | 7 16 | 4 39 | 7 21 | 4 35 | 7 25 | 4 30 | 7 30 | 4 25 | 7 35 | 4 20 | 7 40 | 4 17 | 7 43 |
| 46 | 4 41 | 7 19 | 4 36 | 7 24 | 4 31 | 7 29 | 4 26 | 7 34 | 4 21 | 7 39 | 4 16 | 7 44 | 4 13 | 7 47 |
| 47 | 4 38 | 7 22 | 4 33 | 7 27 | 4 28 | 7 32 | 4 23 | 7 37 | 4 17 | 7 43 | 4 12 | 7 48 | 4 9 | 7 51 |
| 48 | 4 35 | 7 25 | 4 30 | 7 30 | 4 25 | 7 35 | 4 19 | 7 41 | 4 13 | 7 47 | 4 7 | 7 53 | 4 5 | 7 55 |
| 49 | 4 32 | 7 28 | 4 27 | 7 33 | 4 21 | 7 39 | 4 15 | 7 45 | 4 9 | 7 51 | 4 3 | 7 57 | 4 0 | 8 0 |
| 50 | 4 29 | 7 31 | 4 23 | 7 37 | 4 17 | 7 43 | 4 11 | 7 49 | 4 5 | 7 55 | 3 58 | 8 2 | 3 55 | 8 5 |
| 51 | 4 25 | 7 35 | 4 19 | 7 41 | 4 13 | 7 47 | 4 7 | 7 53 | 4 0 | 8 0 | 3 54 | 8 6 | 3 50 | 8 10 |
| 52 | 4 22 | 7 38 | 4 15 | 7 45 | 4 9 | 7 51 | 4 2 | 7 58 | 3 55 | 8 5 | 3 48 | 8 12 | 3 45 | 8 15 |
| 53 | 4 18 | 7 42 | 4 11 | 7 49 | 4 4 | 7 56 | 3 58 | 8 2 | 3 50 | 8 10 | 3 43 | 8 17 | 3 39 | 8 21 |
| 54 | 4 14 | 7 46 | 4 7 | 7 53 | 4 0 | 8 0 | 3 52 | 8 8 | 3 45 | 8 15 | 3 37 | 8 23 | 3 33 | 8 27 |
| 55 | 4 9 | 7 51 | 4 2 | 7 58 | 3 55 | 8 5 | 3 47 | 8 13 | 3 39 | 8 21 | 3 31 | 8 29 | 3 27 | 8 33 |
| 56 | 4 5 | 7 55 | 3 57 | 8 3 | 3 49 | 8 11 | 3 41 | 8 19 | 3 33 | 8 27 | 3 24 | 8 36 | 3 20 | 8 40 |
| 57 | 4 0 | 8 0 | 3 52 | 8 8 | 3 44 | 8 16 | 3 35 | 8 25 | 3 26 | 8 34 | 3 17 | 8 43 | 3 12 | 8 48 |
| 58 | 3 55 | 8 5 | 3 46 | 8 14 | 3 38 | 8 22 | 3 28 | 8 32 | 3 19 | 8 41 | 3 9 | 8 51 | 3 4 | 8 56 |
| 59 | 3 49 | 8 11 | 3 40 | 8 20 | 3 31 | 8 29 | 3 21 | 8 39 | 3 11 | 8 49 | 3 0 | 9 0 | 2 55 | 9 5 |
| 60 | 3 43 | 8 17 | 3 34 | 8 26 | 3 24 | 8 36 | 3 13 | 8 47 | 3 2 | 8 58 | 2 51 | 9 9 | 2 45 | 9 15 |
| 61 | 3 36 | 8 24 | 3 26 | 8 34 | 3 16 | 8 44 | 3 5 | 8 55 | 2 53 | 9 7 | 2 40 | 9 20 | 2 34 | 9 26 |
| 62 | 3 29 | 8 31 | 3 18 | 8 42 | 3 7 | 8 53 | 2 55 | 9 5 | 2 42 | 9 18 | 2 28 | 9 32 | 2 21 | 9 39 |
| 63 | 3 22 | 8 38 | 3 10 | 8 50 | 2 58 | 9 2 | 2 44 | 9 16 | 2 30 | 9 30 | 2 14 | 9 46 | 2 6 | 9 54 |
| 64 | 3 13 | 8 47 | 3 0 | 9 0 | 2 47 | 9 13 | 2 32 | 9 28 | 2 16 | 9 44 | 1 58 | 10 2 | 1 48 | 10 12 |
| 65 | 3 3 | 8 57 | 2 50 | 9 10 | 2 35 | 9 25 | 2 18 | 9 42 | 2 0 | 10 0 | 1 38 | 10 22 | 1 26 | 10 34 |
| 66 | 2 53 | 9 7 | 2 37 | 9 23 | 2 21 | 9 39 | 2 2 | 9 58 | 1 39 | 10 21 | 1 10 | 10 50 | 0 51 | 11 9 |
| 66½ | 2 46 | 9 14 | 2 30 | 9 30 | 2 12 | 9 48 | 1 51 | 10 9 | 1 26 | 10 34 | 0 48 | 11 12 | 0 0 | 12 0 |
| Lat. | Sett. | Ris. | Sett. | Ris. | Sett. | Ris. | Sett. | Ris. | Sett. | Ris. | Sett. | Ris. | Sett. | Ris. |

Latitude and Declination of contrary Names.

## APPROXIMATE APPARENT TIMES OF THE MERIDIAN PASSAGES OF THE PRINCIPAL FIXED STARS

ON THE FIRST DAY OF EACH MONTH, 1902.

| Name | | Jan. | Feb. | Mar. | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | h m | h m | h m | h m | h m | h m | h m | h m | h m | h m | h m | h m |
| α Andromedæ | *Alpherats* | 5 19 | 3 6 | 1 17 | 23 23 | 21 32 | 19 29 | 17 25 | 15 20 | 13 24 | 11 36 | 9 40 | 7 37 |
| γ Pegasi | *Algenib* | 5 24 | 3 11 | 1 22 | 23 28 | 21 37 | 19 34 | 17 30 | 15 25 | 13 29 | 11 41 | 9 45 | 7 42 |
| α Phœnicis | | 5 37 | 3 24 | 1 35 | 23 41 | 21 50 | 19 47 | 17 43 | 15 38 | 13 42 | 11 54 | 9 58 | 7 55 |
| α Cassiopeæ | *Schedar* | 5 51 | 3 38 | 1 49 | 23 55 | 22 4 | 20 1 | 17 57 | 15 52 | 13 56 | 12 8 | 10 12 | 8 9 |
| β Ceti | *Deneb Kaitos* | 5 55 | 3 42 | 1 53 | 23 59 | 22 8 | 20 5 | 18 1 | 15 56 | 14 0 | 12 12 | 10 16 | 8 13 |
| α Ursæ Minoris | *Polaris* | 6 40 | 4 27 | 2 37 | 0 43 | 22 52 | 20 49 | 18 46 | 16 41 | 14 46 | 12 58 | 11 2 | 8 59 |
| α Eridani | *Achernar* | 6 50 | 4 37 | 2 48 | 0 54 | 23 3 | 21 0 | 18 56 | 16 51 | 14 55 | 13 7 | 11 11 | 9 8 |
| γ Andromedæ | *Almach* | 7 14 | 5 1 | 3 12 | 1 18 | 23 27 | 21 24 | 19 20 | 17 15 | 15 19 | 13 31 | 11 35 | 9 32 |
| α Arietis | *Hamel* | 7 18 | 5 5 | 3 16 | 1 22 | 23 31 | 21 28 | 19 24 | 17 19 | 15 23 | 13 35 | 11 39 | 9 36 |
| α Ceti | *Menkar* | 8 13 | 6 0 | 4 11 | 2 17 | 0 26 | 22 23 | 20 19 | 18 14 | 16 18 | 14 30 | 12 34 | 10 31 |
| α Persei | *Mirfak* | 8 33 | 6 20 | 4 31 | 2 37 | 0 46 | 22 43 | 20 39 | 18 34 | 16 38 | 14 50 | 12 54 | 10 51 |
| α Tauri | *Aldebaran* | 9 46 | 7 33 | 5 44 | 3 50 | 1 59 | 23 56 | 21 52 | 19 47 | 17 51 | 16 3 | 14 7 | 12 4 |
| α Aurigæ | *Capella* | 10 25 | 8 12 | 6 23 | 4 29 | 2 38 | 0 35 | 22 31 | 20 26 | 18 31 | 16 43 | 14 47 | 12 43 |
| β Orionis | *Rigel* | 10 26 | 8 13 | 6 24 | 4 30 | 2 39 | 0 36 | 22 32 | 20 27 | 18 31 | 16 43 | 14 47 | 12 43 |
| β Tauri | *Nath* | 10 36 | 8 23 | 6 34 | 4 40 | 2 49 | 0 46 | 22 42 | 20 37 | 18 41 | 16 53 | 14 57 | 12 54 |
| δ Orionis | | 10 43 | 8 30 | 6 41 | 4 47 | 2 56 | 0 53 | 22 49 | 20 44 | 18 48 | 17 0 | 15 4 | 13 1 |
| ε Orionis | *Alnilam* | 10 47 | 8 34 | 6 45 | 4 51 | 3 0 | 0 57 | 22 53 | 20 48 | 18 52 | 17 4 | 15 8 | 13 5 |
| α Columbæ | *Phact* | 10 52 | 8 39 | 6 50 | 4 56 | 3 5 | 1 2 | 22 58 | 20 53 | 18 57 | 17 9 | 15 13 | 13 10 |
| α Orionis | *Betelguese* | 11 6 | 8 53 | 7 4 | 5 10 | 3 19 | 1 16 | 23 12 | 21 7 | 19 11 | 17 23 | 15 27 | 13 23 |
| β Aurigæ | *Menkalinan* | 11 8 | 8 55 | 7 6 | 5 13 | 3 21 | 1 18 | 23 14 | 21 9 | 19 13 | 17 25 | 15 29 | 13 25 |
| α Argûs | *Canopus* | 11 38 | 9 25 | 7 36 | 5 42 | 3 51 | 1 48 | 23 44 | 21 39 | 19 43 | 17 55 | 15 59 | 13 55 |
| γ Geminorum | *Alhena* | 11 48 | 9 35 | 7 46 | 5 52 | 4 1 | 1 58 | 23 54 | 21 49 | 19 53 | 18 5 | 16 9 | 14 6 |
| α Canis Majoris | *Sirius* | 11 57 | 9 44 | 7 55 | 6 1 | 4 10 | 2 7 | 0 3 | 21 58 | 20 2 | 18 14 | 16 18 | 14 14 |
| ε Canis Majoris | *Adara* | 12 11 | 9 58 | 8 9 | 6 15 | 4 24 | 2 21 | 0 17 | 22 12 | 20 16 | 18 28 | 16 32 | 14 28 |
| α² Geminorum | *Castor* | 12 44 | 10 31 | 8 42 | 6 48 | 4 57 | 2 54 | 0 50 | 22 45 | 20 49 | 19 1 | 17 5 | 15 2 |
| α Canis Minoris | *Procyon* | 12 50 | 10 37 | 8 48 | 6 54 | 5 3 | 3 0 | 0 56 | 22 51 | 20 55 | 19 7 | 17 11 | 15 8 |
| β Geminorum | *Pollux* | 12 55 | 10 42 | 8 53 | 6 59 | 5 8 | 3 5 | 1 1 | 22 56 | 21 0 | 19 12 | 17 16 | 15 13 |
| ζ Argûs | | 13 16 | 11 3 | 9 14 | 7 20 | 5 29 | 3 26 | 1 22 | 23 17 | 21 21 | 19 33 | 17 37 | 15 34 |
| δ Argûs | | 13 58 | 11 45 | 9 56 | 8 2 | 6 11 | 4 8 | 2 4 | 23 59 | 22 3 | 20 15 | 18 19 | 16 16 |
| α Hydræ | *Alphard* | 14 39 | 12 26 | 10 37 | 8 43 | 6 52 | 4 49 | 2 45 | 0 40 | 22 44 | 20 56 | 19 0 | 16 56 |
| α Leonis | *Regulus* | 15 19 | 13 6 | 11 17 | 9 23 | 7 32 | 5 29 | 3 25 | 1 20 | 23 24 | 21 36 | 19 40 | 17 37 |
| γ¹ Leonis | *Algeiba* | 15 30 | 13 17 | 11 28 | 9 34 | 7 43 | 5 40 | 3 36 | 1 31 | 23 35 | 21 47 | 19 51 | 17 48 |
| η Argûs | | 15 57 | 13 44 | 11 55 | 10 1 | 8 10 | 6 7 | 4 3 | 1 58 | 0 2 | 22 14 | 20 18 | 18 15 |
| α Ursæ Majoris | *Dubhe* | 16 13 | 14 0 | 12 11 | 10 17 | 8 26 | 6 23 | 4 19 | 2 14 | 0 18 | 22 30 | 20 34 | 18 31 |
| δ Leonis | *Zosma* | 16 25 | 14 12 | 12 23 | 10 29 | 8 38 | 6 35 | 4 31 | 2 26 | 0 30 | 22 42 | 20 46 | 18 42 |
| β Leonis | *Denebola* | 17 0 | 14 47 | 12 58 | 11 4 | 9 13 | 7 10 | 5 6 | 3 1 | 1 5 | 23 17 | 21 21 | 19 17 |
| γ Ursæ Majoris | *Phecda* | 17 4 | 14 51 | 13 2 | 11 8 | 9 17 | 7 14 | 5 10 | 3 5 | 1 9 | 23 21 | 21 25 | 19 21 |
| α¹ Crucis | | 17 37 | 15 24 | 13 35 | 11 41 | 9 50 | 7 47 | 5 43 | 3 38 | 1 42 | 23 54 | 21 58 | 19 54 |
| β Corvi | | 17 45 | 15 32 | 13 43 | 11 49 | 9 58 | 7 55 | 5 51 | 3 46 | 1 50 | 0 2 | 22 6 | 20 2 |
| α Canum Venaticorum | | 18 7 | 15 54 | 14 5 | 12 11 | 10 20 | 8 17 | 6 13 | 4 8 | 2 12 | 0 24 | 22 28 | 20 24 |
| α Virginis | *Spica* | 18 36 | 16 23 | 14 34 | 12 40 | 10 49 | 8 46 | 6 42 | 4 37 | 2 41 | 0 53 | 22 57 | 20 53 |
| η Ursæ Majoris | *Benetnasch* | 19 0 | 16 47 | 14 58 | 13 4 | 11 13 | 9 10 | 7 6 | 5 1 | 3 5 | 1 17 | 23 21 | 21 17 |
| β Centauri | | 19 13 | 17 0 | 15 11 | 13 17 | 11 26 | 9 23 | 7 19 | 5 14 | 3 18 | 1 30 | 23 34 | 21 30 |
| α Draconis | *Thuban* | 19 18 | 17 5 | 15 16 | 13 22 | 11 31 | 9 28 | 7 24 | 5 19 | 3 23 | 1 35 | 23 39 | 21 35 |
| α Boötis | *Arcturus* | 19 27 | 17 14 | 15 25 | 13 31 | 11 40 | 9 37 | 7 33 | 5 28 | 3 32 | 1 44 | 23 48 | 21 44 |
| α² Centauri | | 19 49 | 17 36 | 15 47 | 13 53 | 12 2 | 9 59 | 7 55 | 5 50 | 3 54 | 2 6 | 0 10 | 22 6 |
| α Libræ | *Zuben el Genubi* | 20 1 | 17 48 | 15 59 | 14 5 | 12 14 | 10 11 | 8 7 | 6 2 | 4 6 | 2 18 | 0 22 | 22 18 |
| β Ursæ Minoris | *Kochab* | 20 7 | 17 54 | 16 5 | 14 11 | 12 20 | 10 17 | 8 13 | 6 8 | 4 12 | 2 24 | 0 28 | 22 24 |
| β Libræ | *Zuben el Chamali* | 20 28 | 18 15 | 16 26 | 14 32 | 12 41 | 10 38 | 8 34 | 6 29 | 4 33 | 2 45 | 0 49 | 22 45 |
| α Coronæ Borealis | *Alphacca* | 20 47 | 18 34 | 16 45 | 14 51 | 13 0 | 10 57 | 8 53 | 6 48 | 4 52 | 3 4 | 1 8 | 23 4 |
| α Serpentis | *Unukalhai* | 20 55 | 18 42 | 16 53 | 14 59 | 13 8 | 11 5 | 9 1 | 6 56 | 5 0 | 3 12 | 1 16 | 23 12 |
| β¹ Scorpii | | 21 15 | 19 2 | 17 13 | 15 19 | 13 28 | 11 25 | 9 21 | 7 16 | 5 20 | 3 32 | 1 36 | 23 32 |
| α Scorpii | *Antares* | 21 39 | 19 26 | 17 37 | 15 43 | 13 52 | 11 49 | 9 45 | 7 40 | 5 44 | 3 56 | 2 0 | 23 56 |
| α Trianguli Australis | | 21 54 | 19 41 | 17 52 | 15 58 | 14 7 | 12 4 | 10 0 | 7 55 | 5 59 | 4 11 | 2 15 | 0 11 |
| β Draconis | *Alwaid* | 22 44 | 20 31 | 18 42 | 16 48 | 14 57 | 12 55 | 10 50 | 8 45 | 6 49 | 5 1 | 3 5 | 1 2 |
| α Ophiuchi | *Ras Alhague* | 22 46 | 20 33 | 18 44 | 16 50 | 14 59 | 12 57 | 10 52 | 8 47 | 6 51 | 5 3 | 3 7 | 1 4 |
| γ Draconis | *Rastaban* | 23 10 | 20 58 | 19 8 | 17 15 | 15 23 | 13 21 | 11 16 | 9 11 | 7 15 | 5 27 | 3 31 | 1 28 |
| α Lyræ | *Vega* | 23 49 | 21 37 | 19 47 | 17 54 | 16 3 | 14 0 | 11 56 | 9 51 | 7 55 | 6 7 | 4 11 | 2 7 |
| α Aquilæ | *Altair* | 1 2 | 22 49 | 20 59 | 19 6 | 17 15 | 15 12 | 13 8 | 11 3 | 9 7 | 7 19 | 5 23 | 3 20 |
| α Pavonis | | 1 34 | 23 21 | 21 31 | 19 38 | 17 47 | 15 44 | 13 40 | 11 35 | 9 39 | 7 51 | 5 55 | 3 51 |
| α Cygni | *Deneb* | 1 54 | 23 41 | 21 51 | 19 58 | 18 7 | 16 4 | 14 0 | 11 55 | 9 59 | 8 11 | 6 15 | 4 11 |
| α Cephei | *Alderamin* | 2 32 | 0 19 | 22 30 | 20 36 | 18 45 | 16 42 | 14 38 | 12 33 | 10 37 | 8 49 | 6 53 | 4 50 |
| ε Pegasi | | 2 55 | 0 42 | 22 53 | 20 59 | 19 8 | 17 5 | 15 1 | 12 56 | 11 0 | 9 12 | 7 16 | 5 13 |
| α Gruis | | 3 18 | 1 5 | 23 16 | 21 22 | 19 31 | 17 28 | 15 24 | 13 19 | 11 23 | 9 35 | 7 39 | 5 36 |
| β Gruis | | 3 53 | 1 40 | 23 51 | 21 57 | 20 6 | 18 3 | 15 59 | 13 54 | 11 58 | 10 10 | 8 14 | 6 11 |
| α Piscis Aust. | *Fomalhaut* | 4 8 | 1 55 | 0 6 | 22 12 | 20 21 | 18 18 | 16 14 | 14 9 | 12 13 | 10 25 | 8 29 | 6 26 |
| α Pegasi | *Markab* | 4 16 | 2 3 | 0 14 | 22 20 | 20 29 | 18 26 | 16 22 | 14 17 | 12 21 | 10 33 | 8 37 | 6 34 |

CORRECTION OF THE TIMES IN TABLE 27 FOR THE DAY OF THE MONTH,

To be *Subtracted.*

| Days. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0h 0m | 0h 0m | 0h 0m | 0h 0m | 0h 0m | 0h 0m | 0h 0m | 0h 0m | 0h 0m | 0h 0m | 0h 0m | 0h 0m |
| 2 | 0 4 | 0 4 | 0 4 | 0 4 | 0 4 | 0 4 | 0 4 | 0 4 | 0 4 | 0 4 | 0 4 | 0 4 |
| 3 | 0 9 | 0 8 | 0 7 | 0 7 | 0 8 | 0 8 | 0 8 | 0 8 | 0 7 | 0 7 | 0 8 | 0 9 |
| 4 | 0 13 | 0 12 | 0 11 | 0 11 | 0 11 | 0 12 | 0 12 | 0 12 | 0 11 | 0 11 | 0 12 | 0 13 |
| 5 | 0 18 | 0 16 | 0 15 | 0 15 | 0 15 | 0 16 | 0 16 | 0 15 | 0 14 | 0 15 | 0 16 | 0 17 |
| 6 | 0 22 | 0 20 | 0 19 | 0 18 | 0 19 | 0 21 | 0 21 | 0 19 | 0 18 | 0 18 | 0 20 | 0 22 |
| 7 | 0 26 | 0 24 | 0 22 | 0 22 | 0 23 | 0 25 | 0 25 | 0 23 | 0 22 | 0 22 | 0 24 | 0 26 |
| 8 | 0 30 | 0 28 | 0 26 | 0 26 | 0 27 | 0 29 | 0 29 | 0 27 | 0 25 | 0 25 | 0 28 | 0 30 |
| 9 | 0 35 | 0 32 | 0 30 | 0 29 | 0 30 | 0 33 | 0 33 | 0 31 | 0 29 | 0 29 | 0 32 | 0 35 |
| 10 | 0 39 | 0 36 | 0 33 | 0 33 | 0 35 | 0 37 | 0 37 | 0 35 | 0 32 | 0 33 | 0 36 | 0 39 |
| 11 | 0 43 | 0 40 | 0 37 | 0 36 | 0 39 | 0 41 | 0 41 | 0 38 | 0 36 | 0 37 | 0 40 | 0 44 |
| 12 | 0 48 | 0 44 | 0 41 | 0 40 | 0 42 | 0 45 | 0 45 | 0 42 | 0 40 | 0 40 | 0 44 | 0 48 |
| 13 | 0 52 | 0 48 | 0 44 | 0 44 | 0 46 | 0 49 | 0 49 | 0 46 | 0 43 | 0 44 | 0 48 | 0 52 |
| 14 | 0 56 | 0 52 | 0 48 | 0 48 | 0 50 | 0 54 | 0 53 | 0 50 | 0 47 | 0 48 | 0 52 | 0 57 |
| 15 | 1 1 | 0 56 | 0 52 | 0 51 | 0 54 | 0 58 | 0 57 | 0 53 | 0 50 | 0 51 | 0 56 | 1 1 |
| 16 | 1 5 | 1 0 | 0 55 | 0 55 | 0 58 | 1 2 | 1 1 | 0 57 | 0 54 | 0 55 | 1 0 | 1 6 |
| 17 | 1 9 | 1 3 | 0 59 | 0 59 | 1 2 | 1 6 | 1 5 | 1 1 | 0 58 | 0 59 | 1 4 | 1 10 |
| 18 | 1 13 | 1 7 | 1 2 | 1 2 | 1 6 | 1 10 | 1 9 | 1 5 | 1 1 | 1 3 | 1 9 | 1 15 |
| 19 | 1 18 | 1 11 | 1 6 | 1 6 | 1 10 | 1 14 | 1 13 | 1 8 | 1 5 | 1 6 | 1 13 | 1 19 |
| 20 | 1 22 | 1 15 | 1 10 | 1 10 | 1 14 | 1 19 | 1 17 | 1 12 | 1 8 | 1 10 | 1 17 | 1 24 |
| 21 | 1 26 | 1 19 | 1 14 | 1 13 | 1 18 | 1 23 | 1 21 | 1 16 | 1 12 | 1 14 | 1 21 | 1 28 |
| 22 | 1 31 | 1 23 | 1 17 | 1 17 | 1 22 | 1 27 | 1 25 | 1 19 | 1 16 | 1 18 | 1 25 | 1 32 |
| 23 | 1 35 | 1 26 | 1 21 | 1 21 | 1 26 | 1 31 | 1 29 | 1 23 | 1 19 | 1 21 | 1 30 | 1 37 |
| 24 | 1 39 | 1 30 | 1 24 | 1 25 | 1 30 | 1 35 | 1 33 | 1 27 | 1 23 | 1 25 | 1 34 | 1 41 |
| 25 | 1 43 | 1 34 | 1 28 | 1 28 | 1 34 | 1 39 | 1 37 | 1 31 | 1 26 | 1 29 | 1 38 | 1 46 |
| 26 | 1 47 | 1 38 | 1 32 | 1 32 | 1 38 | 1 44 | 1 41 | 1 34 | 1 30 | 1 33 | 1 42 | 1 50 |
| 27 | 1 51 | 1 42 | 1 35 | 1 36 | 1 42 | 1 48 | 1 45 | 1 38 | 1 34 | 1 37 | 1 47 | 1 55 |
| 28 | 1 56 | 1 45 | 1 39 | 1 40 | 1 46 | 1 52 | 1 49 | 1 42 | 1 37 | 1 41 | 1 51 | 1 59 |
| 29 | 2 0 | | 1 43 | 1 44 | 1 50 | 1 56 | 1 53 | 1 45 | 1 41 | 1 44 | 1 55 | 2 3 |
| 30 | 2 4 | | 1 46 | 1 47 | 1 55 | 2 0 | 1 57 | 1 49 | 1 44 | 1 48 | 1 59 | 2 8 |
| 31 | 2 8 | | 1 50 | | 1 59 | | 2 1 | 1 52 | | 1 52 | | 2 12 |

## TABLE 28

| CORRECTION OF THE TIME OF THE MOON'S MER. PASSAGE | | | | | | | | | | | | | | | Long. in time. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Long. | Daily Variation of the Moon's Meridian Passage | | | | | | | | | | | | | | |
| | 40m | 42m | 44m | 46m | 48m | 50m | 52m | 54m | 56m | 58m | 60m | 62m | 64m | 66m | H. M. |
| 5° | 1m | 1m | 1m | 1m | 1m | 1m | 1m | 1m | 1m | 1m | 1m | 1m | 1m | 1m | 0 20 |
| 10 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 0 40 |
| 20 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 1 20 |
| 30 | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 2 0 |
| 40 | 4 | 5 | 5 | 5 | 5 | 5 | 6 | 6 | 6 | 6 | 7 | 7 | 7 | 7 | 2 40 |
| 50 | 6 | 6 | 6 | 6 | 7 | 7 | 7 | 7 | 8 | 8 | 8 | 9 | 9 | 9 | 3 20 |
| 60 | 7 | 7 | 7 | 8 | 8 | 8 | 9 | 9 | 9 | 10 | 10 | 10 | 11 | 11 | 4 0 |
| 70 | 8 | 8 | 9 | 9 | 9 | 10 | 10 | 10 | 11 | 11 | 12 | 12 | 13 | 13 | 4 40 |
| 80 | 9 | 9 | 10 | 10 | 11 | 11 | 12 | 12 | 12 | 13 | 13 | 14 | 14 | 15 | 5 20 |
| 90 | 10 | 10 | 11 | 11 | 12 | 12 | 13 | 13 | 14 | 14 | 15 | 15 | 16 | 16 | 6 0 |
| 100 | 11 | 12 | 12 | 13 | 13 | 14 | 14 | 15 | 16 | 16 | 17 | 17 | 18 | 18 | 6 40 |
| 110 | 12 | 13 | 13 | 14 | 15 | 15 | 16 | 16 | 17 | 18 | 18 | 19 | 20 | 20 | 7 20 |
| 120 | 13 | 14 | 15 | 15 | 16 | 17 | 17 | 18 | 19 | 19 | 20 | 21 | 21 | 22 | 8 0 |
| 130 | 14 | 15 | 16 | 17 | 17 | 18 | 19 | 19 | 20 | 21 | 22 | 22 | 23 | 24 | 8 40 |
| 140 | 16 | 16 | 17 | 18 | 19 | 19 | 20 | 21 | 22 | 23 | 23 | 24 | 25 | 26 | 9 20 |
| 150 | 17 | 17 | 18 | 19 | 20 | 21 | 22 | 22 | 23 | 24 | 25 | 26 | 27 | 27 | 10 0 |
| 160 | 18 | 18 | 20 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 28 | 29 | 10 40 |
| 170 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 11 20 |
| 180 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 12 0 |

## HOUR ANGLE AND ALTITUDE OF A BODY UPON THE PRIME VERTICAL

| Lat. | Declination | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1° | | 2° | | 3° | | 4° | | 5° | | 6° | | 7° | | 8° | |
| | H. A. | Alt. | H. A. | Alt. | H. A. | Alt. | H. A. | Alt. | H. A. | Alt. | H. A. | Alt. | H. A. | Alt. | H. A. | Alt. |
| ° | h m | ° | h m | ° | h m | ° | h m | ° | h m | ° | h m | ° | h m | ° | h m | ° |
| 2 | 4 0 | 30·0 | | | | | | | | | | | | | | |
| 3 | 4 42 | 19·5 | 3 13 | 41·8 | | | | | | | | | | | | |
| 4 | 5 2 | 14·5 | 4 0 | 30·0 | 2 46 | 48·6 | | | | | | | | | | |
| 5 | 5 14 | 11·5 | 4 26 | 23·6 | 3 33 | 36·9 | 2 28 | 53·2 | | | | | | | | |
| 6 | 5 22 | 9·6 | 4 42 | 19·5 | 4 0 | 30·0 | 3 13 | 41·8 | 2 15 | 56·4 | | | | | | |
| 7 | 5 27 | 8·2 | 4 54 | 16·6 | 4 19 | 25·4 | 3 42 | 34·9 | 2 58 | 45·7 | 2 4 | 59·1 | | | | |
| 8 | 5 31 | 7·2 | 5 2 | 14·5 | 4 32 | 22·1 | 4 1 | 30·1 | 3 26 | 38·6 | 2 46 | 48·7 | 1 56 | 61·1 | | |
| 9 | 5 35 | 6·4 | 5 9 | 12·8 | 4 43 | 19·5 | 4 15 | 26·5 | 3 46 | 33·8 | 3 14 | 41·9 | 2 37 | 51·2 | 1 50 | 62·8 |
| 10 | 5 37 | 5·8 | 5 14 | 11·6 | 4 51 | 17·3 | 4 27 | 23·7 | 4 1 | 30·1 | 3 34 | 37·0 | 3 3 | 44·6 | 2 29 | 53·3 |
| 11 | 5 39 | 5·3 | 5 19 | 10·5 | 4 57 | 15·9 | 4 36 | 21·6 | 4 13 | 27·2 | 3 49 | 33·1 | 3 23 | 39·7 | 2 55 | 46·8 |
| 12 | 5 41 | 4·8 | 5 22 | 9·6 | 5 3 | 14·6 | 4 43 | 19·6 | 4 23 | 24·8 | 4 1 | 30·2 | 3 39 | 35·9 | 3 14 | 42·0 |
| 13 | 5 43 | 4·5 | 5 25 | 8·9 | 5 8 | 13·4 | 4 49 | 18·1 | 4 31 | 22·8 | 4 12 | 27·7 | 3 51 | 32·8 | 3 30 | 38·2 |
| 14 | 5 44 | 4·1 | 5 28 | 8·3 | 5 11 | 12·5 | 4 55 | 16·8 | 4 38 | 21·1 | 4 20 | 25·6 | 4 2 | 30·2 | 3 43 | 35·1 |
| 15 | 5 45 | 3·9 | 5 30 | 7·7 | 5 15 | 11·7 | 4 59 | 15·6 | 4 44 | 19·7 | 4 28 | 23·8 | 4 11 | 28·1 | 3 53 | 32·5 |
| 16 | 5 46 | 3·6 | 5 32 | 7·3 | 5 18 | 10·9 | 5 4 | 14·7 | 4 49 | 18·4 | 4 34 | 22·3 | 4 19 | 25·2 | 4 3 | 30·3 |
| 17 | 5 47 | 3·4 | 5 34 | 6·8 | 5 21 | 10·3 | 5 7 | 13·8 | 4 53 | 17·3 | 4 40 | 20·9 | 4 25 | 24·6 | 4 10 | 28·4 |
| 18 | 5 48 | 3·2 | 5 35 | 6·5 | 5 23 | 9·7 | 5 10 | 13·1 | 4 58 | 16·4 | 4 44 | 19·8 | 4 31 | 23·2 | 4 17 | 26·8 |
| 19 | 5 48 | 3·1 | 5 37 | 6·2 | 5 25 | 9·2 | 5 13 | 12·4 | 5 1 | 15·5 | 4 49 | 18·7 | 4 36 | 22·0 | 4 24 | 25·3 |
| 20 | 5 49 | 2·9 | 5 38 | 5·8 | 5 27 | 8·8 | 5 15 | 11·8 | 5 4 | 14·8 | 4 53 | 17·8 | 4 41 | 20·8 | 4 29 | 24·0 |
| 21 | 5 50 | 2·8 | 5 39 | 5·6 | 5 29 | 8·4 | 5 18 | 11·2 | 5 7 | 14·1 | 4 56 | 17·0 | 4 45 | 19·8 | 4 35 | 22·8 |
| 22 | 5 50 | 2·7 | 5 40 | 5·3 | 5 30 | 8·0 | 5 20 | 10·7 | 5 10 | 13·4 | 5 0 | 16·2 | 4 49 | 19·0 | 4 39 | 21·8 |
| 23 | 5 51 | 2·6 | 5 41 | 5·1 | 5 32 | 7·7 | 5 22 | 10·3 | 5 12 | 12·8 | 5 3 | 15·5 | 4 53 | 18·2 | 4 43 | 20·8 |
| 24 | 5 51 | 2·5 | 5 42 | 4·9 | 5 33 | 7·4 | 5 24 | 9·8 | 5 15 | 12·4 | 5 5 | 14·9 | 4 56 | 17·4 | 4 46 | 20·0 |
| 25 | 5 51 | 2·4 | 5 43 | 4·7 | 5 34 | 7·1 | 5 25 | 9·5 | 5 17 | 11·9 | 5 8 | 14·3 | 4 59 | 16·8 | 4 50 | 19·2 |
| 26 | 5 52 | 2·3 | 5 44 | 4·6 | 5 35 | 6·8 | 5 27 | 9·1 | 5 19 | 11·5 | 5 10 | 13·8 | 5 2 | 16·1 | 4 53 | 18·5 |
| 27 | 5 52 | 2·2 | 5 44 | 4·4 | 5 36 | 6·6 | 5 28 | 8·8 | 5 20 | 11·1 | 5 12 | 13·3 | 5 4 | 15·5 | 4 56 | 17·8 |
| 28 | 5 52 | 2·1 | 5 45 | 4·3 | 5 37 | 6·4 | 5 30 | 8·5 | 5 22 | 10·7 | 5 14 | 12·8 | 5 7 | 15·0 | 4 59 | 17·2 |
| 29 | 5 53 | 2·1 | 5 45 | 4·1 | 5 38 | 6·2 | 5 31 | 8·2 | 5 24 | 10·3 | 5 16 | 12·4 | 5 9 | 14·6 | 5 1 | 16·7 |
| 30 | 5 53 | 2·0 | 5 46 | 4·0 | 5 39 | 6·0 | 5 32 | 8·0 | 5 25 | 10·0 | 5 18 | 12·1 | 5 11 | 14·1 | 5 4 | 16·2 |
| 31 | 5 53 | 2·0 | 5 47 | 3·8 | 5 40 | 5·8 | 5 33 | 7·8 | 5 27 | 9·7 | 5 20 | 11·7 | 5 13 | 13·7 | 5 6 | 15·7 |
| 32 | 5 54 | 1·9 | 5 47 | 3·8 | 5 41 | 5·7 | 5 34 | 7·6 | 5 28 | 9·5 | 5 21 | 11·4 | 5 15 | 13·3 | 5 8 | 15·2 |
| 33 | 5 54 | 1·8 | 5 48 | 3·7 | 5 41 | 5·5 | 5 35 | 7·4 | 5 29 | 9·2 | 5 23 | 11·1 | 5 16 | 12·9 | 5 10 | 14·8 |
| 34 | 5 54 | 1·8 | 5 48 | 3·6 | 5 42 | 5·4 | 5 36 | 7·2 | 5 30 | 9·0 | 5 24 | 10·8 | 5 18 | 12·6 | 5 12 | 14·4 |
| 35 | 5 54 | 1·8 | 5 49 | 3·5 | 5 43 | 5·2 | 5 37 | 7·0 | 5 31 | 8·7 | 5 25 | 10·5 | 5 20 | 12·3 | 5 14 | 14·0 |
| 36 | 5 54 | 1·7 | 5 49 | 3·4 | 5 43 | 5·1 | 5 38 | 6·8 | 5 32 | 8·5 | 5 27 | 10·2 | 5 21 | 12·0 | 5 15 | 13·7 |
| 37 | 5 55 | 1·7 | 5 49 | 3·3 | 5 44 | 5·0 | 5 39 | 6·7 | 5 33 | 8·3 | 5 28 | 10·0 | 5 22 | 11·7 | 5 17 | 13·4 |
| 38 | 5 55 | 1·6 | 5 50 | 3·2 | 5 45 | 4·8 | 5 39 | 6·5 | 5 34 | 8·1 | 5 29 | 9·8 | 5 24 | 11·4 | 5 19 | 13·1 |
| 39 | 5 55 | 1·6 | 5 50 | 3·2 | 5 45 | 4·8 | 5 40 | 6·4 | 5 35 | 8·0 | 5 30 | 9·6 | 5 25 | 11·2 | 5 20 | 12·8 |
| 40 | 5 55 | 1·5 | 5 50 | 3·1 | 5 46 | 4·7 | 5 41 | 6·2 | 5 36 | 7·8 | 5 31 | 9·4 | 5 26 | 10·9 | 5 21 | 12·5 |
| 41 | 5 55 | 1·5 | 5 51 | 3·0 | 5 46 | 4·6 | 5 42 | 6·1 | 5 37 | 7·6 | 5 32 | 9·2 | 5 28 | 10·7 | 5 23 | 12·2 |
| 42 | 5 56 | 1·5 | 5 51 | 3·0 | 5 47 | 4·5 | 5 42 | 6·0 | 5 38 | 7·5 | 5 33 | 9·0 | 5 29 | 10·5 | 5 24 | 12·0 |
| 43 | 5 56 | 1·5 | 5 51 | 2·9 | 5 47 | 4·4 | 5 43 | 5·9 | 5 38 | 7·3 | 5 34 | 8·8 | 5 30 | 10·3 | 5 25 | 11·8 |
| 44 | 5 56 | 1·4 | 5 52 | 2·8 | 5 48 | 4·3 | 5 43 | 5·8 | 5 39 | 7·2 | 5 35 | 8·6 | 5 31 | 10·1 | 5 27 | 11·5 |
| 45 | 5 56 | 1·4 | 5 52 | 2·8 | 5 48 | 4·2 | 5 44 | 5·7 | 5 40 | 7·1 | 5 36 | 8·5 | 5 32 | 9·9 | 5 28 | 11·3 |
| 46 | 5 56 | 1·4 | 5 52 | 2·8 | 5 48 | 4·2 | 5 45 | 5·6 | 5 41 | 7·0 | 5 37 | 8·4 | 5 33 | 9·7 | 5 29 | 11·1 |
| 47 | 5 56 | 1·4 | 5 53 | 2·7 | 5 49 | 4·1 | 5 45 | 5·5 | 5 41 | 6·8 | 5 37 | 8·2 | 5 34 | 9·6 | 5 30 | 11·0 |
| 48 | 5 56 | 1·3 | 5 53 | 2·7 | 5 49 | 4·0 | 5 46 | 5·4 | 5 42 | 6·7 | 5 38 | 8·1 | 5 35 | 9·4 | 5 31 | 10·8 |
| 49 | 5 57 | 1·3 | 5 53 | 2·6 | 5 50 | 4·0 | 5 46 | 5·3 | 5 43 | 6·6 | 5 39 | 8·0 | 5 35 | 9·3 | 5 32 | 10·6 |
| 50 | 5 57 | 1·3 | 5 53 | 2·6 | 5 50 | 3·9 | 5 47 | 5·2 | 5 43 | 6·5 | 5 40 | 7·8 | 5 36 | 9·1 | 5 33 | 10·5 |
| 51 | 5 57 | 1·3 | 5 54 | 2·6 | 5 50 | 3·8 | 5 47 | 5·1 | 5 44 | 6·4 | 5 40 | 7·7 | 5 37 | 9·0 | 5 34 | 10·3 |
| 52 | 5 57 | 1·3 | 5 54 | 2·5 | 5 51 | 3·8 | 5 47 | 5·1 | 5 44 | 6·3 | 5 41 | 7·6 | 5 38 | 8·9 | 5 35 | 10·2 |
| 53 | 5 57 | 1·3 | 5 54 | 2·5 | 5 51 | 3·8 | 5 48 | 5·0 | 5 45 | 6·3 | 5 42 | 7·5 | 5 39 | 8·8 | 5 36 | 10·0 |
| 54 | 5 57 | 1·2 | 5 54 | 2·5 | 5 51 | 3·7 | 5 48 | 5·0 | 5 45 | 6·2 | 5 42 | 7·4 | 5 40 | 8·6 | 5 37 | 9·9 |
| 55 | 5 57 | 1·2 | 5 54 | 2·4 | 5 52 | 3·7 | 5 49 | 4·9 | 5 46 | 6·1 | 5 43 | 7·3 | 5 40 | 8·5 | 5 37 | 9·8 |
| 56 | 5 57 | 1·2 | 5 55 | 2·4 | 5 52 | 3·6 | 5 49 | 4·8 | 5 46 | 6·0 | 5 44 | 7·2 | 5 41 | 8·4 | 5 38 | 9·6 |
| 57 | 5 57 | 1·2 | 5 55 | 2·4 | 5 52 | 3·6 | 5 50 | 4·8 | 5 47 | 6·0 | 5 45 | 7·1 | 5 42 | 8·3 | 5 39 | 9·5 |
| 58 | 5 57 | 1·2 | 5 55 | 2·4 | 5 52 | 3·5 | 5 50 | 4·7 | 5 47 | 5·8 | 5 45 | 7·1 | 5 42 | 8·3 | 5 40 | 9·4 |
| 59 | 5 58 | 1·2 | 5 55 | 2·3 | 5 53 | 3·5 | 5 50 | 4·7 | 5 48 | 5·8 | 5 46 | 7·0 | 5 43 | 8·2 | 5 41 | 9·3 |
| 60 | 5 58 | 1·1 | 5 55 | 2·3 | 5 53 | 3·5 | 5 51 | 4·6 | 5 48 | 5·8 | 5 46 | 6·9 | 5 44 | 8·1 | 5 41 | 9·2 |
| 61 | 5 59 | 1·1 | 5 56 | 2·3 | 5 53 | 3·4 | 5 51 | 4·6 | 5 49 | 5·7 | 5 47 | 6·8 | 5 44 | 8·0 | 5 42 | 9·1 |

## HOUR ANGLE AND ALTITUDE OF A BODY UPON THE PRIME VERTICAL

| Lat. | Declination 1° H. A. | 1° Alt. | 2° H. A. | 2° Alt. | 3° H. A. | 3° Alt. | 4° H. A. | 4° Alt. | 5° H. A. | 5° Alt. | 6° H. A. | 6° Alt. | 7° H. A. | 7° Alt. | 8° H. A. | 8° Alt. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° | h m | ° | h m | ° | h m | ° | h m | ° | h m | ° | h m | ° | h m | ° | h m | ° |
| 62 | 5 58 | 1·1 | 5 56 | 2·3 | 5 54 | 3·4 | 5 51 | 4·5 | 5 49 | 5·7 | 5 47 | 6·8 | 5 45 | 7·9 | 5 43 | 9·1 |
| 63 | 5 58 | 1·1 | 5 56 | 2·2 | 5 54 | 3·4 | 5 52 | 4·5 | 5 50 | 5·6 | 5 48 | 6·7 | 5 46 | 7·8 | 5 44 | 9·0 |
| 64 | 5 58 | 1·1 | 5 56 | 2·2 | 5 54 | 3·3 | 5 52 | 4·4 | 5 50 | 5·6 | 5 48 | 6·7 | 5 46 | 7·8 | 5 44 | 8·9 |
| 65 | 5 58 | 1·1 | 5 56 | 2·2 | 5 54 | 3·3 | 5 53 | 4·4 | 5 51 | 5·5 | 5 49 | 6·6 | 5 47 | 7·7 | 5 45 | 8·8 |
| 66 | 5 58 | 1·1 | 5 56 | 2·2 | 5 55 | 3·3 | 5 53 | 4·4 | 5 51 | 5·5 | 5 49 | 6·6 | 5 47 | 7·7 | 5 46 | 8·7 |
| 67 | 5 58 | 1·1 | 5 57 | 2·2 | 5 55 | 3·2 | 5 53 | 4·3 | 5 51 | 5·4 | 5 50 | 6·5 | 5 48 | 7·6 | 5 46 | 8·7 |
| 68 | 5 58 | 1·1 | 5 57 | 2·1 | 5 55 | 3·2 | 5 54 | 4·3 | 5 52 | 5·4 | 5 50 | 6·5 | 5 49 | 7·5 | 5 47 | 8·6 |
| 69 | 5 58 | 1·1 | 5 57 | 2·1 | 5 55 | 3·2 | 5 54 | 4·3 | 5 52 | 5·4 | 5 51 | 6·4 | 5 49 | 7·5 | 5 48 | 8·6 |
| 70 | 5 59 | 1·1 | 5 57 | 2·1 | 5 56 | 3·2 | 5 54 | 4·2 | 5 53 | 5·3 | 5 51 | 6·4 | 5 50 | 7·4 | 5 48 | 8·5 |

| ° | 9° H. A. | 9° Alt. | 10° H. A. | 10° Alt. | 11° H. A. | 11° Alt. | 12° H. A. | 12° Alt. | 13° H. A. | 13° Alt. | 14° H. A. | 14° Alt. | 15° H. A. | 15° Alt. | 16° H. A. | 16° Alt. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 1 44 | 64·3 | | | | | | | | | | | | | | |
| 11 | 2 22 | 55·1 | 1 40 | 65·5 | | | | | | | | | | | | |
| 12 | 2 47 | 48·8 | 2 16 | 56·6 | 1 35 | 66·6 | | | | | | | | | | |
| 13 | 3 7 | 44·1 | 2 41 | 50·5 | 2 11 | 58·0 | 1 32 | 67·5 | | | | | | | | |
| 14 | 3 32 | 40·3 | 3 0 | 45·9 | 2 35 | 52·1 | 2 6 | 59·2 | 1 29 | 68·5 | | | | | | |
| 15 | 3 35 | 37·2 | 3 16 | 42·1 | 2 54 | 47·5 | 2 30 | 53·4 | 2 2 | 60·3 | 1 26 | 69·2 | | | | |
| 16 | 3 46 | 34·6 | 3 28 | 39·1 | 3 9 | 43·8 | 2 49 | 49·0 | 2 26 | 54·7 | 1 58 | 61·4 | 1 23 | 69·9 | | |
| 17 | 3 55 | 32·3 | 3 39 | 36·4 | 3 22 | 40·7 | 3 4 | 45·3 | 2 24 | 50·3 | 2 21 | 55·8 | 1 55 | 62·3 | 1 21 | 70·5 |
| 18 | 4 3 | 30·4 | 3 49 | 34·2 | 3 33 | 38·1 | 3 17 | 42·3 | 2 59 | 46·7 | 2 40 | 51·5 | 2 18 | 56·8 | 1 52 | 63·1 |
| 19 | 4 10 | 28·7 | 3 57 | 32·2 | 3 43 | 35·8 | 3 28 | 39·7 | 3 12 | 43·7 | 2 54 | 48·0 | 2 36 | 52·6 | 2 14 | 57·8 |
| 20 | 4 17 | 27·2 | 4 4 | 30·5 | 3 51 | 33·9 | 3 37 | 37·4 | 3 23 | 41·1 | 3 7 | 45·0 | 2 50 | 49·2 | 2 32 | 53·7 |
| 21 | 4 23 | 25·8 | 4 11 | 29·0 | 3 58 | 32·2 | 3 46 | 35·5 | 3 32 | 38·8 | 3 18 | 42·5 | 3 3 | 46·2 | 2 47 | 50·3 |
| 22 | 4 28 | 24·7 | 4 16 | 27·3 | 4 5 | 30·6 | 3 53 | 33·7 | 3 41 | 36·9 | 3 28 | 40·2 | 3 14 | 43·7 | 2 59 | 47·4 |
| 23 | 4 32 | 23·6 | 4 22 | 26·4 | 4 11 | 29·2 | 4 0 | 32·1 | 3 48 | 35·1 | 3 36 | 38·2 | 3 23 | 40·3 | 3 10 | 44·9 |
| 24 | 4 37 | 22·6 | 4 27 | 25·3 | 4 16 | 28·0 | 4 6 | 30·7 | 3 55 | 33·6 | 3 44 | 36·5 | 3 32 | 39·5 | 3 20 | 42·7 |
| 25 | 4 41 | 21·7 | 4 31 | 24·3 | 4 21 | 26·8 | 4 12 | 29·5 | 4 1 | 32·1 | 3 51 | 34·9 | 3 40 | 37·8 | 3 28 | 40·7 |
| 26 | 4 44 | 20·9 | 4 35 | 23·3 | 4 26 | 25·8 | 4 17 | 28·3 | 4 7 | 30·8 | 3 57 | 33·5 | 3 47 | 36·2 | 3 36 | 39·0 |
| 27 | 4 48 | 20·1 | 4 39 | 22·5 | 4 30 | 24·8 | 4 21 | 27·2 | 4 12 | 29·7 | 4 3 | 32·2 | 3 54 | 34·8 | 3 43 | 37·4 |
| 28 | 4 51 | 19·5 | 4 43 | 21·7 | 4 34 | 24·0 | 4 26 | 26·3 | 4 17 | 28·6 | 4 8 | 31·0 | 3 59 | 33·4 | 3 49 | 35·9 |
| 29 | 4 54 | 18·3 | 4 46 | 21·0 | 4 38 | 23·2 | 4 30 | 25·4 | 4 22 | 27·6 | 4 13 | 29·9 | 4 4 | 32·1 | 3 55 | 34·6 |
| 30 | 4 56 | 18·2 | 4 49 | 20·3 | 4 41 | 22·4 | 4 34 | 24·6 | 4 26 | 26·7 | 4 18 | 28·9 | 4 9 | 31·2 | 4 1 | 33·4 |
| 31 | 4 59 | 17·7 | 4 52 | 19·7 | 4 44 | 21·7 | 4 37 | 23·8 | 4 30 | 25·9 | 4 22 | 28·0 | 4 14 | 30·2 | 4 6 | 32·4 |
| 32 | 5 1 | 17·2 | 4 54 | 19·1 | 4 47 | 21·1 | 4 40 | 23·1 | 4 33 | 25·1 | 4 26 | 27·2 | 4 18 | 29·2 | 4 11 | 31·3 |
| 33 | 5 4 | 16·7 | 4 57 | 18·6 | 4 50 | 20·5 | 4 44 | 22·4 | 4 37 | 24·4 | 4 30 | 26·4 | 4 23 | 28·4 | 4 15 | 30·4 |
| 34 | 5 6 | 16·2 | 4 59 | 18·1 | 4 53 | 19·9 | 4 47 | 21·8 | 4 40 | 23·7 | 4 33 | 25·5 | 4 26 | 27·6 | 4 19 | 29·5 |
| 35 | 5 8 | 15·8 | 5 2 | 17·6 | 4 56 | 19·4 | 4 49 | 21·2 | 4 43 | 23·1 | 4 37 | 24·9 | 4 30 | 26·8 | 4 23 | 28·7 |
| 36 | 5 10 | 15·4 | 5 4 | 17·2 | 4 58 | 18·9 | 4 52 | 20·7 | 4 46 | 22·5 | 4 40 | 24·3 | 4 33 | 26·1 | 4 27 | 28·0 |
| 37 | 5 11 | 15·1 | 5 6 | 16·8 | 5 0 | 18·5 | 4 54 | 20·2 | 4 49 | 21·9 | 4 43 | 23·7 | 4 37 | 25·5 | 4 31 | 27·2 |
| 38 | 5 13 | 14·7 | 5 8 | 16·4 | 5 3 | 18·6 | 4 57 | 19·7 | 4 51 | 21·4 | 4 46 | 23·1 | 4 40 | 24·5 | 4 34 | 26·6 |
| 39 | 5 15 | 14·4 | 5 10 | 16·0 | 5 4 | 18·5 | 4 59 | 19·3 | 4 54 | 20·9 | 4 48 | 22·6 | 4 43 | 24·3 | 4 38 | 26·0 |
| 40 | 5 16 | 14·1 | 5 11 | 15·7 | 5 6 | 17·3 | 5 1 | 18·8 | 4 56 | 20·5 | 4 51 | 22·1 | 4 46 | 23·7 | 4 40 | 25·4 |
| 41 | 5 18 | 13·8 | 5 13 | 15·3 | 5 8 | 16·9 | 5 3 | 18·5 | 4 58 | 20·0 | 4 53 | 21·6 | 4 48 | 23·2 | 4 43 | 24·8 |
| 42 | 5 19 | 13·5 | 5 15 | 15·2 | 5 10 | 16·6 | 5 5 | 18·1 | 5 1 | 19·6 | 4 56 | 21·2 | 4 51 | 22·9 | 4 46 | 24·3 |
| 43 | 5 21 | 13·3 | 5 16 | 14·7 | 5 12 | 16·2 | 5 7 | 17·7 | 5 3 | 19·3 | 4 58 | 20·8 | 4 53 | 22·3 | 4 48 | 23·8 |
| 44 | 5 22 | 13·0 | 5 18 | 14·5 | 5 14 | 15·9 | 5 9 | 17·4 | 5 5 | 18·9 | 5 0 | 10·4 | 4 56 | 21·8 | 4 51 | 23·4 |
| 45 | 5 24 | 12·8 | 5 19 | 14·2 | 5 15 | 15·7 | 5 11 | 17·1 | 5 7 | 18·5 | 5 2 | 20·0 | 4 58 | 21·5 | 4 53 | 22·9 |
| 46 | 5 25 | 12·6 | 5 21 | 14·0 | 5 17 | 15·4 | 5 13 | 16·8 | 5 8 | 18·2 | 5 4 | 19·6 | 5 0 | 21·1 | 4 56 | 22·5 |
| 47 | 5 26 | 12·3 | 5 22 | 13·7 | 5 18 | 15·1 | 5 14 | 16·5 | 5 10 | 17·9 | 5 6 | 19·3 | 5 2 | 20·7 | 4 58 | 22·1 |
| 48 | 5 27 | 12·1 | 5 23 | 13·5 | 5 20 | 14·8 | 5 16 | 16·2 | 5 12 | 17·6 | 5 8 | 19·0 | 5 4 | 20·4 | 5 0 | 21·8 |
| 49 | 5 28 | 12·0 | 5 25 | 13·3 | 5 21 | 14·6 | 5 17 | 16·0 | 5 14 | 17·3 | 5 10 | 18·7 | 5 6 | 20·1 | 5 2 | 21·4 |
| 50 | 5 29 | 11·8 | 5 26 | 13·2 | 5 22 | 14·4 | 5 19 | 15·7 | 5 15 | 17·1 | 5 12 | 18·4 | 5 8 | 19·7 | 5 4 | 21·1 |
| 51 | 5 31 | 11·6 | 5 27 | 12·9 | 5 24 | 14·2 | 5 20 | 15·5 | 5 17 | 16·8 | 5 13 | 18·1 | 5 10 | 19·4 | 5 6 | 20·8 |
| 52 | 5 32 | 11·4 | 5 28 | 12·7 | 5 25 | 14·0 | 5 22 | 15·3 | 5 18 | 16·6 | 5 15 | 17·8 | 5 12 | 19·2 | 5 8 | 20·5 |
| 53 | 5 33 | 11·3 | 5 29 | 12·6 | 5 26 | 13·8 | 5 23 | 15·2 | 5 20 | 16·4 | 5 17 | 17·6 | 5 14 | 18·9 | 5 10 | 20·2 |
| 54 | 5 34 | 11·1 | 5 31 | 12·4 | 5 28 | 13·6 | 5 24 | 14·8 | 5 21 | 16·1 | 5 18 | 17·4 | 5 16 | 18·7 | 5 12 | 19·9 |
| 55 | 5 35 | 11·0 | 5 32 | 12·2 | 5 29 | 13·5 | 5 26 | 14·7 | 5 23 | 15·9 | 5 20 | 17·2 | 5 17 | 18·4 | 5 14 | 19·7 |
| 56 | 5 35 | 10·8 | 5 33 | 12·1 | 5 30 | 13·3 | 5 27 | 14·5 | 5 24 | 15·7 | 5 21 | 17·0 | 5 18 | 18·2 | 5 16 | 19·4 |
| 57 | 5 36 | 10·7 | 5 34 | 11·9 | 5 31 | 13·2 | 5 28 | 14·3 | 5 26 | 15·6 | 5 23 | 16·8 | 5 20 | 18·0 | 5 17 | 19·2 |
| 58 | 5 37 | 10·6 | 5 35 | 11·8 | 5 33 | 13·0 | 5 29 | 14·2 | 5 27 | 15·4 | 5 24 | 16·6 | 5 22 | 17·8 | 5 19 | 19·0 |

## HOUR ANGLE AND ALTITUDE OF A BODY UPON THE PRIME VERTICAL

| Lat. | 9° H. A. | 9° Alt. | 10° H. A. | 10° Alt. | 11° H. A. | 11° Alt. | 12° H. A. | 12° Alt. | 13° H. A. | 13° Alt. | 14° H. A. | 14° Alt. | 15° H. A. | 15° Alt. | 16° H. A. | 16° Alt. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° | h m | ° | h m | ° | h m | ° | h m | ° | h m | ° | h m | ° | h m | ° | h m | ° |
| 59 | 5 38 | 10.5 | 5 36 | 11.7 | 5 33 | 12.8 | 5 31 | 14.0 | 5 28 | 15.2 | 5 26 | 16.4 | 5 23 | 17.6 | 5 20 | 18.8 |
| 60 | 5 39 | 10.4 | 5 37 | 11.6 | 5 34 | 12.7 | 5 32 | 13.8 | 5 29 | 15.0 | 5 27 | 16.2 | 5 24 | 17.4 | 5 22 | 18.6 |
| 61 | 5 40 | 10.3 | 5 38 | 11.4 | 5 35 | 12.6 | 5 33 | 13.7 | 5 31 | 15.9 | 5 28 | 16.0 | 5 26 | 17.2 | 5 23 | 18.4 |
| 62 | 5 41 | 10.2 | 5 38 | 11.3 | 5 36 | 12.5 | 5 34 | 13.6 | 5 32 | 14.8 | 5 30 | 15.9 | 5 27 | 17.0 | 5 25 | 18.2 |
| 63 | 5 41 | 10.1 | 5 39 | 11.2 | 5 37 | 12.4 | 5 35 | 13.5 | 5 33 | 14.6 | 5 31 | 15.7 | 5 29 | 16.8 | 5 26 | 18.0 |
| 64 | 5 42 | 10.0 | 5 40 | 11.1 | 5 38 | 12.2 | 5 36 | 13.4 | 5 34 | 14.5 | 5 32 | 15.6 | 5 30 | 16.7 | 5 28 | 17.8 |
| 65 | 5 43 | 9.9 | 5 41 | 11.0 | 5 39 | 12.1 | 5 37 | 13.3 | 5 35 | 14.4 | 5 33 | 15.5 | 5 31 | 16.6 | 5 29 | 17.7 |
| 66 | 5 44 | 9.8 | 5 42 | 10.9 | 5 40 | 12.0 | 5 38 | 13.2 | 5 36 | 14.2 | 5 34 | 15.3 | 5 33 | 16.4 | 5 31 | 17.6 |
| 67 | 5 45 | 9.8 | 5 43 | 10.8 | 5 41 | 12.0 | 5 39 | 13.0 | 5 37 | 14.1 | 5 36 | 15.2 | 5 34 | 16.3 | 5 32 | 17.4 |
| 68 | 5 45 | 9.7 | 5 44 | 10.8 | 5 42 | 11.9 | 5 40 | 13.0 | 5 39 | 14.0 | 5 37 | 15.1 | 5 35 | 16.2 | 5 33 | 17.3 |
| 69 | 5 46 | 9.6 | 5 44 | 10.7 | 5 43 | 11.8 | 5 41 | 12.8 | 5 40 | 13.9 | 5 38 | 15.0 | 5 36 | 16.1 | 5 35 | 17.2 |
| 70 | 5 47 | 9.6 | 5 45 | 10.6 | 5 44 | 11.7 | 5 42 | 12.8 | 5 41 | 13.8 | 5 39 | 14.9 | 5 37 | 16.0 | 5 35 | 17.0 |

| ° | 17° H. A. | 17° Alt. | 18° H. A. | 18° Alt. | 19° H. A. | 19° Alt. | 20° H. A. | 20° Alt. | 21° H. A. | 21° Alt. | 22° H. A. | 22° Alt. | 23° H. A. | 23° Alt. | 24° H. A. | 24° Alt. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18 | 1 19 | 72.0 | | | | | | | | | | | | | | |
| 19 | 1 50 | 63.9 | 1 17 | 71.6 | | | | | | | | | | | | |
| 20 | 2 11 | 58.7 | 1 47 | 64.6 | 1 16 | 72.1 | | | | | | | | | | |
| 21 | 2 29 | 54.8 | 2 9 | 59.6 | 1 45 | 65.3 | 1 14 | 72.6 | | | | | | | | |
| 22 | 2 43 | 51.3 | 2 26 | 55.6 | 2 6 | 60.3 | 1 43 | 65.9 | 1 13 | 73.1 | | | | | | |
| 23 | 2 56 | 48.4 | 2 40 | 52.3 | 2 23 | 56.4 | 2 4 | 61.1 | 1 41 | 66.5 | 1 11 | 73.5 | | | | |
| 24 | 3 7 | 46.0 | 2 53 | 49.4 | 2 37 | 53.2 | 2 21 | 57.2 | 2 2 | 61.8 | 1 39 | 67.1 | 1 10 | 73.9 | | |
| 25 | 3 16 | 43.8 | 3 3 | 47.0 | 2 50 | 50.4 | 2 35 | 54.0 | 2 18 | 58.0 | 2 0 | 62.4 | 1 38 | 67.6 | 1 9 | 74.3 |
| 26 | 3 25 | 41.8 | 3 13 | 44.8 | 3 0 | 48.0 | 2 47 | 51.3 | 2 32 | 54.8 | 2 16 | 58.7 | 1 58 | 63.0 | 1 36 | 68.1 |
| 27 | 3 33 | 40.1 | 3 22 | 42.9 | 3 10 | 45.8 | 2 58 | 48.8 | 2 44 | 52.1 | 2 30 | 55.6 | 2 14 | 59.4 | 1 56 | 63.6 |
| 28 | 3 40 | 38.5 | 3 29 | 41.2 | 3 19 | 43.9 | 3 7 | 46.8 | 2 55 | 49.8 | 2 42 | 52.9 | 2 28 | 56.3 | 2 13 | 60.0 |
| 29 | 3 47 | 37.1 | 3 36 | 39.6 | 3 26 | 42.2 | 3 16 | 44.8 | 3 5 | 47.7 | 2 53 | 50.6 | 2 40 | 53.7 | 2 26 | 57.0 |
| 30 | 3 52 | 35.8 | 3 43 | 38.2 | 3 34 | 40.6 | 3 24 | 43.2 | 3 13 | 45.8 | 3 2 | 48.5 | 2 51 | 51.4 | 2 38 | 54.4 |
| 31 | 3 58 | 34.6 | 3 49 | 36.8 | 3 40 | 39.2 | 3 31 | 41.6 | 3 21 | 44.1 | 3 11 | 46.7 | 3 0 | 49.3 | 2 48 | 52.1 |
| 32 | 4 3 | 33.5 | 3 55 | 35.7 | 3 46 | 37.9 | 3 37 | 40.2 | 3 28 | 42.6 | 3 19 | 45.0 | 3 9 | 47.5 | 2 58 | 50.1 |
| 33 | 4 8 | 32.5 | 4 0 | 34.6 | 3 52 | 36.7 | 3 44 | 38.8 | 3 36 | 41.1 | 3 26 | 43.4 | 3 17 | 45.8 | 3 7 | 48.1 |
| 34 | 4 12 | 31.5 | 4 5 | 33.5 | 3 57 | 35.6 | 3 49 | 37.7 | 3 41 | 39.8 | 3 33 | 42.1 | 3 24 | 44.3 | 3 15 | 46.7 |
| 35 | 4 16 | 30.6 | 4 9 | 32.6 | 4 2 | 34.3 | 3 55 | 36.6 | 3 47 | 38.7 | 3 39 | 40.6 | 3 31 | 42.9 | 3 23 | 45.2 |
| 36 | 4 20 | 29.8 | 4 14 | 31.7 | 4 7 | 33.6 | 4 0 | 35.6 | 3 52 | 37.7 | 3 45 | 39.6 | 3 37 | 41.7 | 3 29 | 43.8 |
| 37 | 4 24 | 29.1 | 4 18 | 30.9 | 4 11 | 32.7 | 4 4 | 34.6 | 3 57 | 36.6 | 3 50 | 38.5 | 3 43 | 40.5 | 3 35 | 42.5 |
| 38 | 4 28 | 28.3 | 4 22 | 30.1 | 4 15 | 31.9 | 4 9 | 33.7 | 4 2 | 35.6 | 3 55 | 37.5 | 3 49 | 39.4 | 3 41 | 41.4 |
| 39 | 4 31 | 27.7 | 4 25 | 29.4 | 4 19 | 31.1 | 4 13 | 32.9 | 4 7 | 34.7 | 4 0 | 36.5 | 3 54 | 38.4 | 3 47 | 40.3 |
| 40 | 4 35 | 27.0 | 4 29 | 28.7 | 4 23 | 30.4 | 4 17 | 32.1 | 4 11 | 33.8 | 4 5 | 35.6 | 3 58 | 37.4 | 3 52 | 39.2 |
| 41 | 4 38 | 26.5 | 4 32 | 28.1 | 4 27 | 29.7 | 4 21 | 31.4 | 4 15 | 33.2 | 4 10 | 34.8 | 4 3 | 36.5 | 3 57 | 38.3 |
| 42 | 4 41 | 25.9 | 4 35 | 26.9 | 4 30 | 29.1 | 4 25 | 30.7 | 4 19 | 32.4 | 4 13 | 34.0 | 4 7 | 35.7 | 4 1 | 37.4 |
| 43 | 4 43 | 25.4 | 4 38 | 26.6 | 4 33 | 28.5 | 4 28 | 30.1 | 4 23 | 31.7 | 4 17 | 33.3 | 4 12 | 34.9 | 4 6 | 36.6 |
| 44 | 4 46 | 24.8 | 4 41 | 26.2 | 4 36 | 27.9 | 4 31 | 29.5 | 4 26 | 31.1 | 4 21 | 32.6 | 4 16 | 34.2 | 4 10 | 35.8 |
| 45 | 4 49 | 24.4 | 4 44 | 25.9 | 4 39 | 27.4 | 4 35 | 28.9 | 4 30 | 30.4 | 4 25 | 32.0 | 4 20 | 33.5 | 4 14 | 35.1 |
| 46 | 4 51 | 24.0 | 4 47 | 25.4 | 4 42 | 26.9 | 4 38 | 28.4 | 4 33 | 29.8 | 4 28 | 31.4 | 4 23 | 32.9 | 4 18 | 34.4 |
| 47 | 4 54 | 23.6 | 4 49 | 25.0 | 4 45 | 26.4 | 4 41 | 27.9 | 4 36 | 29.3 | 4 31 | 30.8 | 4 27 | 32.3 | 4 22 | 33.8 |
| 48 | 4 56 | 23.2 | 4 58 | 24.6 | 4 48 | 25.9 | 4 43 | 27.4 | 4 39 | 28.8 | 4 35 | 30.3 | 4 30 | 31.7 | 4 25 | 33.2 |
| 49 | 4 58 | 22.8 | 4 54 | 24.2 | 4 50 | 25.5 | 4 46 | 26.9 | 4 42 | 28.3 | 4 38 | 29.7 | 4 33 | 31.2 | 4 29 | 32.6 |
| 50 | 5 1 | 22.4 | 4 57 | 23.8 | 4 53 | 25.1 | 4 49 | 26.5 | 4 45 | 27.9 | 4 41 | 29.3 | 4 37 | 30.7 | 4 32 | 32.1 |
| 51 | 5 3 | 22.1 | 4 59 | 23.4 | 4 55 | 24.8 | 4 51 | 26.1 | 4 48 | 27.5 | 4 44 | 28.8 | 4 40 | 30.1 | 4 35 | 31.6 |
| 52 | 5 5 | 21.8 | 5 1 | 23.1 | 4 58 | 24.4 | 4 54 | 25.7 | 4 50 | 27.0 | 4 46 | 28.4 | 4 43 | 29.7 | 4 39 | 31.1 |
| 53 | 5 7 | 21.5 | 5 3 | 22.8 | 5 0 | 24.0 | 4 56 | 25.4 | 4 53 | 26.6 | 4 49 | 28.0 | 4 45 | 29.3 | 4 42 | 30.7 |
| 54 | 5 9 | 21.2 | 5 5 | 22.4 | 5 2 | 23.7 | 4 59 | 25.0 | 4 55 | 26.3 | 4 52 | 27.6 | 4 48 | 28.9 | 4 44 | 30.2 |
| 55 | 5 11 | 20.9 | 5 7 | 22.2 | 5 4 | 23.4 | 5 1 | 24.7 | 4 58 | 25.9 | 4 54 | 27.2 | 4 51 | 28.5 | 4 47 | 29.8 |
| 56 | 5 12 | 20.6 | 5 9 | 21.9 | 5 6 | 23.1 | 5 3 | 24.4 | 5 0 | 25.6 | 4 57 | 26.8 | 4 53 | 28.1 | 4 51 | 29.4 |
| 57 | 5 14 | 20.4 | 5 11 | 21.6 | 5 8 | 22.8 | 5 5 | 24.1 | 5 2 | 25.3 | 4 59 | 26.5 | 4 56 | 27.8 | 4 53 | 29.0 |
| 58 | 5 16 | 20.2 | 5 13 | 21.4 | 5 10 | 22.6 | 5 7 | 23.8 | 5 4 | 25.0 | 5 1 | 26.2 | 4 58 | 27.4 | 4 55 | 28.7 |
| 59 | 5 18 | 19.9 | 5 15 | 21.1 | 5 12 | 22.3 | 5 9 | 23.5 | 5 7 | 24.7 | 5 4 | 25.9 | 5 1 | 27.1 | 4 58 | 28.3 |
| 60 | 5 19 | 19.7 | 5 17 | 20.9 | 5 14 | 22.1 | 5 11 | 23.3 | 5 9 | 24.4 | 5 6 | 25.6 | 5 3 | 26.8 | 5 0 | [illegible] |
| 61 | 5 21 | 19.5 | 5 18 | 20.7 | 5 16 | 21.8 | 5 13 | 23.0 | 5 11 | 24.2 | 5 8 | 25.4 | 5 6 | 26.5 | 5 3 | 27.7 |
| 62 | 5 23 | 19.3 | 5 20 | 20.5 | 5 18 | 21.6 | 5 15 | 22.8 | 5 13 | 23.9 | 5 10 | 25.1 | 5 8 | 26.3 | 5 5 | 27.4 |
| 63 | 5 24 | 19.1 | 5 22 | 20.3 | 5 20 | 21.4 | 5 17 | 22.6 | 5 15 | 23.7 | 5 12 | 24.8 | 5 10 | 26.0 | 5 8 | 27.2 |
| 64 | 5 26 | 19.0 | 5 24 | 20.1 | 5 21 | 21.2 | 5 19 | 22.4 | 5 17 | 23.5 | 5 15 | 24.6 | 5 12 | 25.8 | 5 10 | 26.9 |

## HOUR ANGLE AND ALTITUDE OF A BODY UPON THE PRIME VERTICAL

| Lat. | Declination 17° | | 18° | | 19° | | 20° | | 21° | | 22° | | 23° | | 24° | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | H. A. | Alt. | H. A. | Alt. | H. A. | Alt. | H. A. | Alt. | H. A. | Alt. | H. A. | Alt. | H. A. | Alt. | H. A. | Alt. |
| ° | h m | ° | h m | ° | h m | ° | h m | ° | h m | ° | h m | ° | h m | ° | h m | ° |
| 65 | 5 27 | 18·8 | 5 25 | 19·9 | 5 23 | 21·0 | 5 21 | 22·2 | 5 19 | 23·3 | 5 17 | 24·4 | 5 14 | 25·5 | 5 12 | 26·7 |
| 66 | 5 25 | 18·7 | 5 27 | 19·8 | 5 24 | 20·8 | 5 23 | 22·0 | 5 21 | 23·1 | 5 19 | 24·2 | 5 16 | 25·3 | 5 14 | 26·4 |
| 67 | 5 30 | 18·5 | 5 28 | 19·6 | 5 26 | 20·7 | 5 24 | 21·8 | 5 22 | 22·9 | 5 20 | 24·0 | 5 18 | 25·1 | 5 16 | 26·2 |
| 68 | 5 32 | 18·4 | 5 30 | 19·5 | 5 28 | 20·5 | 5 26 | 21·6 | 5 24 | 22·7 | 5 22 | 23·8 | 5 20 | 24·9 | 5 19 | 26·0 |
| 69 | 5 33 | 18·2 | 5 31 | 19·3 | 5 30 | 20·4 | 5 28 | 21·5 | 5 26 | 22·6 | 5 24 | 23·6 | 5 22 | 24·7 | 5 21 | 25·8 |
| 70 | 5 34 | 18·1 | 5 33 | 19·2 | 5 31 | 20·3 | 5 30 | 21·3 | 5 28 | 22·4 | 5 26 | 23·5 | 5 24 | 24·6 | 5 23 | 25·6 |

| ° | 25° | | 26° | | 27° | | 28° | | 29° | | 30° | | 31° | | 32° | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 26 | 1 8 | 74·6 | | | | | | | | | | | | | | |
| 27 | 1 35 | 68·6 | 1 7 | 74·9 | | | | | | | | | | | | |
| 28 | 1 55 | 64·2 | 1 34 | 69·0 | 1 6 | 75·3 | | | | | | | | | | |
| 29 | 2 11 | 60·6 | 1 53 | 64·7 | 1 33 | 69·5 | 1 6 | 75·5 | | | | | | | | |
| 30 | 2 25 | 57·7 | 2 9 | 61·2 | 1 52 | 65·2 | 1 32 | 69·8 | 1 5 | 75·8 | | | | | | |
| 31 | 2 36 | 55·1 | 2 22 | 58·3 | 2 8 | 61·8 | 1 51 | 65·7 | 1 31 | 70·3 | 1 4 | 76·1 | | | | |
| 32 | 2 47 | 52·9 | 2 35 | 55·8 | 2 21 | 58·9 | 2 7 | 62·4 | 1 50 | 66·2 | 1 30 | 70·6 | 1 4 | 76·4 | | |
| 33 | 2 56 | 50·9 | 2 45 | 53·0 | 2 33 | 56·5 | 2 20 | 59·5 | 2 6 | 62·9 | 1 49 | 66·6 | 1 29 | 71·0 | 1 3 | 75·6 |
| 34 | 3 5 | 49·1 | 2 55 | 51·6 | 2 44 | 54·3 | 2 32 | 57·1 | 2 19 | 60·1 | 2 5 | 63·4 | 1 48 | 67·1 | 1 28 | 71·4 |
| 35 | 3 13 | 47·5 | 3 3 | 49·8 | 2 53 | 52·3 | 2 42 | 54·9 | 2 31 | 57·7 | 2 17 | 60·7 | 2 4 | 63·8 | 1 47 | 67·5 |
| 36 | 3 20 | 46·0 | 3 11 | 48·2 | 3 2 | 50·6 | 2 51 | 53·0 | 2 41 | 55·6 | 2 29 | 58·3 | 2 17 | 61·2 | 2 3 | 64·3 |
| 37 | 3 27 | 44·6 | 3 19 | 46·7 | 3 10 | 49·0 | 3 0 | 51·3 | 2 51 | 53·7 | 2 40 | 56·2 | 2 28 | 58·8 | 2 16 | 61·7 |
| 38 | 3 33 | 43·0 | 3 25 | 45·4 | 3 17 | 47·5 | 3 8 | 49·7 | 2 59 | 51·9 | 2 49 | 54·3 | 2 39 | 56·8 | 2 28 | 59·3 |
| 39 | 3 39 | 42·2 | 3 32 | 44·1 | 3 24 | 46·2 | 3 16 | 48·2 | 3 7 | 50·4 | 2 58 | 52·6 | 2 49 | 54·9 | 2 38 | 57·3 |
| 40 | 3 45 | 41·1 | 3 38 | 43·3 | 3 30 | 44·9 | 3 23 | 46·9 | 3 15 | 49·0 | 3 6 | 51·1 | 2 58 | 5[illegible]·2 | 2 47 | 55·5 |
| 41 | 3 50 | 40·1 | 3 43 | 41·9 | 3 36 | 43·8 | 3 29 | 45·7 | 3 22 | 47·6 | 3 14 | 49·6 | 3 5 | 51·7 | 2 56 | 53·8 |
| 42 | 3 55 | 39·2 | 3 49 | 40·9 | 3 42 | 42·7 | 3 35 | 44·6 | 3 28 | 46·4 | 3 20 | 48·3 | 3 13 | 50·3 | 3 4 | 52·4 |
| 43 | 4 0 | 38·3 | 3 54 | 40·0 | 3 48 | 41·7 | 3 41 | 43·5 | 3 34 | 45·3 | 3 27 | 47·1 | 3 20 | 49·0 | 3 12 | 51·0 |
| 44 | 4 4 | 37·5 | 3 59 | 39·1 | 3 53 | 40·8 | 3 46 | 42·5 | 3 40 | 44·3 | 3 33 | 46·0 | 3 26 | 47·8 | 3 19 | 49·7 |
| 45 | 4 9 | 36·7 | 4 3 | 38·3 | 3 57 | 39·9 | 3 52 | 41·6 | 3 45 | 43·3 | 3 39 | 45·0 | 3 32 | 46·7 | 3 25 | 48·5 |
| 46 | 4 13 | 36·0 | 4 8 | 37·5 | 4 2 | 39·1 | 3 56 | 40·7 | 3 51 | 42·4 | 3 44 | 44·0 | 3 38 | 45·7 | 3 32 | 47·4 |
| 47 | 4 17 | 35·3 | 4 12 | 36·8 | 4 7 | 38·4 | 4 1 | 39·9 | 3 55 | 41·5 | 3 49 | 43·1 | 3 44 | 44·8 | 3 37 | 46·4 |
| 48 | 4 21 | 34·7 | 4 16 | 36·1 | 4 11 | 37·7 | 4 6 | 39·2 | 4 0 | 40·7 | 3 55 | 42·3 | 3 49 | 43·8 | 3 43 | 45·5 |
| 49 | 4 24 | 34·0 | 4 20 | 35·5 | 4 15 | 37·0 | 4 10 | 38·4 | 4 5 | 40·0 | 3 59 | 41·5 | 3 54 | 43·0 | 3 48 | 44·6 |
| 50 | 4 28 | 33·5 | 4 23 | 34·9 | 4 19 | 36·3 | 4 14 | 37·8 | 4 9 | 39·3 | 4 4 | 40·7 | 3 59 | 42·2 | 3 54 | 43·7 |
| 51 | 4 31 | 32·9 | 4 27 | 34·3 | 4 23 | 35·7 | 4 18 | 37·2 | 4 13 | 38·6 | 4 8 | 40·0 | 4 4 | 41·5 | 3 58 | 43·0 |
| 52 | 4 35 | 32·4 | 4 30 | 33·8 | 4 26 | 35·2 | 4 22 | 36·6 | 4 17 | 38·0 | 4 13 | 39·4 | 4 8 | 40·8 | 4 3 | 42·3 |
| 53 | 4 38 | 31·9 | 4 34 | 33·3 | 4 30 | 34·6 | 4 26 | 36·0 | 4 21 | 37·4 | 4 17 | 38·8 | 4 12 | 40·1 | 4 8 | 41·6 |
| 54 | 4 41 | 31·5 | 4 37 | 32·8 | 4 34 | 34·1 | 4 30 | 35·5 | 4 25 | 36·8 | 4 21 | 38·2 | 4 16 | 39·5 | 4 12 | 40·9 |
| 55 | 4 44 | 31·1 | 4 40 | 32·3 | 4 36 | 33·6 | 4 33 | 35·0 | 4 29 | 36·3 | 4 25 | 37·6 | 4 20 | 38·9 | 4 16 | 40·3 |
| 56 | 4 47 | 30·6 | 4 43 | 31·9 | 4 40 | 33·2 | 4 36 | 34·5 | 4 32 | 35·8 | 4 28 | 37·1 | 4 24 | 38·4 | 4 20 | 39·7 |
| 57 | 4 49 | 30·3 | 4 46 | 31·5 | 4 43 | 32·8 | 4 39 | 34·0 | 4 36 | 35·3 | 4 32 | 36·6 | 4 28 | 37·8 | 4 24 | 39·2 |
| 58 | 4 52 | 29·9 | 4 49 | 31·1 | 4 46 | 32·4 | 4 42 | 33·6 | 4 39 | 34·8 | 4 35 | 36·1 | 4 32 | 37·4 | 4 28 | 38·7 |
| 59 | 4 55 | 29·5 | 4 52 | 30·7 | 4 49 | 32·0 | 4 45 | 33·2 | 4 42 | 34·4 | 4 39 | 35·7 | 4 35 | 36·9 | 4 32 | 38·2 |
| 60 | 4 58 | 29·2 | 4 55 | 30·4 | 4 52 | 31·6 | 4 48 | 32·8 | 4 45 | 34·0 | 4 42 | 35·3 | 4 39 | 36·5 | 4 35 | 37·7 |
| 61 | 5 0 | 28·9 | 4 57 | 30·1 | 4 54 | 31·3 | 4 51 | 32·5 | 4 48 | 33·7 | 4 45 | 34·8 | 4 42 | 36·1 | 4 39 | 37·3 |
| 62 | 5 3 | 28·6 | 5 0 | 29·7 | 4 57 | 30·9 | 4 54 | 32·1 | 4 51 | 33·3 | 4 48 | 34·5 | 4 45 | 35·7 | 4 42 | 36·8 |
| 63 | 5 5 | 28·3 | 5 2 | 29·5 | 5 0 | 30·5 | 4 57 | 31·8 | 4 54 | 33·0 | 4 52 | 34·1 | 4 48 | 35·3 | 4 46 | 36·5 |
| 64 | 5 7 | 28·0 | 5 5 | 29·2 | 5 2 | 30·3 | 5 0 | 31·5 | 4 57 | 32·6 | 4 55 | 33·8 | 4 50 | 35·0 | 4 49 | 36·1 |
| 65 | 5 10 | 27·8 | 5 7 | 28·9 | 5 5 | 30·1 | 5 3 | 31·2 | 5 0 | 32·3 | 4 58 | 33·5 | 4 53 | 34·6 | 4 52 | 35·8 |
| 66 | 5 12 | 27·6 | 5 10 | 28·7 | 5 8 | 29·8 | 5 5 | 30·9 | 5 3 | 32·0 | 5 0 | 33·2 | 4 56 | 34·3 | 4 55 | 35·4 |
| 67 | 5 14 | 27·5 | 5 12 | 28·4 | 5 10 | 29·5 | 5 8 | 30·7 | 5 5 | 31·8 | 5 3 | 32·9 | 4 59 | 34·0 | 4 58 | 35·1 |
| 68 | 5 17 | 27·3 | 5 15 | 28·2 | 5 12 | 29·3 | 5 10 | 30·4 | 5 8 | 31·5 | 5 7 | 32·6 | 5 1 | 33·7 | 5 1 | 34·8 |
| 69 | 5 19 | 26·9 | 5 17 | 28·0 | 5 15 | 29·1 | 5 13 | 30·2 | 5 11 | 31·3 | 5 9 | 32·4 | 5 5 | 33·5 | 5 4 | 34·6 |
| 70 | 5 21 | 26·7 | 5 19 | 27·8 | 5 17 | 28·8 | 5 15 | 30·0 | 5 13 | 31·1 | 5 11 | 32·1 | 5 8 | 33·2 | 5 7 | 34·3 |

## HOUR ANGLE AND ALTITUDE OF A BODY UPON THE PRIME VERTICAL.

| Lat. | 33° H. A. | 33° Alt. | 34° H. A. | 34° Alt. | 35° H. A. | 35° Alt. | 36° H. A. | 36° Alt. | 37° H. A. | 37° Alt. | 38° H. A. | 38° Alt. | 39° H. A. | 39° Alt. | 40° H. A. | 40° Alt. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° | h m | ° | h m | ° | h m | ° | h m | ° | h m | ° | h m | ° | h m | ° | h m | ° |
| 34 | 1 3 | 76·9 | | | | | | | | | | | | | | |
| 35 | 1 28 | 71·7 | 1 2 | 77·1 | | | | | | | | | | | | |
| 36 | 1 47 | 67·9 | 1 27 | 72·0 | 1 2 | 77·4 | | | | | | | | | | |
| 37 | 2 2 | 64·8 | 1 46 | 68·3 | 1 27 | 72·4 | 1 1 | 77·6 | | | | | | | | |
| 38 | 2 15 | 62·2 | 2 1 | 65·3 | 1 45 | 68·7 | 1 26 | 72·7 | 1 1 | 77·8 | | | | | | |
| 39 | 2 27 | 59·9 | 2 14 | 62·7 | 2 1 | 65·7 | 1 45 | 69·1 | 1 26 | 73·0 | 1 1 | 78·0 | | | | |
| 40 | 2 37 | 57·9 | 2 26 | 60·4 | 2 14 | 63·2 | 2 0 | 66·1 | 1 44 | 69·4 | 1 26 | 73·3 | 1 1 | 78·2 | | |
| 41 | 2 47 | 56·1 | 2 36 | 58·5 | 2 25 | 61·0 | 2 13 | 63·6 | 2 0 | 66·5 | 1 44 | 69·8 | 1 25 | 73·6 | 1 1 | 78·5 |
| 42 | 2 55 | 54·5 | 2 46 | 56·7 | 2 36 | 59·0 | 2 25 | 61·4 | 2 13 | 64·1 | 1 59 | 66·9 | 1 44 | 70·1 | 1 25 | 73·9 |
| 43 | 3 3 | 53·0 | 2 55 | 55·1 | 2 45 | 57·2 | 2 35 | 59·5 | 2 24 | 61·9 | 2 12 | 64·5 | 1 59 | 67·3 | 1 43 | 70·5 |
| 44 | 3 11 | 51·6 | 3 3 | 53·6 | 2 54 | 55·7 | 2 45 | 57·8 | 2 35 | 60·0 | 2 24 | 62·4 | 2 12 | 64·9 | 1 59 | 67·7 |
| 45 | 3 18 | 50·4 | 3 10 | 52·3 | 3 2 | 54·2 | 2 54 | 56·2 | 2 44 | 58·3 | 2 34 | 60·5 | 2 24 | 62·8 | 2 12 | 65·4 |
| 46 | 3 25 | 49·2 | 3 17 | 51·0 | 3 10 | 52·8 | 3 2 | 54·8 | 2 53 | 56·8 | 2 44 | 58·8 | 2 34 | 61·0 | 2 23 | 63·3 |
| 47 | 3 30 | 48·1 | 3 24 | 49·8 | 3 17 | 51·6 | 3 9 | 53·5 | 3 1 | 55·4 | 2 53 | 57·3 | 2 44 | 59·3 | 2 34 | 61·5 |
| 48 | 3 37 | 47·1 | 3 30 | 48·8 | 3 24 | 50·5 | 3 17 | 52·3 | 3 9 | 54·1 | 3 1 | 55·9 | 2 53 | 57·8 | 2 44 | 59·9 |
| 49 | 3 43 | 46·2 | 3 36 | 47·8 | 3 30 | 49·5 | 3 23 | 51·1 | 3 16 | 52·8 | 3 9 | 54·7 | 3 1 | 56·5 | 2 53 | 58·4 |
| 50 | 3 48 | 45·3 | 3 42 | 46·8 | 3 36 | 48·5 | 3 30 | 50·1 | 3 23 | 51·8 | 3 16 | 53·5 | 3 9 | 55·5 | 3 1 | 57·0 |
| 51 | 3 53 | 44·5 | 3 48 | 46·0 | 3 42 | 47·6 | 3 36 | 49·1 | 3 30 | 50·4 | 3 23 | 52·4 | 3 16 | 54·1 | 3 9 | 55·8 |
| 52 | 3 58 | 43·7 | 3 53 | 45·2 | 3 47 | 46·8 | 3 42 | 48·2 | 3 36 | 49·8 | 3 30 | 51·4 | 3 23 | 53·0 | 3 16 | 54·7 |
| 53 | 4 2 | 43·0 | 3 58 | 44·4 | 3 53 | 45·9 | 3 47 | 47·4 | 3 42 | 48·9 | 3 36 | 50·4 | 3 30 | 52·0 | 3 23 | 53·6 |
| 54 | 4 7 | 42·3 | 4 3 | 43·7 | 3 58 | 45·1 | 3 53 | 46·6 | 3 47 | 48·1 | 3 42 | 49·5 | 3 36 | 51·1 | 3 30 | 52·6 |
| 55 | 4 12 | 41·7 | 4 7 | 43·0 | 4 3 | 44·4 | 3 58 | 45·8 | 3 53 | 47·3 | 3 47 | 48·7 | 3 42 | 50·2 | 3 36 | 51·7 |
| 56 | 4 16 | 41·1 | 4 12 | 42·4 | 4 7 | 43·8 | 4 3 | 45·1 | 3 58 | 46·5 | 3 53 | 47·9 | 3 48 | 49·4 | 3 42 | 50·8 |
| 57 | 4 20 | 40·5 | 4 16 | 41·8 | 4 12 | 43·1 | 4 7 | 44·5 | 4 3 | 45·8 | 3 58 | 47·2 | 3 53 | 48·6 | 3 48 | 50·0 |
| 58 | 4 24 | 40·0 | 4 20 | 41·2 | 4 16 | 42·5 | 4 12 | 43·9 | 4 8 | 45·2 | 4 3 | 46·5 | 3 58 | 47·9 | 3 53 | 49·3 |
| 59 | 4 28 | 39·4 | 4 24 | 40·7 | 4 20 | 42·0 | 4 16 | 43·3 | 4 12 | 44·6 | 4 8 | 45·9 | 4 4 | 47·1 | 3 59 | 48·6 |
| 60 | 4 32 | 39·0 | 4 28 | 40·2 | 4 25 | 41·5 | 4 21 | 42·7 | 4 17 | 44·0 | 4 13 | 45·3 | 4 8 | 46·6 | 4 4 | 47·9 |
| 61 | 4 36 | 38·5 | 4 32 | 39·7 | 4 29 | 41·0 | 4 25 | 42·2 | 4 21 | 43·5 | 4 17 | 44·7 | 4 13 | 46·0 | 4 9 | 47·3 |
| 62 | 4 39 | 38·2 | 4 36 | 39·3 | 4 33 | 40·5 | 4 29 | 41·7 | 4 26 | 42·9 | 4 22 | 44·2 | 4 18 | 45·5 | 4 14 | 46·7 |
| 63 | 4 43 | 37·7 | 4 40 | 38·8 | 4 36 | 40·1 | 4 33 | 41·3 | 4 30 | 42·5 | 4 26 | 43·7 | 4 23 | 44·9 | 4 19 | 46·2 |
| 64 | 4 47 | 37·3 | 4 43 | 38·5 | 4 40 | 39·6 | 4 37 | 40·8 | 4 34 | 42·0 | 4 30 | 43·2 | 4 27 | 44·4 | 4 23 | 45·7 |
| 65 | 4 49 | 36·9 | 4 47 | 38·1 | 4 44 | 39·3 | 4 41 | 40·4 | 4 38 | 41·6 | 4 35 | 42·8 | 4 31 | 44·0 | 4 28 | 45·2 |
| 66 | 4 53 | 36·6 | 4 50 | 37·7 | 4 47 | 38·9 | 4 44 | 40·0 | 4 42 | 41·2 | 4 39 | 42·4 | 4 35 | 43·5 | 4 32 | 44·7 |
| 67 | 4 56 | 36·3 | 4 53 | 37·4 | 4 51 | 38·5 | 4 48 | 39·7 | 4 45 | 40·8 | 4 43 | 42·0 | 4 40 | 43·1 | 4 37 | 44·3 |
| 68 | 4 59 | 36·0 | 4 57 | 37·1 | 4 54 | 38·2 | 4 52 | 39·3 | 4 49 | 40·5 | 4 46 | 41·6 | 4 44 | 42·7 | 4 41 | 43·8 |
| 69 | 5 2 | 35·7 | 5 0 | 36·8 | 4 58 | 37·9 | 4 55 | 39·0 | 4 53 | 40·1 | 4 50 | 41·2 | 4 48 | 42·4 | 4 45 | 43·5 |
| 70 | 5 5 | 35·4 | 5 3 | 36·5 | 5 1 | 37·6 | 4 59 | 38·7 | 4 56 | 39·8 | 4 54 | 40·9 | 4 51 | 42·0 | 4 49 | 43·2 |

| ° | 41° H. A. | 41° Alt. | 42° H. A. | 42° Alt. | 43° H. A. | 43° Alt. | 44° H. A. | 44° Alt. | 45° H. A. | 45° Alt. | 46° H. A. | 46° Alt. | 47° H. A. | 47° Alt. | 48° H. A. | 48° Alt. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 42 | 1 0 | 78·6 | | | | | | | | | | | | | | |
| 43 | 1 25 | 74·1 | 1 0 | 78·8 | | | | | | | | | | | | |
| 44 | 1 43 | 70·8 | 1 25 | 74·4 | 1 0 | 79·0 | | | | | | | | | | |
| 45 | 1 58 | 68·1 | 1 43 | 71·1 | 1 25 | 74·7 | 1 0 | 79·2 | | | | | | | | |
| 46 | 2 12 | 65·8 | 1 58 | 68·5 | 1 43 | 71·5 | 1 25 | 74·9 | 1 0 | 79·4 | | | | | | |
| 47 | 2 23 | 63·8 | 2 12 | 66·2 | 1 58 | 68·8 | 1 43 | 71·8 | 1 25 | 75·2 | 1 0 | 79·6 | | | | |
| 48 | 2 34 | 62·0 | 2 23 | 64·2 | 2 12 | 66·6 | 1 58 | 69·2 | 1 43 | 72·2 | 1 25 | 75·5 | 1 0 | 79·8 | | |
| 49 | 2 44 | 60·4 | 2 33 | 62·4 | 2 23 | 64·6 | 2 12 | 67·0 | 1 58 | 69·5 | 1 43 | 72·4 | 1 25 | 75·7 | 1 0 | 79·9 |
| 50 | 2 53 | 58·9 | 2 44 | 60·9 | 2 34 | 62·9 | 2 23 | 65·1 | 2 12 | 67·4 | 1 59 | 69·9 | 1 43 | 72·7 | 1 25 | 75·9 |
| 51 | 3 1 | 57·6 | 2 53 | 59·4 | 2 44 | 61·3 | 2 34 | 63·4 | 2 24 | 65·5 | 2 12 | 67·8 | 1 59 | 70·2 | 1 44 | 73·0 |
| 52 | 3 9 | 56·4 | 3 1 | 58·1 | 2 53 | 59·9 | 2 44 | 61·8 | 2 34 | 63·8 | 2 24 | 65·9 | 2 12 | 68·1 | 1 59 | 70·6 |
| 53 | 3 16 | 55·2 | 3 9 | 56·9 | 3 1 | 58·6 | 2 53 | 60·4 | 2 44 | 62·3 | 2 35 | 65·2 | 2 24 | 66·3 | 2 13 | 68·5 |
| 54 | 3 23 | 54·[illegible] | 3 17 | 55·8 | 3 9 | 57·5 | 3 2 | 59·2 | 2 54 | 60·9 | 2 45 | 62·8 | 2 35 | 64·7 | 2 25 | 66·7 |
| 55 | 3 30 | 53·2 | 3 24 | 54·8 | 3 17 | 56·4 | 3 10 | 58·0 | 3 2 | 59·7 | 2 54 | 61·4 | 2 45 | 63·2 | 2 36 | 65·1 |
| 56 | 3 36 | 52·3 | 3 30 | 53·8 | 3 24 | 55·3 | 3 17 | 56·9 | 3 10 | 58·5 | 3 3 | 60·2 | 2 55 | 61·9 | 2 46 | 63·7 |
| 57 | 3 43 | 51·5 | 3 37 | 52·9 | 3 31 | 54·4 | 3 25 | 55·9 | 3 18 | 57·5 | 3 11 | 59·1 | 3 3 | 60·7 | 2 55 | 62·4 |
| 58 | 3 48 | 50·7 | 3 43 | 52·1 | 3 37 | 53·5 | 3 32 | 55·0 | 3 25 | 56·5 | 3 19 | 58·0 | 3 12 | 59·6 | 3 4 | 61·2 |
| 59 | 3 54 | 49·9 | 3 49 | 51·3 | 3 44 | 52·7 | 3 38 | 54·1 | 3 32 | 55·6 | 3 26 | 57·0 | 3 20 | 58·6 | 3 13 | 60·2 |
| 60 | 3 59 | 49·2 | 3 55 | 50·6 | 3 50 | 51·9 | 3 44 | 53·3 | 3 39 | 54·7 | 3 33 | 56·2 | 3 27 | 57·6 | 3 20 | 59·1 |
| 61 | 4 5 | 48·6 | 4 0 | 49·9 | 3 55 | 51·2 | 3 51 | 52·6 | 3 45 | 53·9 | 3 40 | 55·3 | 3 34 | 56·7 | 3 28 | 58·2 |
| 62 | 4 10 | 48·0 | 4 6 | 49·3 | 4 1 | 50·6 | 3 56 | 51·8 | 3 52 | 53·2 | 3 46 | 54·5 | 3 41 | 55·9 | 3 35 | 57·3 |
| 63 | 4 15 | 47·4 | 4 11 | 48·7 | 4 4 | 49·9 | 4 2 | 51·2 | 3 57 | 52·5 | 3 53 | 53·8 | 3 48 | 55·2 | 3 42 | 56·5 |

**APPARENT DIP OF THE SEA HORIZON**

| Ht. | Dip. |
|---|---|
| | ' " |
| 0 | 0 0 |
| 1 | 1 0 |
| 2 | 1 24 |
| 3 | 1 42 |
| 4 | 1 58 |
| 5 | 2 12 |
| 6 | 2 25 |
| 7 | 2 36 |
| 8 | 2 47 |
| 9 | 2 57 |
| 10 | 3 7 |
| 12 | 3 25 |
| 14 | 3 41 |
| 16 | 3 56 |
| 18 | 4 11 |
| 20 | 4 24 |
| 22 | 4 37 |
| 24 | 4 49 |
| 26 | 5 1 |
| 28 | 5 13 |
| 30 | 5 24 |
| 35 | 5 49 |
| 40 | 6 13 |
| 45 | 6 36 |
| 50 | 6 58 |
| 55 | 7 18 |
| 60 | 7 37 |
| 65 | 7 56 |
| 70 | 8 14 |
| 75 | 8 31 |
| 80 | 8 48 |
| 85 | 9 4 |
| 90 | 9 20 |
| 100 | 9 51 |
| 110 | 10 19 |
| 120 | 10 47 |
| 130 | 11 14 |
| 140 | 11 39 |
| 150 | 12 3 |
| 160 | 12 27 |
| 170 | 12 50 |
| 180 | 13 12 |
| 190 | 13 34 |
| 200 | 13 55 |
| 210 | 14 16 |
| 220 | 14 36 |
| 240 | 15 15 |
| 260 | 15 52 |
| 280 | 16 27 |
| 300 | 17 0 |

**MEAN ASTRONOMICAL REFRACTION.**

(Barometer, 30 inches. Fahrenheit's Thermometer, 50°)

| App. Alt. | Refrac. | D. to 10' | App. Alt. | Refrac. | D. to 10' | App. Alt. | Refrac. | D. to 10' | App. Alt. | Refrac. | D. to 10' |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0° 0' | 34' 17" | " 122 | 6° 10' | 8' 18" | " 12 | 12° 50' | 4' 11" | " 3·2 | 35° 0' | 1' 23·2 | " ·50 |
| 10 | 32 15 | 112 | 15 | 8 12 | 12 | 13 0 | 4 8 | 3·1 | 30 | 1 21·7 | ·50 |
| 20 | 30 23 | 102 | 20 | 8 6 | 11 | 10 | 4 5 | 3·1 | 36 0 | 1 20·2 | ·47 |
| 30 | 28 41 | 94 | 25 | 8 1 | 11 | 20 | 4 2 | 3·0 | 30 | 1 18·8 | ·47 |
| 40 | 27 7 | 86 | 30 | 7 56 | 11 | 30 | 3 59 | 3·0 | 37 0 | 1 17·4 | ·47 |
| 50 | 25 41 | 78 | 35 | 7 50 | 11 | 40 | 3 56 | 2·9 | 30 | 1 16·0 | ·47 |
| 1 0 | 24 22 | 73 | 40 | 7 45 | 10 | 50 | 3 53 | 2·9 | 38 0 | 1 14·6 | ·43 |
| 10 | 23 9 | 67 | 45 | 7 40 | 10 | 14 0 | 3 50 | 2·8 | 30 | 1 13·3 | ·43 |
| 20 | 22 2 | 62 | 50 | 7 35 | 10 | 10 | 3 47 | 2·7 | 39 0 | 1 12·0 | ·43 |
| 30 | 21 0 | 58 | 55 | 7 30 | 10 | 20 | 3 45 | 2·6 | 30 | 1 10·7 | ·42 |
| 40 | 20 2 | 53 | 7 0 | 7 25 | 9 | 30 | 3 42 | 2·5 | 40 0 | 1 9·5 | ·40 |
| 50 | 19 9 | 49 | 5 | 7 20 | 9 | 40 | 3 40 | 2·5 | 41 0 | 1 7·1 | ·38 |
| 2 0 | 18 20 | 46 | 10 | 7 16 | 9 | 50 | 3 37 | 2·4 | 42 0 | 1 4·8 | ·35 |
| 10 | 17 34 | 44 | 15 | 7 11 | 9 | 15 0 | 3 35 | 2·4 | 43 0 | 1 2·6 | ·34 |
| 15 | 17 12 | 42 | 20 | 7 7 | 9 | 10 | 3 32 | 2·3 | 44 0 | 1 0·4 | ·34 |
| 20 | 16 51 | 40 | 25 | 7 3 | 9 | 20 | 3 30 | 2·2 | 45 0 | 0 58·4 | ·33 |
| 25 | 16 31 | 39 | 30 | 6 59 | 9 | 30 | 3 28 | 2·2 | 46 0 | 0 56·3 | ·32 |
| 30 | 16 11 | 38 | 35 | 6 54 | 9 | 40 | 3 25 | 2·1 | 47 0 | 0 54·4 | ·31 |
| 35 | 15 52 | 37 | 40 | 6 50 | 8 | 50 | 3 23 | 2·1 | 48 0 | 0 52·6 | ·30 |
| 40 | 15 34 | 36 | 45 | 6 46 | 8 | 16 0 | 3 21 | 2·1 | 49 0 | 0 50·7 | ·29 |
| 45 | 15 16 | 35 | 50 | 6 42 | 8 | 10 | 3 19 | 2·1 | 50 0 | 0 49·0 | ·28 |
| 50 | 14 59 | 34 | 55 | 6 38 | 8 | 20 | 3 17 | 2·1 | 51 0 | 0 47·3 | ·27 |
| 55 | 14 42 | 33 | 8 0 | 6 35 | 8 | 30 | 3 15 | 2·0 | 52 0 | 0 45·6 | ·26 |
| 3 0 | 14 26 | 32 | 5 | 6 31 | 7 | 40 | 3 13 | 2·0 | 53 0 | 0 44·0 | ·26 |
| 5 | 14 10 | 31 | 10 | 6 27 | 7 | 50 | 3 11 | 2·0 | 54 0 | 0 42·4 | ·25 |
| 10 | 13 55 | 30 | 15 | 6 23 | 7 | 17 0 | 3 9 | 1·9 | 55 0 | 0 40·9 | ·25 |
| 15 | 13 41 | 29 | 20 | 6 20 | 7 | 30 | 3 3 | 1·9 | 56 0 | 0 39·4 | ·25 |
| 20 | 13 27 | 28 | 25 | 6 16 | 7 | 18 0 | 2 58 | 1·8 | 57 0 | 0 37·9 | ·24 |
| 25 | 13 13 | 27 | 30 | 6 13 | 7 | 30 | 2 53 | 1·7 | 58 0 | 0 36·5 | ·24 |
| 30 | 13 0 | 26 | 35 | 6 9 | 7 | 19 0 | 2 48 | 1·6 | 59 0 | 0 35·1 | ·23 |
| 35 | 12 47 | 25 | 40 | 6 6 | 6 | 30 | 2 44 | 1·5 | 60 0 | 0 33·7 | ·22 |
| 40 | 12 34 | 25 | 45 | 6 3 | 6 | 20 0 | 2 39 | 1·4 | 61 0 | 0 32·4 | ·22 |
| 45 | 12 22 | 24 | 50 | 6 0 | 6 | 30 | 2 35 | 1·3 | 62 0 | 0 31·0 | ·22 |
| 50 | 12 10 | 24 | 55 | 5 57 | 6 | 21 0 | 2 31 | 1·2 | 63 0 | 0 29·8 | ·21 |
| 55 | 11 58 | 23 | 9 0 | 5 54 | 6 | 30 | 2 27 | 1·2 | 64 0 | 0 28·5 | ·21 |
| 4 0 | 11 47 | 22 | 5 | 5 51 | 6 | 22 0 | 2 24 | 1·1 | 65 0 | 0 27·2 | ·20 |
| 5 | 11 36 | 21 | 10 | 5 48 | 6 | 30 | 2 20 | 1·1 | 66 0 | 0 26·0 | ·20 |
| 10 | 11 26 | 21 | 15 | 5 45 | 6 | 23 0 | 2 17 | 1·0 | 67 0 | 0 24·8 | ·20 |
| 15 | 11 15 | 20 | 20 | 5 42 | 6 | 30 | 2 13 | 1·0 | 68 0 | 0 23·6 | ·20 |
| 20 | 11 5 | 20 | 25 | 5 39 | 6 | 24 0 | 2 10 | 1·0 | 69 0 | 0 22·4 | ·20 |
| 25 | 10 55 | 19 | 30 | 5 36 | 5 | 30 | 2 7 | 0·9 | 70 0 | 0 21·3 | ·20 |
| 30 | 10 46 | 19 | 35 | 5 33 | 5 | 25 0 | 2 5 | 0·9 | 71 0 | 0 20·1 | ·20 |
| 35 | 10 37 | 18 | 40 | 5 31 | 5 | 30 | 2 2 | 0·9 | 72 0 | 0 19·0 | ·19 |
| 40 | 10 28 | 18 | 50 | 5 25 | 5 | 26 0 | 1 59 | 0·9 | 73 0 | 0 17·9 | ·19 |
| 45 | 10 19 | 18 | 10 0 | 5 20 | 5 | 30 | 1 56 | 0·9 | 74 0 | 0 16·7 | ·18 |
| 50 | 10 10 | 17 | 10 | 5 15 | 5 | 27 0 | 1 54 | 0·8 | 75 0 | 0 15·7 | ·18 |
| 55 | 10 2 | 16 | 20 | 5 10 | 5 | 30 | 1 51 | 0·8 | 76 0 | 0 14·6 | ·18 |
| 5 0 | 9 54 | 16 | 30 | 5 6 | 5 | 28 0 | 1 49 | 0·8 | 77 0 | 0 13·5 | ·17 |
| 5 | 9 46 | 16 | 40 | 5 1 | 5 | 30 | 1 47 | 0·7 | 78 0 | 0 12·4 | ·17 |
| 10 | 9 38 | 15 | 50 | 4 56 | 4 | 29 0 | 1 45 | 0·7 | 79 0 | 0 11·3 | ·17 |
| 15 | 9 30 | 15 | 11 0 | 4 52 | 4 | 30 | 1 43 | 0·7 | 80 0 | 0 10·3 | ·17 |
| 20 | 9 23 | 15 | 10 | 4 48 | 4 | 30 0 | 1 41 | 0·7 | 81 0 | 0 9·2 | ·17 |
| 25 | 9 16 | 14 | 20 | 4 44 | 4 | 30 | 1 39 | 0·6 | 82 0 | 0 8·2 | ·17 |
| 30 | 9 9 | 14 | 30 | 4 40 | 4 | 31 0 | 1 37 | 0·6 | 83 0 | 0 7·2 | ·17 |
| 35 | 9 2 | 14 | 40 | 4 36 | 4 | 30 | 1 35 | 0·6 | 84 0 | 0 6·1 | ·17 |
| 40 | 8 55 | 13 | 50 | 4 32 | 4 | 32 0 | 1 33 | 0·6 | 85 0 | 0 5·1 | ·17 |
| 45 | 8 48 | 13 | 12 0 | 4 28 | 4 | 30 | 1 31 | 0·6 | 86 0 | 0 4·1 | ·17 |
| 50 | 8 42 | 13 | 10 | 4 25 | 4 | 33 0 | 1 30 | 0·6 | 87 0 | 0 3·1 | ·17 |
| 55 | 8 36 | 12 | 20 | 4 21 | 4 | 30 | 1 28 | 0·5 | 88 0 | 0 2·0 | ·17 |
| 6 0 | 8 30 | 12 | 30 | 4 18 | 4 | 34 0 | 1 26 | 0·5 | 89 0 | 0 1·0 | ·17 |
| 5 | 8 24 | | 40 | 4 14 | | 30 | 1 25 | | 90 0 | 0 0 | |

## CORRECTION OF THE MEAN REFRACTION FOR THE HEIGHT OF THE THERMOMETER

| Therm. | 4° | 5° | 5½° | 6° | 6½° | 7° | 7½° | 8° | 9° | 10° | 12° | 15° | 20° | 30° | 40° | 50° | 70° | 90° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | add | add | add | add | add | add | add | add | add | add | add | add | add | add | add | add | add | |
| 0° | 69″ | 61″ | 57″ | 54″ | 51″ | 48″ | 46″ | 43″ | 39″ | 36″ | 30″ | 25″ | 18″ | 12″ | 8″.1 | 5″.7 | 2″.5 | 0 |
| 2 | 66 | 58 | 55 | 51 | 48 | 46 | 43 | 41 | 37 | 34 | 29 | 23 | 18 | 11 | 7.7 | 5.4 | 2.4 | 0 |
| 4 | 63 | 56 | 52 | 49 | 46 | 44 | 41 | 39 | 36 | 32 | 28 | 22 | 17 | 11 | 7.4 | 5.2 | 2.3 | 0 |
| 6 | 60 | 53 | 50 | 47 | 44 | 42 | 39 | 37 | 34 | 31 | 26 | 21 | 16 | 10 | 7.0 | 4.9 | 2.1 | 0 |
| 8 | 57 | 50 | 47 | 44 | 42 | 40 | 37 | 36 | 32 | 29 | 25 | 20 | 15 | 10 | 6.7 | 4.7 | 2.0 | 0 |
| 10 | 55 | 48 | 45 | 42 | 40 | 37 | 35 | 34 | 31 | 28 | 24 | 19 | 14 | 9 | 6.3 | 4.4 | 1.9 | 0 |
| 12 | 51 | 45 | 42 | 40 | 37 | 35 | 34 | 32 | 29 | 26 | 22 | 18 | 14 | 9 | 6.0 | 4.2 | 1.8 | 0 |
| 14 | 48 | 42 | 40 | 37 | 35 | 33 | 32 | 30 | 27 | 25 | 21 | 17 | 13 | 8 | 5.6 | 4.0 | 1.7 | 0 |
| 16 | 44 | 40 | 37 | 35 | 33 | 31 | 30 | 28 | 26 | 23 | 20 | 16 | 12 | 8 | 5.3 | 3.7 | 1.6 | 0 |
| 18 | 42 | 37 | 35 | 33 | 31 | 29 | 28 | 26 | 24 | 22 | 19 | 15 | 11 | 7 | 5.0 | 3.5 | 1.5 | 0 |
| 20 | 39 | 35 | 33 | 31 | 29 | 28 | 26 | 25 | 22 | 20 | 17 | 14 | 11 | 7 | 4.6 | 3.3 | 1.4 | 0 |
| 22 | 36 | 32 | 30 | 29 | 27 | 25 | 24 | 23 | 21 | 19 | 16 | 13 | 10 | 6 | 4.3 | 3.0 | 1.3 | 0 |
| 24 | 33 | 30 | 27 | 26 | 25 | 24 | 22 | 21 | 19 | 17 | 15 | 12 | 9 | 6 | 4.0 | 2.8 | 1.2 | 0 |
| 26 | 30 | 27 | 26 | 24 | 23 | 22 | 20 | 19 | 18 | 16 | 14 | 11 | 8 | 5 | 3.7 | 2.6 | 1.1 | 0 |
| 28 | 28 | 25 | 23 | 22 | 21 | 20 | 19 | 18 | 16 | 15 | 12 | 10 | 8 | 5 | 3.3 | 2.4 | 1.0 | 0 |
| 30 | 26 | 23 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 13 | 11 | 9 | 7 | 4 | 3.0 | 2.1 | 0.9 | 0 |
| 32 | 22 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 10 | 8 | 6 | 4 | 2.7 | 1.9 | 0.8 | 0 |
| 34 | 21 | 18 | 17 | 16 | 15 | 14 | 13 | 13 | 12 | 10 | 9 | 7 | 5 | 3 | 2.4 | 1.7 | 0.7 | 0 |
| 36 | 18 | 16 | 15 | 14 | 13 | 12 | 12 | 11 | 10 | 9 | 8 | 6 | 5 | 3 | 2.1 | 1.5 | 0.6 | 0 |
| 38 | 15 | 13 | 12 | 12 | 11 | 10 | 10 | 9 | 9 | 8 | 7 | 5 | 4 | 3 | 1.8 | 1.3 | 0.5 | 0 |
| 40 | 13 | 11 | 10 | 10 | 9 | 9 | 8 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1.5 | 1.0 | 0.4 | 0 |
| 42 | 10 | 9 | 8 | 8 | 7 | 7 | 7 | 6 | 6 | 5 | 4 | 3 | 3 | 2 | 1.2 | 0.8 | 0.4 | 0 |
| 44 | 7 | 6 | 6 | 6 | 5 | 5 | 5 | 5 | 5 | 4 | 3 | 3 | 2 | 1 | 0.9 | 0.6 | 0.3 | 0 |
| 46 | 5 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 0.6 | 0.4 | 0.2 | 0 |
| 48 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 0 | 0.3 | 0.2 | 0.1 | 0 |
| 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | sub. | sub. | sub | sub. | sub. | sub. | sub. | sub. | sub. | sub. | sub. | sub. | sub. | sub. | sub. | sub. | sub. | |
| 52 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0.3 | 0.2 | 0.1 | 0 |
| 54 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 0.6 | 0.4 | 0.2 | 0 |
| 56 | 7 | 6 | 6 | 6 | 5 | 5 | 5 | 5 | 4 | 4 | 3 | 3 | 2 | 1 | 0.9 | 0.6 | 0.3 | 0 |
| 58 | 9 | 8 | 8 | 7 | 7 | 7 | 6 | 6 | 5 | 5 | 4 | 3 | 3 | 2 | 1.1 | 0.8 | 0.3 | 0 |
| 60 | 11 | 10 | 10 | 9 | 9 | 8 | 8 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1.4 | 1.0 | 0.4 | 0 |
| 62 | 14 | 13 | 12 | 11 | 10 | 10 | 9 | 9 | 8 | 7 | 6 | 5 | 4 | 2 | 1.7 | 1.2 | 0.5 | 0 |
| 64 | 17 | 15 | 14 | 13 | 12 | 12 | 11 | 10 | 9 | 9 | 7 | 6 | 4 | 3 | 2.0 | 1.4 | 0.6 | 0 |
| 66 | 19 | 17 | 16 | 15 | 14 | 13 | 12 | 12 | 11 | 10 | 8 | 7 | 5 | 3 | 2.2 | 1.6 | 0.7 | 0 |
| 68 | 21 | 19 | 18 | 16 | 16 | 15 | 14 | 13 | 12 | 11 | 9 | 8 | 6 | 4 | 2.5 | 1.8 | 0.8 | 0 |
| 70 | 23 | 21 | 19 | 18 | 17 | 16 | 15 | 15 | 13 | 12 | 10 | 8 | 6 | 4 | 2.8 | 2.0 | 0.8 | 0 |
| 72 | 25 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 13 | 11 | 9 | 7 | 4 | 3.0 | 2.1 | 0.9 | 0 |
| 74 | 27 | 24 | 23 | 22 | 21 | 19 | 18 | 17 | 16 | 14 | 12 | 10 | 8 | 5 | 3.3 | 2.3 | 1.0 | 0 |
| 76 | 29 | 26 | 25 | 23 | 22 | 21 | 20 | 19 | 17 | 16 | 13 | 11 | 8 | 5 | 3.6 | 2.5 | 1.1 | 0 |
| 78 | 31 | 28 | 27 | 25 | 24 | 22 | 21 | 20 | 18 | 17 | 14 | 12 | 9 | 6 | 3.8 | 2.7 | 1.2 | 0 |
| 80 | 33 | 30 | 28 | 27 | 25 | 24 | 23 | 22 | 20 | 18 | 15 | 12 | 9 | 6 | 4.1 | 2.9 | 1.3 | 0 |
| 82 | 36 | 32 | 30 | 28 | 27 | 25 | 24 | 23 | 21 | 19 | 16 | 13 | 10 | 6 | 4.3 | 3.1 | 1.3 | 0 |
| 84 | 38 | 34 | 32 | 30 | 28 | 27 | 26 | 24 | 22 | 20 | 17 | 14 | 10 | 7 | 4.6 | 3.2 | 1.4 | 0 |
| 86 | 40 | 36 | 34 | 32 | 30 | 28 | 27 | 26 | 23 | 21 | 18 | 15 | 11 | 7 | 4.9 | 3.4 | 1.5 | 0 |
| 88 | 43 | 38 | 35 | 33 | 31 | 30 | 28 | 27 | 24 | 22 | 19 | 15 | 12 | 7 | 5.1 | 3.6 | 1.6 | 0 |
| 90 | 45 | 39 | 37 | 35 | 33 | 31 | 30 | 28 | 26 | 23 | 20 | 16 | 12 | 8 | 5.3 | 3.8 | 1.6 | 0 |
| 92 | 47 | 41 | 39 | 36 | 35 | 33 | 31 | 29 | 27 | 24 | 21 | 17 | 13 | 8 | 5.6 | 3.9 | 1.7 | 0 |
| 94 | 49 | 43 | 40 | 38 | 36 | 34 | 32 | 31 | 28 | 26 | 22 | 18 | 13 | 8 | 5.8 | 4.1 | 1.8 | 0 |
| 96 | 51 | 45 | 42 | 40 | 37 | 37 | 34 | 32 | 29 | 27 | 23 | 18 | 14 | 9 | 6.1 | 4.3 | 1.9 | 0 |
| 98 | 53 | 46 | 44 | 41 | 39 | 37 | 35 | 33 | 30 | 28 | 23 | 19 | 14 | 9 | 6.3 | 4.5 | 1.9 | 0 |
| 100 | 55 | 48 | 45 | 43 | 40 | 38 | 36 | 35 | 31 | 29 | 24 | 20 | 15 | 9 | 6.5 | 4.6 | 2.0 | 0 |

## CORRECTION OF THE MEAN REFRACTION FOR THE HEIGHT OF THE BAROMETER

| Bar. | Altitudes 4° | 5° | 5½° | 6° | 6½° | 7° | 7½° | 8° | 9° | 10° | 12° | 15° | 20° | 30° | 40° | 50° | 70° | 90° | Bar. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| sub. | | | | | | | | | | | | | | | | | | | add |
| 27·5 | 60″ | 50″ | 46″ | 42″ | 40″ | 37″ | 35″ | 33″ | 29″ | 27″ | 22″ | 18″ | 13″ | 8″ | 5″8 | 4″0 | 1″8 | 0 | |
| 27·6 | 57 | 48 | 44 | 41 | 38 | 36 | 34 | 32 | 28 | 26 | 21 | 17 | 13 | 8 | 5·5 | 3·8 | 1·7 | 0 | |
| 27·7 | 54 | 46 | 42 | 39 | 37 | 34 | 32 | 30 | 27 | 25 | 20 | 17 | 12 | 8 | 5·3 | 3·7 | 1·6 | 0 | |
| 27·8 | 51 | 44 | 40 | 37 | 35 | 33 | 31 | 29 | 26 | 24 | 20 | 16 | 12 | 7 | 5·1 | 3·5 | 1·5 | 0 | |
| 27·9 | 48 | 42 | 38 | 36 | 33 | 31 | 29 | 28 | 25 | 22 | 19 | 15 | 11 | 7 | 4·8 | 3·3 | 1·5 | 0 | |
| 28·0 | 46 | 40 | 37 | 34 | 32 | 30 | 28 | 26 | 24 | 21 | 18 | 14 | 11 | 7 | 4·6 | 3·2 | 1·4 | 0 | |
| 28·1 | 44 | 38 | 35 | 32 | 30 | 28 | 27 | 25 | 22 | 20 | 18 | 14 | 10 | 6 | 4·4 | 3·0 | 1·3 | 0 | |
| 28·2 | 41 | 36 | 33 | 31 | 29 | 27 | 25 | 24 | 21 | 19 | 17 | 13 | 10 | 6 | 4·1 | 2·9 | 1·3 | 0 | |
| 28·3 | 39 | 34 | 31 | 29 | 27 | 25 | 24 | 22 | 20 | 18 | 16 | 12 | 9 | 6 | 3·9 | 2·7 | 1·2 | 0 | |
| 28·4 | 37 | 32 | 29 | 27 | 25 | 24 | 22 | 21 | 19 | 17 | 15 | 12 | 8 | 5 | 3·7 | 2·6 | 1·1 | 0 | |
| 28·5 | 35 | 30 | 27 | 25 | 24 | 22 | 21 | 20 | 18 | 16 | 14 | 11 | 8 | 5 | 3·4 | 2·4 | 1·0 | 0 | 31·5 |
| 28·6 | 32 | 28 | 26 | 24 | 22 | 21 | 20 | 18 | 17 | 15 | 13 | 10 | 7 | 5 | 3·2 | 2·2 | 1·0 | 0 | 31·4 |
| 28·7 | 30 | 26 | 24 | 22 | 21 | 19 | 18 | 17 | 15 | 14 | 12 | 9 | 7 | 4 | 3·0 | 1·9 | 0·9 | 0 | 31·3 |
| 28·8 | 27 | 24 | 22 | 20 | 19 | 18 | 17 | 16 | 14 | 13 | 11 | 9 | 6 | 4 | 2·8 | 1·8 | 0·8 | 0 | 31·2 |
| 28·9 | 25 | 22 | 20 | 19 | 17 | 16 | 15 | 15 | 13 | 12 | 10 | 8 | 6 | 4 | 2·5 | 1·7 | 0·8 | 0 | 31·1 |
| 29·0 | 23 | 20 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 9 | 7 | 5 | 3 | 2·3 | 1·6 | 0·7 | 0 | 31·0 |
| 29·1 | 20 | 18 | 16 | 15 | 14 | 13 | 13 | 12 | 11 | 10 | 8 | 6 | 5 | 3 | 2·1 | 1·4 | 0·6 | 0 | 30·9 |
| 29·2 | 18 | 16 | 15 | 14 | 13 | 12 | 11 | 11 | 9 | 9 | 7 | 6 | 4 | 3 | 1·8 | 1·3 | 0·6 | 0 | 30·8 |
| 29·3 | 16 | 14 | 13 | 12 | 11 | 10 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 2 | 1·6 | 1·1 | 0·5 | 0 | 30·7 |
| 29·4 | 14 | 12 | 11 | 10 | 10 | 9 | 8 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1·4 | 1·0 | 0·4 | 0 | 30·6 |
| 29·5 | 12 | 10 | 9 | 8 | 8 | 7 | 7 | 7 | 6 | 5 | 4 | 4 | 3 | 2 | 1·1 | 0·8 | 0·3 | 0 | 30·5 |
| 29·6 | 9 | 8 | 7 | 7 | 6 | 6 | 6 | 5 | 5 | 4 | 4 | 3 | 2 | 1 | 0·9 | 0·6 | 0·3 | 0 | 30·4 |
| 29·7 | 6 | 6 | 5 | 5 | 5 | 4 | 4 | 4 | 4 | 3 | 3 | 2 | 2 | 1 | 0·7 | 0·5 | 0·2 | 0 | 30·3 |
| 29·8 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 0·5 | 0·3 | 0·1 | 0 | 30·2 |
| 29·9 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0·2 | 0·2 | 0·1 | 0 | 30·1 |
| 30·0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0·0 | 0 | 0 | 0 | 30·0 |

TABLE 34

## THE SUN'S PARALLAX IN ALTITUDE, AND SEMIDIAMETER

| Month | Semid. | Altitude 0° | 10° | 20° | 30° | 40° | 50° | 60° | 70° | 80° | 90° | Semid. | Month |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan. 1 | 16′ 17″ | 8″7 | 8″6 | 8″2 | 7″6 | 6″7 | 5″6 | 4″4 | 3·0 | 1·5 | 0″ | 16′ 15″ | Dec. 1 |
| Feb. 1 | 16 15 | 8·7 | 8·6 | 8·2 | 7·6 | 6·6 | 5·6 | 4·3 | 3·0 | 1·5 | 0 | 16 9 | Nov. 1 |
| Mar. 1 | 16 9 | 8·6 | 8·5 | 8·1 | 7·5 | 6·6 | 5·5 | 4·3 | 3·0 | 1·5 | 0 | 16 1 | Oct. 1 |
| Apr. 1 | 16 1 | 8·5 | 8·4 | 8·0 | 7·4 | 6·5 | 5·5 | 4·3 | 2·9 | 1·5 | 0 | 15 53 | Sept. 1 |
| May 1 | 15 53 | 8·4 | 8·3 | 8·0 | 7·3 | 6·5 | 5·4 | 4·2 | 2·9 | 1·5 | 0 | 15 47 | Aug. 1 |
| June 1 | 15 47 | 8·4 | 8·3 | 8·0 | 7·3 | 6·4 | 5·4 | 4·2 | 2·9 | 1·5 | 0 | 15 45 | July 1 |

TABLE 35

## DIP OF THE SHORE HORIZON

| Dist. in Miles | Ht. of the Eye in ft. 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 |
|---|---|---|---|---|---|---|---|---|
| ½ | 6′ | 12′ | 17′ | 23′ | 28′ | 34′ | 40′ | 45′ |
| 1 | 3 | 6 | 9 | 12 | 15 | 17 | 20 | 23 |
| 1½ | 3 | 4 | 6 | 8 | 10 | 12 | 14 | 16 |
| 2 | 2 | 4 | 5 | 7 | 8 | 9 | 11 | 12 |
| 2½ | 2 | 3 | 4 | 6 | 7 | 8 | 9 | 10 |
| 3 | | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 3½ | | 3 | 4 | 5 | 6 | 6 | 7 | 8 |
| 4 | | 3 | 4 | 5 | 5 | 6 | 7 | 7 |
| 5 | | | 4 | 4 | 5 | 6 | 6 | 7 |
| 6 | | | | | 5 | 5 | 6 | 6 |

## TABLE 36

**Corresponding Thermometers, Fahrenheit, Centigrade, Réaumur.**

| F. | C. | R. | F. | C. | R. |
|---|---|---|---|---|---|
| ° | ° | ° | ° | ° | ° |
| 0 | −17·8 | −14·2 | 60 | 15·6 | 12·4 |
| 1 | −17·2 | −13·8 | 61 | 16·1 | 12·9 |
| 2 | −16·7 | −13·3 | 62 | 16·7 | 13·3 |
| 3 | −16·1 | −12·9 | 63 | 17·2 | 13·8 |
| 4 | −15·6 | −12·4 | 64 | 17·8 | 14·2 |
| 5 | −15·0 | −12·0 | 65 | 18·3 | 14·7 |
| 6 | −14·4 | −11·6 | 66 | 18·9 | 15·1 |
| 7 | −13·9 | −11·1 | 67 | 19·4 | 15·6 |
| 8 | −13·3 | −10·7 | 68 | 20·0 | 16·0 |
| 9 | −12·8 | −10·2 | 69 | 20·6 | 16·4 |
| 10 | −12·2 | − 9·8 | 70 | 21·1 | 16·9 |
| 11 | −11·7 | − 9·3 | 71 | 21·7 | 17·3 |
| 12 | −11·1 | − 8·9 | 72 | 22·2 | 17·8 |
| 13 | −10·6 | − 8·4 | 73 | 22·8 | 18·2 |
| 14 | −10·0 | − 8·0 | 74 | 23·3 | 18·7 |
| 15 | − 9·4 | − 7·5 | 75 | 23·9 | 19·1 |
| 16 | − 8·9 | − 7·1 | 76 | 24·4 | 19·6 |
| 17 | − 8·3 | − 6·7 | 77 | 25·0 | 20·0 |
| 18 | − 7·8 | − 6·2 | 78 | 25·6 | 20·5 |
| 19 | − 7·2 | − 5·8 | 79 | 26·1 | 20·9 |
| 20 | − 6·7 | − 5·3 | 80 | 26·7 | 21·3 |
| 21 | − 6·1 | − 4·9 | 81 | 27·2 | 21·8 |
| 22 | − 5·6 | − 4·4 | 82 | 27·8 | 22·2 |
| 23 | − 5·0 | − 4·0 | 83 | 28·3 | 22·7 |
| 24 | − 4·4 | − 3·6 | 84 | 28·9 | 23·1 |
| 25 | − 3·9 | − 3·1 | 85 | 29·4 | 23·6 |
| 26 | − 3·3 | − 2·7 | 86 | 30·0 | 24·0 |
| 27 | − 2·8 | − 2·2 | 87 | 30·6 | 24·4 |
| 28 | − 2·2 | − 1·8 | 88 | 31·1 | 24·9 |
| 29 | − 1·7 | − 1·3 | 89 | 31·7 | 25·3 |
| 30 | − 1·1 | − 0·9 | 90 | 32·2 | 25·8 |
| 31 | − 0·6 | − 0·4 | 91 | 32·8 | 26·2 |
| 32 | 0 | 0 | 92 | 33·3 | 26·7 |
| 33 | 0·6 | 0·4 | 93 | 33·9 | 27·1 |
| 34 | 1·1 | 0·9 | 94 | 34·4 | 27·6 |
| 35 | 1·7 | 1·3 | 95 | 35·0 | 28·0 |
| 36 | 2·2 | 1·8 | 96 | 35·6 | 28·4 |
| 37 | 2·8 | 2·2 | 97 | 36·1 | 28·9 |
| 38 | 3·3 | 2·7 | 98 | 36·7 | 29·3 |
| 39 | 3·9 | 3·1 | 99 | 37·2 | 29·8 |
| 40 | 4·4 | 3·6 | 100 | 37·8 | 30·2 |
| 41 | 5·0 | 4·0 | 101 | 38·3 | 30·7 |
| 42 | 5·6 | 4·4 | 102 | 38·9 | 31·1 |
| 43 | 6·1 | 4·9 | 103 | 39·4 | 31·6 |
| 44 | 6·7 | 5·3 | 104 | 40·0 | 32·0 |
| 45 | 7·2 | 5·8 | 105 | 40·6 | 32·4 |
| 46 | 7·8 | 6·2 | 106 | 41·1 | 32·9 |
| 47 | 8·3 | 6·7 | 107 | 41·7 | 33·3 |
| 48 | 8·9 | 7·1 | 108 | 42·2 | 33·8 |
| 49 | 9·4 | 7·5 | 109 | 42·8 | 34·2 |
| 50 | 10·0 | 8·0 | 110 | 43·3 | 34·7 |
| 51 | 10·6 | 8·4 | 111 | 43·9 | 35·1 |
| 52 | 11·1 | 8·9 | 112 | 44·4 | 35·5 |
| 53 | 11·7 | 9·3 | 113 | 45·0 | 36·0 |
| 54 | 12·2 | 9·8 | 114 | 45·6 | 36·4 |
| 55 | 12·8 | 10·2 | 115 | 46·1 | 36·9 |
| 56 | 13·3 | 10·7 | 116 | 46·7 | 37·3 |
| 57 | 13·9 | 11·1 | 117 | 47·2 | 37·8 |
| 58 | 14·4 | 11·6 | 118 | 47·8 | 38·2 |
| 59 | 15·0 | 12·0 | 119 | 48·3 | 38·7 |
| 60 | 15·6 | 12·4 | 120 | 48·9 | 39·1 |

## TABLE 37

**Corresponding French & English Measures**

Fr. Kilomètre, Mètre, Décimètre, Centimètre, Millimètre.
Eng. Nautical Miles, Feet, Inches.

| Fr. | English | | | | | Barometer Scales | |
|---|---|---|---|---|---|---|---|
| No. | Miles corr. to Kil. | Feet corr. to Mètr. | Feet corr. to Décim. | In. corr. to Cent. | In. corr. to Mill. | Fr. Mill. | Eng. In. |
| 1 | 0·539 | 3·28 | 0·33 | 0·39 | 0·04 | 640 | 25·2 |
| 2 | 1·079 | 6·56 | 0·66 | 0·79 | 0·08 | 643 | 25·3 |
| 3 | 1·618 | 9·84 | 0·98 | 1·18 | 0·12 | 645 | 25·4 |
| 4 | 2·158 | 13·12 | 1·31 | 1·57 | 0·16 | 648 | 25·5 |
| 5 | 2·697 | 16·40 | 1·64 | 1·97 | 0·20 | 650 | 25·6 |
| 6 | 3·237 | 19·68 | 1·97 | 2·36 | 0·24 | 653 | 25·7 |
| 7 | 3·776 | 22·97 | 2·30 | 2·76 | 0·28 | 655 | 25·8 |
| 8 | 4·316 | 26·25 | 2·62 | 3·15 | 0·31 | 658 | 25·9 |
| 9 | 4·855 | 29·53 | 2·95 | 3·54 | 0·35 | 660 | 26·0 |
| 10 | 5·394 | 32·81 | 3·28 | 3·94 | 0·39 | 663 | 26·1 |
| 20 | 10·79 | 65·62 | 6·56 | 7·87 | 0·79 | 665 | 26·2 |
| 30 | 16·18 | 98·43 | 9·84 | 11·81 | 1·18 | 668 | 26·3 |
| 40 | 21·58 | 131·2 | 13·1 | 15·75 | 1·57 | 670 | 26·4 |
| 50 | 26·97 | 164·0 | 16·4 | 19·69 | 1·97 | 673 | 26·5 |
| 60 | 32·37 | 196·9 | 19·7 | 23·62 | 2·36 | 676 | 26·6 |
| 70 | 37·76 | 229·7 | 23·0 | 27·56 | 2·76 | 678 | 26·7 |
| 80 | 43·15 | 262·5 | 26·2 | 31·50 | 3·15 | 681 | 26·8 |
| 90 | 48·55 | 295·3 | 29·5 | 35·43 | 3·54 | 683 | 26·9 |
| 100 | 53·94 | 328·1 | 32·8 | 39·4 | 3·94 | 686 | 27·0 |
| 200 | 107·9 | 656·2 | | | 7·87 | 688 | 27·1 |
| 300 | 161·8 | 984·3 | | | 11·81 | 691 | 27·2 |
| 400 | 215·8 | 1312·4 | | | 15·75 | 693 | 27·3 |
| 500 | 269·7 | 1640·4 | | | 19·68 | 696 | 27·4 |
| 600 | 323·7 | 1968·5 | | | 23·62 | 698 | 27·5 |
| 700 | 377·6 | 2296·6 | | | 27·56 | 701 | 27·6 |
| 800 | 431·5 | 2624·7 | | | 31·50 | 704 | 27·7 |
| 900 | 485·5 | 2952·8 | | | 35·43 | 706 | 27·8 |
| 1000 | 539·4 | 3280·9 | | | 39·37 | 709 | 27·9 |
| | | | | | | 711 | 28·0 |
| | | | | | | 714 | 28·1 |
| | | | | | | 716 | 28·2 |
| | | | | | | 719 | 28·3 |
| | | | | | | 721 | 28·4 |
| | | | | | | 724 | 28·5 |
| | | | | | | 726 | 28·6 |
| | | | | | | 729 | 28·7 |
| | | | | | | 732 | 28·8 |
| | | | | | | 734 | 28·9 |
| | | | | | | 737 | 29·0 |
| | | | | | | 739 | 29·1 |
| | | | | | | 742 | 29·2 |
| | | | | | | 744 | 29·3 |
| | | | | | | 747 | 29·4 |
| | | | | | | 749 | 29·5 |
| | | | | | | 752 | 29·6 |
| | | | | | | 754 | 29·7 |
| | | | | | | 757 | 29·8 |
| | | | | | | 759 | 29·9 |
| | | | | | | 762 | 30·0 |
| | | | | | | 765 | 30·1 |
| | | | | | | 767 | 30·2 |
| | | | | | | 770 | 30·3 |
| | | | | | | 772 | 30·4 |
| | | | | | | 775 | 30·5 |
| | | | | | | 777 | 30·6 |
| | | | | | | 780 | 30·7 |
| | | | | | | 782 | 30·8 |
| | | | | | | 785 | 30·9 |
| | | | | | | 787 | 31·0 |

## CORRECTIONS OF ALTITUDE OF THE SUN AND STARS
**(Involving Dip, Refraction, ☉'s Semid. and Parallax),**
**FOR APPROXIMATE USE AT SEA.**

**The SUN.** *Add* the Corr. to the Alt. of the *Lower* limb, *except where marked* −.

| Alt. | Height of the Eye in Feet. 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 26 | 28 | 30 | 32 | 34 | 37 | 40 | 45 | 50 | 60 | Alt. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ° |
| 4½ | 2·6 | 2·3 | 2·0 | 1·7 | 1·4 | 1·2 | 1·0 | 0·7 | 0·5 | 0·3 | 0·1 | −·1 | −·3 | −·5 | −·7 | −1·0 | −1·3 | −1·7 | −2·4 | 4½ |
| 5 | 3·5 | 3·2 | 2·9 | 2·6 | 2·4 | 2·1 | 1·9 | 1·6 | 1·4 | 1·2 | 1·0 | 0·8 | 0·7 | 0·5 | 0·2 | 0·0 | −0·4 | −0·8 | −1·5 | 5 |
| 5½ | 4·2 | 3·9 | 3·6 | 3·3 | 3·1 | 2·9 | 2·7 | 2·4 | 2·2 | 2·0 | 1·8 | 1·6 | 1·4 | 1·2 | 1·0 | 0·7 | 0·3 | −0·1 | −0·7 | 5½ |
| 6 | 4·9 | 4·6 | 4·3 | 4·0 | 3·7 | 3·5 | 3·3 | 3·1 | 2·9 | 2·6 | 2·4 | 2·3 | 2·1 | 1·9 | 1·7 | 1·4 | 1·0 | 0·6 | 0·0 | 6 |
| 6½ | 5·4 | 5·1 | 4·8 | 4·5 | 4·3 | 4·0 | 3·8 | 3·6 | 3·4 | 3·2 | 3·0 | 2·8 | 2·6 | 2·4 | 2·2 | 2·0 | 1·6 | 1·2 | 0·6 | 6½ |
| 7 | 6·0 | 5·6 | 5·3 | 5·0 | 4·8 | 4·6 | 4·3 | 4·1 | 3·9 | 3·7 | 3·5 | 3·3 | 3·1 | 2·9 | 2·7 | 2·5 | 2·1 | 1·7 | 1·0 | 7 |
| 8 | 6·7 | 6·4 | 6·1 | 5·8 | 5·6 | 5·3 | 5·1 | 4·9 | 4·7 | 4·5 | 4·3 | 4·1 | 3·9 | 3·7 | 3·5 | 3·3 | 2·9 | 2·6 | 1·9 | 8 |
| 9 | 7·4 | 7·1 | 6·8 | 6·5 | 6·3 | 6·0 | 5·8 | 5·6 | 5·4 | 5·2 | 5·0 | 4·8 | 4·6 | 4·4 | 4·2 | 4·0 | 3·6 | 3·3 | 2·6 | 9 |
| 10 | 8·0 | 7·7 | 7·4 | 7·1 | 6·8 | 6·6 | 6·4 | 6·1 | 5·9 | 5·7 | 5·5 | 5·4 | 5·2 | 5·0 | 4·8 | 4·5 | 4·2 | 3·9 | 3·2 | 10 |
| 11 | 8·5 | 8·1 | 7·8 | 7·6 | 7·3 | 7·1 | 6·8 | 6·6 | 6·4 | 6·2 | 6·0 | 5·8 | 5·7 | 5·5 | 5·3 | 5·0 | 4·7 | 4·3 | 3·7 | 11 |
| 12 | 8·9 | 8·6 | 8·2 | 8·0 | 7·7 | 7·5 | 7·2 | 7·0 | 6·8 | 6·6 | 6·4 | 6·2 | 6·1 | 5·9 | 5·7 | 5·5 | 5·1 | 4·7 | 4·1 | 12 |
| 14 | 9·5 | 9·2 | 8·9 | 8·6 | 8·3 | 8·1 | 7·9 | 7·6 | 7·4 | 7·2 | 7·1 | 6·9 | 6·7 | 6·5 | 6·3 | 6·1 | 5·7 | 5·4 | 4·7 | 14 |
| 16 | 10·0 | 9·7 | 9·4 | 9·1 | 8·8 | 8·6 | 8·4 | 8·1 | 8·0 | 7·8 | 7·6 | 7·4 | 7·2 | 7·0 | 6·8 | 6·6 | 6·3 | 5·9 | 5·2 | 16 |
| 18 | 10·4 | 10·1 | 9·8 | 9·5 | 9·2 | 9·0 | 8·8 | 8·5 | 8·3 | 8·1 | 7·9 | 7·7 | 7·6 | 7·4 | 7·2 | 6·9 | 6·6 | 6·3 | 5·6 | 18 |
| 20 | 10·7 | 10·4 | 10·1 | 9·8 | 9·5 | 9·3 | 9·1 | 8·9 | 8·7 | 8·5 | 8·3 | 8·1 | 7·9 | 7·7 | 7·5 | 7·2 | 6·9 | 6·6 | 5·9 | 20 |
| 22 | 11·0 | 10·6 | 10·3 | 10·1 | 9·8 | 9·6 | 9·3 | 9·1 | 8·9 | 8·7 | 8·5 | 8·3 | 8·2 | 8·0 | 7·7 | 7·5 | 7·2 | 6·8 | 6·2 | 22 |
| 25 | 11·3 | 10·9 | 10·6 | 10·4 | 10·1 | 9·9 | 9·6 | 9·4 | 9·2 | 9·0 | 8·8 | 8·7 | 8·5 | 8·3 | 8·1 | 7·9 | 7·5 | 7·1 | 6·5 | 25 |
| 30 | 11·7 | 11·3 | 11·0 | 10·8 | 10·5 | 10·3 | 10·0 | 9·8 | 9·6 | 9·4 | 9·2 | 9·1 | 8·9 | 8·7 | 8·4 | 8·2 | 7·8 | 7·5 | 6·8 | 30 |
| 35 | 12·0 | 11·6 | 11·3 | 11·1 | 10·8 | 10·6 | 10·3 | 10·1 | 9·9 | 9·7 | 9·5 | 9·4 | 9·2 | 9·0 | 8·7 | 8·5 | 8·1 | 7·8 | 7·1 | 35 |
| 40 | 12·2 | 11·8 | 11·5 | 11·3 | 11·0 | 10·8 | 10·6 | 10·3 | 10·1 | 9·9 | 9·7 | 9·6 | 9·4 | 9·2 | 9·0 | 8·8 | 8·4 | 8·0 | 7·3 | 40 |
| 45 | 12·4 | 12·0 | 11·7 | 11·5 | 11·2 | 11·0 | 10·8 | 10·5 | 10·3 | 10·1 | 9·9 | 9·7 | 9·5 | 9·4 | 9·1 | 8·9 | 8·5 | 8·2 | 7·5 | 45 |
| 50 | 12·5 | 12·2 | 11·9 | 11·6 | 11·3 | 11·1 | 10·9 | 10·7 | 10·5 | 10·3 | 10·1 | 9·9 | 9·7 | 9·5 | 9·3 | 9·1 | 8·7 | 8·3 | 7·7 | 50 |
| 60 | 12·7 | 12·4 | 12·1 | 11·8 | 11·6 | 11·3 | 11·1 | 10·9 | 10·7 | 10·5 | 10·3 | 10·1 | 9·9 | 9·8 | 9·5 | 9·3 | 8·9 | 8·5 | 7·9 | 60 |
| 70 | 12·9 | 12·6 | 12·3 | 12·0 | 11·8 | 11·5 | 11·3 | 11·1 | 10·9 | 10·7 | 10·5 | 10·3 | 10·1 | 9·9 | 9·7 | 9·5 | 9·1 | 8·7 | 8·1 | 70 |
| 80 | 13·1 | 12·7 | 12·4 | 12·2 | 11·9 | 11·7 | 11·4 | 11·2 | 11·0 | 10·8 | 10·6 | 10·4 | 10·3 | 10·1 | 9·8 | 9·6 | 9·2 | 8·9 | 8·3 | 80 |
| 90 | 13·2 | 12·9 | 12·6 | 12·3 | 12·0 | 11·8 | 11·6 | 11·4 | 11·2 | 11·0 | 10·8 | 10·6 | 10·4 | 10·2 | 10·0 | 9·8 | 9·4 | 9·0 | 8·4 | 90 |

| Month | Jan. | Feb. | Mar. | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Correction to sun's alt. | ′ +0·3 | ′ +0·2 | ′ +0·1 | ′ −0·1 | ′ −0·2 | ′ −0·2 | ′ −0·3 | ′ −0·2 | ′ −0·1 | ′ +0·1 | ′ +0·2 | ′ +0·3 |

**A STAR.** *Subtract* the Corr.

| Alt. | Height of the Eye in Feet. 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 26 | 28 | 30 | 32 | 34 | 37 | 40 | 45 | 50 | 60 | Alt. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ° |
| 4 | 14·8 | 15·1 | 15·4 | 15·7 | 16·0 | 16·2 | 16·4 | 16·6 | 16·8 | 17·0 | 17·2 | 17·4 | 17·6 | 17·9 | 18·1 | 18·4 | 18·8 | 19·6 | 4 |
| 4½ | 13·8 | 14·1 | 14·4 | 14·7 | 15·0 | 15·2 | 15·4 | 15·6 | 15·8 | 16·0 | 16·2 | 16·4 | 16·6 | 16·9 | 17·1 | 17·4 | 17·7 | 18·5 | 4½ |
| 5 | 12·9 | 13·2 | 13·5 | 13·8 | 14·1 | 14·3 | 14·5 | 14·7 | 14·9 | 15·1 | 15·3 | 15·5 | 15·7 | 16·0 | 16·2 | 16·5 | 16·9 | 17·6 | 5 |
| 5½ | 12·2 | 12·5 | 12·8 | 13·0 | 13·3 | 13·5 | 13·7 | 13·9 | 14·1 | 14·3 | 14·5 | 14·7 | 14·9 | 15·2 | 15·4 | 15·7 | 16·1 | 16·8 | 5½ |
| 6 | 11·5 | 11·8 | 12·1 | 12·4 | 12·6 | 12·8 | 13·0 | 13·2 | 13·4 | 13·6 | 13·8 | 14·0 | 14·2 | 14·5 | 14·7 | 15·0 | 15·3 | 16·2 | 6 |
| 6½ | 11·0 | 11·3 | 11·6 | 11·9 | 12·1 | 12·3 | 12·5 | 12·7 | 12·9 | 13·1 | 13·3 | 13·5 | 13·7 | 13·9 | 14·2 | 14·4 | 14·8 | 15·6 | 6½ |
| 7 | 10·5 | 10·8 | 11·1 | 11·4 | 11·6 | 11·8 | 12·0 | 12·2 | 12·4 | 12·6 | 12·8 | 13·0 | 13·2 | 13·4 | 13·7 | 14·0 | 14·4 | 15·0 | 7 |
| 8 | 9·6 | 9·9 | 10·2 | 10·5 | 10·8 | 11·0 | 11·2 | 11·4 | 11·6 | 11·8 | 12·0 | 12·2 | 12·4 | 12·6 | 12·9 | 13·2 | 13·6 | 14·3 | 8 |
| 9 | 8·9 | 9·2 | 9·5 | 9·8 | 10·1 | 10·3 | 10·5 | 10·7 | 10·9 | 11·1 | 11·3 | 11·5 | 11·7 | 11·9 | 12·2 | 12·6 | 13·0 | 13·7 | 9 |
| 10 | 8·4 | 8·7 | 9·0 | 9·3 | 9·6 | 9·8 | 10·0 | 10·2 | 10·4 | 10·6 | 10·8 | 10·9 | 11·1 | 11·3 | 11·6 | 12·0 | 12·3 | 13·0 | 10 |
| 11 | 7·9 | 8·2 | 8·5 | 8·8 | 9·1 | 9·3 | 9·5 | 9·7 | 9·9 | 10·1 | 10·3 | 10·4 | 10·6 | 10·8 | 11·1 | 11·5 | 11·9 | 12·5 | 11 |
| 12 | 7·5 | 7·8 | 8·1 | 8·4 | 8·6 | 8·9 | 9·1 | 9·3 | 9·5 | 9·7 | 9·9 | 10·0 | 10·2 | 10·4 | 10·6 | 11·0 | 11·4 | 12·0 | 12 |
| 14 | 6·9 | 7·2 | 7·5 | 7·8 | 8·0 | 8·3 | 8·5 | 8·7 | 8·9 | 9·1 | 9·3 | 9·4 | 9·6 | 9·8 | 10·1 | 10·5 | 10·8 | 11·5 | 14 |
| 16 | 6·4 | 6·7 | 7·0 | 7·3 | 7·5 | 7·8 | 8·0 | 8·2 | 8·4 | 8·6 | 8·8 | 9·0 | 9·1 | 9·3 | 9·6 | 10·0 | 10·4 | 11·0 | 16 |
| 18 | 6·0 | 6·3 | 6·6 | 6·9 | 7·2 | 7·4 | 7·6 | 7·8 | 8·0 | 8·2 | 8·4 | 8·5 | 8·7 | 8·9 | 9·2 | 9·6 | 10·0 | 10·6 | 18 |
| 20 | 5·7 | 6·0 | 6·3 | 6·6 | 6·9 | 7·1 | 7·3 | 7·5 | 7·7 | 7·9 | 8·1 | 8·2 | 8·4 | 8·6 | 8·9 | 9·2 | 9·6 | 10·2 | 20 |
| 22 | 5·5 | 5·8 | 6·1 | 6·3 | 6·6 | 6·8 | 7·0 | 7·2 | 7·4 | 7·6 | 7·8 | 8·0 | 8·1 | 8·4 | 8·6 | 8·9 | 9·3 | 9·8 | 22 |
| 25 | 5·2 | 5·5 | 5·8 | 6·0 | 6·3 | 6·5 | 6·7 | 6·9 | 7·1 | 7·3 | 7·5 | 7·7 | 7·8 | 8·1 | 8·3 | 8·6 | 9·0 | 9·5 | 25 |
| 30 | 4·8 | 5·1 | 5·4 | 5·6 | 5·9 | 6·1 | 6·3 | 6·5 | 6·7 | 6·9 | 7·1 | 7·2 | 7·4 | 7·7 | 7·9 | 8·3 | 8·7 | 9·3 | 30 |
| 35 | 4·5 | 4·8 | 5·1 | 5·3 | 5·6 | 5·8 | 6·0 | 6·2 | 6·4 | 6·6 | 6·8 | 7·0 | 7·2 | 7·4 | 7·6 | 8·0 | 8·4 | 9·0 | 35 |
| 40 | 4·3 | 4·6 | 4·9 | 5·1 | 5·3 | 5·5 | 5·8 | 6·0 | 6·2 | 6·4 | 6·5 | 6·7 | 6·9 | 7·1 | 7·4 | 7·8 | 8·2 | 8·7 | 40 |
| 45 | 4·1 | 4·4 | 4·7 | 4·9 | 5·1 | 5·4 | 5·6 | 5·8 | 6·0 | 6·2 | 6·3 | 6·5 | 6·7 | 7·0 | 7·2 | 7·6 | 8·0 | 8·5 | 45 |
| 50 | 3·9 | 4·2 | 4·5 | 4·7 | 5·0 | 5·2 | 5·4 | 5·6 | 5·8 | 6·0 | 6·2 | 6·4 | 6·5 | 6·8 | 7·0 | 7·4 | 7·8 | 8·3 | 50 |
| 60 | 3·7 | 4·0 | 4·2 | 4·5 | 4·8 | 5·0 | 5·2 | 5·4 | 5·6 | 5·8 | 6·0 | 6·1 | 6·3 | 6·6 | 6·8 | 7·1 | 7·5 | 8·1 | 60 |
| 70 | 3·5 | 3·8 | 4·0 | 4·3 | 4·5 | 4·7 | 5·0 | 5·2 | 5·4 | 5·6 | 5·7 | 5·9 | 6·1 | 6·3 | 6·6 | 6·9 | 7·3 | 7·9 | 70 |
| 80 | 3·3 | 3·5 | 3·8 | 4·1 | 4·3 | 4·6 | 4·8 | 5·0 | 5·2 | 5·4 | 5·6 | 5·7 | 5·9 | 6·2 | 6·4 | 6·7 | 7·1 | 7·7 | 80 |
| 90 | 3·1 | 3·4 | 3·7 | 3·9 | 4·2 | 4·4 | 5·6 | 4·8 | 5·0 | 5·2 | 5·4 | 5·6 | 5·7 | 6·0 | 6·2 | 6·6 | 7·0 | 7·6 | 90 |

## TABLE 36

**Corresponding Thermometers, Fahrenheit, Centigrade, Réaumur.**

| F. | C. | R. | F. | C. | R. |
|---|---|---|---|---|---|
| ° | ° | ° | ° | ° | ° |
| 0 | −17·8 | −14·2 | 60 | 15·6 | 12·4 |
| 1 | −17·2 | −13·8 | 61 | 16·1 | 12·9 |
| 2 | −16·7 | −13·3 | 62 | 16·7 | 13·3 |
| 3 | −16·1 | −12·9 | 63 | 17·2 | 13·8 |
| 4 | −15·6 | −12·4 | 64 | 17·8 | 14·2 |
| 5 | −15·0 | −12·0 | 65 | 18·3 | 14·7 |
| 6 | −14·4 | −11·6 | 66 | 18·9 | 15·1 |
| 7 | −13·9 | −11·1 | 67 | 19·4 | 15·6 |
| 8 | −13·3 | −10·7 | 68 | 20·0 | 16·0 |
| 9 | −12·8 | −10·2 | 69 | 20·6 | 16·4 |
| 10 | −12·2 | − 9·8 | 70 | 21·1 | 16·9 |
| 11 | −11·7 | − 9·3 | 71 | 21·7 | 17·3 |
| 12 | −11·1 | − 8·9 | 72 | 22·2 | 17·8 |
| 13 | −10·6 | − 8·4 | 73 | 22·8 | 18·2 |
| 14 | −10·0 | − 8·0 | 74 | 23·3 | 18·7 |
| 15 | − 9·4 | − 7·5 | 75 | 23·9 | 19·1 |
| 16 | − 8·9 | − 7·1 | 76 | 24·4 | 19·6 |
| 17 | − 8·3 | − 6·7 | 77 | 25·0 | 20·0 |
| 18 | − 7·8 | − 6·2 | 78 | 25·6 | 20·5 |
| 19 | − 7·2 | − 5·8 | 79 | 26·1 | 20·9 |
| 20 | − 6·7 | − 5·3 | 80 | 26·7 | 21·3 |
| 21 | − 6·1 | − 4·9 | 81 | 27·2 | 21·8 |
| 22 | − 5·6 | − 4·4 | 82 | 27·8 | 22·2 |
| 23 | − 5·0 | − 4·0 | 83 | 28·3 | 22·7 |
| 24 | − 4·4 | − 3·6 | 84 | 28·9 | 23·1 |
| 25 | − 3·9 | − 3·1 | 85 | 29·4 | 23·6 |
| 26 | − 3·3 | − 2·7 | 86 | 30·0 | 24·0 |
| 27 | − 2·8 | − 2·2 | 87 | 30·6 | 24·4 |
| 28 | − 2·2 | − 1·8 | 88 | 31·1 | 24·9 |
| 29 | − 1·7 | − 1·3 | 89 | 31·7 | 25·3 |
| 30 | − 1·1 | − 0·9 | 90 | 32·2 | 25·8 |
| 31 | − 0·6 | − 0·4 | 91 | 32·8 | 26·2 |
| 32 | 0 | 0 | 92 | 33·3 | 26·7 |
| 33 | 0·6 | 0·4 | 93 | 33·9 | 27·1 |
| 34 | 1·1 | 0·9 | 94 | 34·4 | 27·6 |
| 35 | 1·7 | 1·3 | 95 | 35·0 | 28·0 |
| 36 | 2·2 | 1·8 | 96 | 35·6 | 28·4 |
| 37 | 2·8 | 2·2 | 97 | 36·1 | 28·9 |
| 38 | 3·3 | 2·7 | 98 | 36·7 | 29·3 |
| 39 | 3·9 | 3·1 | 99 | 37·2 | 29·8 |
| 40 | 4·4 | 3·6 | 100 | 37·8 | 30·2 |
| 41 | 5·0 | 4·0 | 101 | 38·3 | 30·7 |
| 42 | 5·6 | 4·4 | 102 | 38·9 | 31·1 |
| 43 | 6·1 | 4·9 | 103 | 39·4 | 31·6 |
| 44 | 6·7 | 5·3 | 104 | 40·0 | 32·0 |
| 45 | 7·2 | 5·8 | 105 | 40·6 | 32·4 |
| 46 | 7·8 | 6·2 | 106 | 41·1 | 32·9 |
| 47 | 8·3 | 6·7 | 107 | 41·7 | 33·3 |
| 48 | 8·9 | 7·1 | 108 | 42·2 | 33·8 |
| 49 | 9·4 | 7·5 | 109 | 42·8 | 34·2 |
| 50 | 10·0 | 8·0 | 110 | 43·3 | 34·7 |
| 51 | 10·6 | 8·4 | 111 | 43·9 | 35·1 |
| 52 | 11·1 | 8·9 | 112 | 44·4 | 35·5 |
| 53 | 11·7 | 9·3 | 113 | 45·0 | 36·0 |
| 54 | 12·2 | 9·8 | 114 | 45·6 | 36·4 |
| 55 | 12·8 | 10·2 | 115 | 46·1 | 36·9 |
| 56 | 13·3 | 10·7 | 116 | 46·7 | 37·3 |
| 57 | 13·9 | 11·1 | 117 | 47·2 | 37·8 |
| 58 | 14·4 | 11·6 | 118 | 47·8 | 38·2 |
| 59 | 15·0 | 12·0 | 119 | 48·3 | 38·7 |
| 60 | 15·6 | 12·4 | 120 | 48·9 | 39·1 |

## TABLE 37

**Corresponding French & English Measures**

Fr. Kilomètre, Mètre, Décimètre, Centimètre, Millimètre.
Eng. Nautical Miles, Feet, Inches.

| Fr. | English | | | | |
|---|---|---|---|---|---|
| No. | Miles corr. to Kil. | Feet corr. to Mètr. | Feet corr. to Décim. | In. corr. to Cent. | In. corr. to Mill. |
| 1 | 0·539 | 3·28 | 0·33 | 0·39 | 0·04 |
| 2 | 1·079 | 6·56 | 0·66 | 0·79 | 0·08 |
| 3 | 1·618 | 9·84 | 0·98 | 1·18 | 0·12 |
| 4 | 2·158 | 13·12 | 1·31 | 1·57 | 0·16 |
| 5 | 2·697 | 16·40 | 1·64 | 1·97 | 0·20 |
| 6 | 3·237 | 19·68 | 1·97 | 2·36 | 0·24 |
| 7 | 3·776 | 22·97 | 2·30 | 2·76 | 0·28 |
| 8 | 4·316 | 26·25 | 2·62 | 3·15 | 0·31 |
| 9 | 4·855 | 29·53 | 2·95 | 3·54 | 0·35 |
| 10 | 5·394 | 32·81 | 3·28 | 3·94 | 0·39 |
| 20 | 10·79 | 65·62 | 6·56 | 7·87 | 0·79 |
| 30 | 16·18 | 98·43 | 9·84 | 11·81 | 1·18 |
| 40 | 21·58 | 131·2 | 13·1 | 15·75 | 1·57 |
| 50 | 26·97 | 164·0 | 16·4 | 19·69 | 1·97 |
| 60 | 32·37 | 196·9 | 19·7 | 23·62 | 2·36 |
| 70 | 37·76 | 229·7 | 23·0 | 27·56 | 2·76 |
| 80 | 43·15 | 262·5 | 26·2 | 31·50 | 3·15 |
| 90 | 48·55 | 295·3 | 29·5 | 35·43 | 3·54 |
| 100 | 53·94 | 328·1 | 32·8 | 39·4 | 3·94 |
| 200 | 107·9 | 656·2 | | | 7·87 |
| 300 | 161·8 | 984·3 | | | 11·81 |
| 400 | 215·8 | 1312·4 | | | 15·75 |
| 500 | 269·7 | 1640·4 | | | 19·68 |
| 600 | 323·7 | 1968·5 | | | 23·62 |
| 700 | 377·6 | 2296·6 | | | 27·56 |
| 800 | 431·5 | 2624·7 | | | 31·50 |
| 900 | 485·5 | 2952·8 | | | 35·43 |
| 1000 | 539·4 | 3280·9 | | | 39·37 |

**Barometer Scales**

| Fr. Mill. | Eng. In. |
|---|---|
| 640 | 25·2 |
| 643 | 25·3 |
| 645 | 25·4 |
| 648 | 25·5 |
| 650 | 25·6 |
| 653 | 25·7 |
| 655 | 25·8 |
| 658 | 25·9 |
| 660 | 26·0 |
| 663 | 26·1 |
| 665 | 26·2 |
| 668 | 26·3 |
| 670 | 26·4 |
| 673 | 26·5 |
| 676 | 26·6 |
| 678 | 26·7 |
| 681 | 26·8 |
| 683 | 26·9 |
| 686 | 27·0 |
| 688 | 27·1 |
| 691 | 27·2 |
| 693 | 27·3 |
| 696 | 27·4 |
| 698 | 27·5 |
| 701 | 27·6 |
| 704 | 27·7 |
| 706 | 27·8 |
| 709 | 27·9 |
| 711 | 28·0 |
| 714 | 28·1 |
| 716 | 28·2 |
| 719 | 28·3 |
| 721 | 28·4 |
| 724 | 28·5 |
| 726 | 28·6 |
| 729 | 28·7 |
| 732 | 28·8 |
| 734 | 28·9 |
| 737 | 29·0 |
| 739 | 29·1 |
| 742 | 29·2 |
| 744 | 29·3 |
| 747 | 29·4 |
| 749 | 29·5 |
| 752 | 29·6 |
| 754 | 29·7 |
| 757 | 29·8 |
| 759 | 29·9 |
| 762 | 30·0 |
| 765 | 30·1 |
| 767 | 30·2 |
| 770 | 30·3 |
| 772 | 30·4 |
| 775 | 30·5 |
| 777 | 30·6 |
| 780 | 30·7 |
| 782 | 30·8 |
| 785 | 30·9 |
| 787 | 31·0 |

## CORRECTIONS OF ALTITUDE OF THE SUN AND STARS

**(Involving Dip, Refraction, ⊙'s Semid. and Parallax),**

FOR APPROXIMATE USE AT SEA.

**The SUN.** *Add* the Corr. to the Alt. of the *Lower* limb, *except where marked* −.

| Alt. | Height of the Eye in Feet. 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 26 | 28 | 30 | 32 | 34 | 37 | 40 | 45 | 50 | 60 | Alt. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ° |
| 4½ | 2·6 | 2·3 | 2·0 | 1·7 | 1·4 | 1·2 | 1·0 | 0·7 | 0·5 | 0·3 | 0·1 | −·1 | −·3 | −·5 | −·7 | −1·0 | −1·3 | −1·7 | −2·4 | 4½ |
| 5 | 3·5 | 3·2 | 2·9 | 2·6 | 2·4 | 2·1 | 1·9 | 1·6 | 1·4 | 1·2 | 1·0 | 0·8 | 0·7 | 0·5 | 0·2 | 0·0 | −0·4 | −0·8 | −1·5 | 5 |
| 5½ | 4·2 | 3·9 | 3·6 | 3·3 | 3·1 | 2·9 | 2·7 | 2·4 | 2·2 | 2·0 | 1·8 | 1·6 | 1·4 | 1·2 | 1·0 | 0·7 | 0·3 | −0·1 | −0·7 | 5½ |
| 6 | 4·9 | 4·6 | 4·3 | 4·0 | 3·7 | 3·5 | 3·3 | 3·1 | 2·9 | 2·6 | 2·4 | 2·3 | 2·1 | 1·9 | 1·7 | 1·4 | 1·0 | 0·6 | 0·0 | 6 |
| 6½ | 5·4 | 5·1 | 4·8 | 4·5 | 4·3 | 4·0 | 3·8 | 3·6 | 3·4 | 3·2 | 3·0 | 2·8 | 2·6 | 2·4 | 2·2 | 2·0 | 1·6 | 1·2 | 0·6 | 6½ |
| 7 | 6·0 | 5·6 | 5·3 | 5·0 | 4·8 | 4·6 | 4·3 | 4·1 | 3·9 | 3·7 | 3·5 | 3·3 | 3·1 | 2·9 | 2·7 | 2·5 | 2·1 | 1·7 | 1·0 | 7 |
| 8 | 6·7 | 6·4 | 6·1 | 5·8 | 5·6 | 5·3 | 5·1 | 4·9 | 4·7 | 4·5 | 4·3 | 4·1 | 3·9 | 3·7 | 3·5 | 3·3 | 2·9 | 2·6 | 1·9 | 8 |
| 9 | 7·4 | 7·1 | 6·8 | 6·5 | 6·3 | 6·0 | 5·8 | 5·6 | 5·4 | 5·2 | 5·0 | 4·8 | 4·6 | 4·4 | 4·2 | 4·0 | 3·6 | 3·3 | 2·6 | 9 |
| 10 | 8·0 | 7·7 | 7·4 | 7·1 | 6·8 | 6·6 | 6·4 | 6·1 | 5·9 | 5·7 | 5·5 | 5·4 | 5·2 | 5·0 | 4·8 | 4·5 | 4·2 | 3·9 | 3·2 | 10 |
| 11 | 8·5 | 8·1 | 7·8 | 7·6 | 7·3 | 7·1 | 6·8 | 6·6 | 6·4 | 6·2 | 6·0 | 5·8 | 5·7 | 5·5 | 5·3 | 5·0 | 4·7 | 4·3 | 3·7 | 11 |
| 12 | 8·9 | 8·6 | 8·2 | 8·0 | 7·7 | 7·5 | 7·2 | 7·0 | 6·8 | 6·6 | 6·4 | 6·2 | 6·1 | 5·9 | 5·7 | 5·5 | 5·1 | 4·7 | 4·1 | 12 |
| 14 | 9·5 | 9·2 | 8·9 | 8·6 | 8·3 | 8·1 | 7·9 | 7·6 | 7·4 | 7·2 | 7·1 | 6·9 | 6·7 | 6·5 | 6·3 | 6·1 | 5·7 | 5·4 | 4·7 | 14 |
| 16 | 10·0 | 9·7 | 9·4 | 9·1 | 8·8 | 8·6 | 8·4 | 8·1 | 8·0 | 7·8 | 7·6 | 7·4 | 7·2 | 7·0 | 6·8 | 6·6 | 6·3 | 5·9 | 5·2 | 16 |
| 18 | 10·4 | 10·1 | 9·8 | 9·5 | 9·2 | 9·0 | 8·8 | 8·5 | 8·3 | 8·1 | 7·9 | 7·7 | 7·6 | 7·4 | 7·2 | 6·9 | 6·6 | 6·3 | 5·6 | 18 |
| 20 | 10·7 | 10·4 | 10·1 | 9·8 | 9·5 | 9·3 | 9·1 | 8·9 | 8·7 | 8·5 | 8·3 | 8·1 | 7·9 | 7·7 | 7·5 | 7·2 | 6·9 | 6·6 | 5·9 | 20 |
| 22 | 11·0 | 10·6 | 10·3 | 10·1 | 9·8 | 9·6 | 9·3 | 9·1 | 8·9 | 8·7 | 8·5 | 8·3 | 8·2 | 8·0 | 7·7 | 7·5 | 7·2 | 6·8 | 6·2 | 22 |
| 25 | 11·3 | 10·9 | 10·6 | 10·4 | 10·1 | 9·9 | 9·6 | 9·4 | 9·2 | 9·0 | 8·8 | 8·7 | 8·5 | 8·3 | 8·1 | 7·9 | 7·5 | 7·1 | 6·5 | 25 |
| 30 | 11·7 | 11·3 | 11·0 | 10·8 | 10·5 | 10·3 | 10·0 | 9·8 | 9·6 | 9·4 | 9·2 | 9·1 | 8·9 | 8·7 | 8·4 | 8·2 | 7·8 | 7·5 | 6·8 | 30 |
| 35 | 12·0 | 11·6 | 11·3 | 11·1 | 10·8 | 10·6 | 10·3 | 10·1 | 9·9 | 9·7 | 9·5 | 9·4 | 9·2 | 9·0 | 8·7 | 8·5 | 8·1 | 7·8 | 7·1 | 35 |
| 40 | 12·2 | 11·8 | 11·5 | 11·3 | 11·0 | 10·8 | 10·6 | 10·3 | 10·1 | 9·9 | 9·7 | 9·6 | 9·4 | 9·2 | 9·0 | 8·8 | 8·4 | 8·0 | 7·3 | 40 |
| 45 | 12·4 | 12·0 | 11·7 | 11·5 | 11·2 | 11·0 | 10·8 | 10·5 | 10·3 | 10·1 | 9·9 | 9·7 | 9·5 | 9·4 | 9·1 | 8·9 | 8·5 | 8·2 | 7·5 | 45 |
| 50 | 12·5 | 12·2 | 11·9 | 11·6 | 11·3 | 11·1 | 10·9 | 10·7 | 10·5 | 10·3 | 10·1 | 9·9 | 9·7 | 9·5 | 9·3 | 9·1 | 8·7 | 8·3 | 7·7 | 50 |
| 60 | 12·7 | 12·4 | 12·1 | 11·8 | 11·6 | 11·3 | 11·1 | 10·9 | 10·7 | 10·5 | 10·3 | 10·1 | 9·9 | 9·8 | 9·5 | 9·3 | 8·9 | 8·5 | 7·9 | 60 |
| 70 | 12·9 | 12·6 | 12·3 | 12·0 | 11·8 | 11·5 | 11·3 | 11·1 | 10·9 | 10·7 | 10·5 | 10·3 | 10·1 | 9·9 | 9·7 | 9·5 | 9·1 | 8·7 | 8·1 | 70 |
| 80 | 13·1 | 12·7 | 12·4 | 12·2 | 11·9 | 11·7 | 11·4 | 11·2 | 11·0 | 10·8 | 10·6 | 10·4 | 10·3 | 10·1 | 9·8 | 9·6 | 9·2 | 8·9 | 8·3 | 80 |
| 90 | 13·2 | 12·9 | 12·6 | 12·3 | 12·0 | 11·8 | 11·6 | 11·4 | 11·2 | 11·0 | 10·8 | 10·6 | 10·4 | 10·2 | 10·0 | 9·8 | 9·4 | 9·0 | 8·4 | 90 |

| Month | Jan. | Feb. | Mar. | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Correction to sun's alt. | +0′·3 | +0′·2 | +0′·1 | −0′·1 | −0′·2 | −0′·2 | −0′·3 | −0′·2 | −0′·1 | +0′·1 | +0′·2 | +0′·3 |

**A STAR.** *Subtract* the Corr.

| Alt. | Height of the Eye in Feet. 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 26 | 28 | 30 | 32 | 34 | 37 | 40 | 45 | 50 | 60 | Alt. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ° |
| 4 | 14·8 | 15·1 | 15·4 | 15·7 | 16·0 | 16·2 | 16·4 | 16·6 | 16·8 | 17·0 | 17·2 | 17·4 | 17·6 | 17·9 | 18·1 | 18·4 | 18·8 | 19·6 | 4 |
| 4½ | 13·8 | 14·1 | 14·4 | 14·7 | 15·0 | 15·2 | 15·4 | 15·6 | 15·8 | 16·0 | 16·2 | 16·4 | 16·6 | 16·9 | 17·1 | 17·4 | 17·7 | 18·5 | 4½ |
| 5 | 12·9 | 13·2 | 13·5 | 13·8 | 14·1 | 14·3 | 14·5 | 14·7 | 14·9 | 15·1 | 15·3 | 15·5 | 15·7 | 16·0 | 16·2 | 16·5 | 16·9 | 17·6 | 5 |
| 5½ | 12·2 | 12·5 | 12·8 | 13·0 | 13·3 | 13·5 | 13·7 | 13·9 | 14·1 | 14·3 | 14·5 | 14·7 | 14·9 | 15·2 | 15·4 | 15·7 | 16·1 | 16·8 | 5½ |
| 6 | 11·5 | 11·8 | 12·1 | 12·4 | 12·6 | 12·8 | 13·0 | 13·2 | 13·4 | 13·6 | 13·8 | 14·0 | 14·2 | 14·5 | 14·7 | 15·0 | 15·3 | 16·2 | 6 |
| 6½ | 11·0 | 11·3 | 11·6 | 11·9 | 12·1 | 12·3 | 12·5 | 12·7 | 12·9 | 13·1 | 13·3 | 13·5 | 13·7 | 13·9 | 14·2 | 14·4 | 14·8 | 15·6 | 6½ |
| 7 | 10·5 | 10·8 | 11·1 | 11·4 | 11·6 | 11·8 | 12·0 | 12·2 | 12·4 | 12·6 | 12·8 | 13·0 | 13·2 | 13·4 | 13·7 | 14·0 | 14·4 | 15·0 | 7 |
| 8 | 9·6 | 9 9 | 10·2 | 10·5 | 10·8 | 11·0 | 11·2 | 11·4 | 11·6 | 11·8 | 12·0 | 12·2 | 12·4 | 12·6 | 12·9 | 13·2 | 13·6 | 14·3 | 8 |
| 9 | 8·9 | 9·2 | 9·5 | 9·8 | 10·1 | 10·3 | 10·5 | 10·7 | 10·9 | 11·1 | 11·3 | 11·5 | 11·7 | 11·9 | 12·2 | 12·6 | 13·0 | 13·7 | 9 |
| 10 | 8·4 | 8·7 | 9·0 | 9·3 | 9·6 | 9·8 | 10·0 | 10·2 | 10·4 | 10·6 | 10·8 | 10·9 | 11·1 | 11·3 | 11·6 | 12·0 | 12·3 | 13·0 | 10 |
| 11 | 7·9 | 8·2 | 8·5 | 8·8 | 9·1 | 9·3 | 9·5 | 9·7 | 9·9 | 10·1 | 10·3 | 10·4 | 10·6 | 10·8 | 11·1 | 11·5 | 11·9 | 12·5 | 11 |
| 12 | 7·5 | 7·8 | 8·1 | 8·4 | 8·6 | 8·9 | 9·1 | 9·3 | 9·5 | 9·7 | 9·9 | 10·0 | 10·2 | 10·4 | 10·6 | 11·0 | 11·4 | 12·0 | 12 |
| 14 | 6·9 | 7·2 | 7·5 | 7·8 | 8·0 | 8·3 | 8·5 | 8·7 | 8·9 | 9·1 | 9·3 | 9·4 | 9·6 | 9·8 | 10·1 | 10·5 | 10·8 | 11·5 | 14 |
| 16 | 6·4 | 6·7 | 7·0 | 7·3 | 7·5 | 7·8 | 8·0 | 8·2 | 8·4 | 8·6 | 8·8 | 9·0 | 9·1 | 9·3 | 9·6 | 10·0 | 10·4 | 11·0 | 16 |
| 18 | 6·0 | 6·3 | 6·6 | 6·9 | 7·2 | 7·4 | 7·6 | 7·8 | 8·0 | 8·2 | 8·4 | 8·5 | 8·7 | 8·9 | 9·2 | 9·6 | 10·0 | 10·6 | 18 |
| 20 | 5·7 | 6·0 | 6·3 | 6·6 | 6·9 | 7·1 | 7·3 | 7·5 | 7·7 | 7·9 | 8·1 | 8·2 | 8·4 | 8·6 | 8·9 | 9·2 | 9·6 | 10·2 | 20 |
| 22 | 5·5 | 5·8 | 6·1 | 6·3 | 6·6 | 6·8 | 7·0 | 7·2 | 7·4 | 7·6 | 7·8 | 8·0 | 8·1 | 8·4 | 8·6 | 8·9 | 9·3 | 9·8 | 22 |
| 25 | 5·2 | 5·5 | 5·8 | 6·0 | 6·3 | 6·5 | 6·7 | 6·9 | 7·1 | 7·3 | 7·5 | 7·7 | 7·8 | 8·1 | 8·3 | 8·6 | 9·0 | 9·5 | 25 |
| 30 | 4·8 | 5·1 | 5·4 | 5·6 | 5·9 | 6·1 | 6·3 | 6·5 | 6·7 | 6·9 | 7·1 | 7·2 | 7·4 | 7·7 | 7·9 | 8·3 | 8 7 | 9·3 | 30 |
| 35 | 4·5 | 4·8 | 5·1 | 5·3 | 5·6 | 5·8 | 6·0 | 6·2 | 6·4 | 6·6 | 6·8 | 7·0 | 7·2 | 7·4 | 7·6 | 8·0 | 8·4 | 9·0 | 35 |
| 40 | 4·3 | 4·6 | 4·9 | 5·1 | 5·3 | 5·5 | 5·8 | 6·0 | 6·2 | 6·4 | 6·5 | 6·7 | 6·9 | 7·1 | 7·4 | 7·8 | 8·2 | 8·7 | 40 |
| 45 | 4·1 | 4·4 | 4·7 | 4·9 | 5·1 | 5·4 | 5·6 | 5·8 | 6·0 | 6·2 | 6·3 | 6·5 | 6·7 | 7·0 | 7·2 | 7·6 | 8·0 | 8·5 | 45 |
| 50 | 3·9 | 4·2 | 4·5 | 4·7 | 5·0 | 5·2 | 5·4 | 5·6 | 5·8 | 6·0 | 6·2 | 6·4 | 6·5 | 6·8 | 7·0 | 7·4 | 7·8 | 8·3 | 50 |
| 60 | 3·7 | 4·0 | 4·2 | 4·5 | 4·8 | 5·0 | 5·2 | 5·4 | 5·6 | 5·8 | 6·0 | 6·1 | 6·3 | 6·6 | 6·8 | 7·1 | 7·5 | 8·1 | 60 |
| 70 | 3·5 | 3·8 | 4·0 | 4·3 | 4·5 | 4·7 | 5·0 | 5·2 | 5·4 | 5·6 | 5·7 | 5·9 | 6·1 | 6·3 | 6·6 | 6·9 | 7·3 | 7·9 | 70 |
| 80 | 3·3 | 3·5 | 3·8 | 4·1 | 4·3 | 4·6 | 4·8 | 5·0 | 5·2 | 5·4 | 5·6 | 5·7 | 5·9 | 6·2 | 6·4 | 6·7 | 7·1 | 7·7 | 80 |
| 90 | 3·1 | 3·4 | 3·7 | 3·9 | 4·2 | 4·4 | 5·6 | 4·8 | 5·0 | 5·2 | 5·4 | 5·6 | 5·7 | 6·0 | 6·2 | 6·6 | 7·0 | 7·6 | 90 |

## CORRECTION OF THE MOON'S APPARENT ALTITUDE

(Barometer, 30 inches. Fahrenheit's Thermometer, 50°)

| ☽ App. Alt. | Horizontal Parallax 53′ | 54′ | 55′ | 56′ | 57′ | 58′ | 59′ | 60′ | 61′ | ″ of Par. | Corr. for ″ of Par. add 0″ | 2″ | 4″ | 6″ | 8″ | Cor. for ′ of Alt. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° ′ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ″ | ″ | ″ | ″ | ″ | ″ | |
| 0 0 | 19 14 | 20 14 | 21 14 | 22 14 | 23 14 | 24 14 | 25 14 | 26 14 | 27 14 | 0 | 0 | 2 | 4 | 6 | 8 | |
| 10 | 21 6 | 22 6 | 23 6 | 24 6 | 25 6 | 26 6 | 27 6 | 28 6 | 29 6 | 10 | 10 | 12 | 14 | 16 | 18 | |
| 20 | 22 51 | 23 51 | 24 51 | 25 51 | 26 51 | 27 51 | 28 51 | 29 51 | 30 51 | 20 | 20 | 22 | 24 | 26 | 28 | |
| 30 | 24 28 | 25 28 | 26 28 | 27 28 | 28 28 | 29 28 | 30 28 | 31 28 | 32 28 | 30 | 30 | 32 | 34 | 36 | 38 | |
| 40 | 25 58 | 26 58 | 27 58 | 28 58 | 29 58 | 30 58 | 31 58 | 32 58 | 33 58 | 40 | 40 | 42 | 44 | 46 | 48 | |
| 50 | 27 21 | 28 21 | 29 21 | 30 21 | 31 21 | 32 21 | 33 21 | 34 21 | 35 21 | 50 | 50 | 52 | 54 | 56 | 58 | |
| 1 0 | 28 39 | 29 39 | 30 39 | 31 39 | 32 39 | 33 39 | 34 39 | 35 39 | 36 39 | 0 | 0 | 2 | 4 | 6 | 8 | |
| 10 | 29 49 | 30 49 | 31 49 | 32 49 | 33 49 | 34 49 | 35 49 | 36 49 | 37 49 | 10 | 10 | 12 | 14 | 16 | 18 | |
| 20 | 30 56 | 31 56 | 32 56 | 33 56 | 34 56 | 35 56 | 36 56 | 37 56 | 38 56 | 20 | 20 | 22 | 24 | 26 | 28 | |
| 30 | 31 57 | 32 57 | 33 57 | 34 57 | 35 57 | 36 57 | 37 57 | 38 57 | 39 57 | 30 | 30 | 32 | 34 | 36 | 38 | |
| 40 | 32 54 | 33 54 | 34 54 | 35 54 | 35 54 | 37 54 | 38 54 | 39 54 | 40 54 | 40 | 40 | 42 | 44 | 46 | 48 | |
| 50 | 33 46 | 34 46 | 35 46 | 36 46 | 37 46 | 38 46 | 39 46 | 40 46 | 41 46 | 50 | 50 | 52 | 54 | 56 | 58 | |
| 2 0 | 34 36 | 35 36 | 36 36 | 37 36 | 38 36 | 39 36 | 40 36 | 41 36 | 42 36 | 0 | 0 | 2 | 4 | 6 | 8 | |
| 10 | 35 22 | 36 22 | 37 22 | 38 22 | 39 22 | 40 22 | 41 22 | 42 22 | 43 22 | 10 | 10 | 12 | 14 | 16 | 18 | |
| 20 | 36 4 | 37 4 | 38 4 | 39 4 | 40 4 | 41 4 | 42 4 | 43 4 | 44 4 | 20 | 20 | 22 | 24 | 26 | 28 | |
| 30 | 36 44 | 37 44 | 38 44 | 39 44 | 40 44 | 41 44 | 42 44 | 43 44 | 44 44 | 30 | 30 | 32 | 34 | 36 | 38 | |
| 40 | 37 21 | 38 21 | 39 21 | 40 21 | 41 21 | 42 21 | 43 21 | 44 21 | 45 21 | 40 | 40 | 42 | 44 | 46 | 48 | |
| 50 | 37 55 | 38 55 | 39 55 | 40 55 | 41 55 | 42 55 | 43 55 | 44 55 | 45 55 | 50 | 50 | 52 | 54 | 56 | 58 | |
| 3 0 | 38 28 | 39 28 | 40 28 | 41 28 | 42 28 | 43 28 | 44 28 | 45 28 | 46 28 | 0 | 0 | 2 | 4 | 6 | 8 | |
| 10 | 38 59 | 39 58 | 40 58 | 41 58 | 42 58 | 43 58 | 44 58 | 45 58 | 46 58 | 10 | 10 | 12 | 14 | 16 | 18 | |
| 20 | 39 27 | 40 27 | 41 27 | 42 27 | 43 26 | 44 26 | 45 26 | 46 26 | 47 26 | 20 | 20 | 22 | 24 | 26 | 28 | |
| 30 | 39 53 | 40 53 | 41 53 | 42 53 | 43 53 | 44 53 | 45 53 | 46 53 | 47 53 | 30 | 30 | 32 | 34 | 36 | 38 | |
| 40 | 40 19 | 41 18 | 42 18 | 43 18 | 44 18 | 45 18 | 46 18 | 47 18 | 48 18 | 40 | 40 | 42 | 44 | 46 | 48 | |
| 50 | 40 42 | 41 42 | 42 42 | 43 42 | 44 42 | 45 42 | 46 42 | 47 41 | 48 41 | 50 | 50 | 52 | 54 | 56 | 58 | |
| 4 0 | 41 5 | 42 5 | 43 4 | 44 4 | 45 4 | 46 4 | 47 4 | 48 4 | 49 4 | 0 | 0 | 2 | 4 | 6 | 8 | |
| 10 | 41 26 | 42 26 | 43 25 | 44 25 | 45 25 | 46 25 | 47 25 | 48 25 | 49 25 | 10 | 10 | 12 | 14 | 16 | 18 | |
| 20 | 41 46 | 42 45 | 43 45 | 44 45 | 45 45 | 46 45 | 47 45 | 48 44 | 49 44 | 20 | 20 | 22 | 24 | 26 | 28 | |
| 30 | 42 4 | 43 4 | 44 4 | 45 4 | 46 4 | 47 3 | 48 3 | 49 3 | 50 3 | 30 | 30 | 32 | 34 | 36 | 38 | |
| 40 | 42 22 | 43 22 | 44 22 | 45 21 | 46 21 | 47 21 | 48 21 | 49 21 | 50 20 | 40 | 40 | 42 | 44 | 46 | 48 | |
| 50 | 42 39 | 43 38 | 44 38 | 45 38 | 46 38 | 47 38 | 48 37 | 49 37 | 50 37 | 50 | 50 | 52 | 54 | 56 | 58 | |
| 5 0 | 42 54 | 43 54 | 44 54 | 45 54 | 46 54 | 47 53 | 48 53 | 49 53 | 50 53 | 0 | 0 | 2 | 4 | 6 | 8 | |
| 10 | 43 9 | 44 9 | 45 9 | 46 9 | 47 9 | 48 8 | 49 8 | 50 8 | 51 8 | 10 | 10 | 12 | 14 | 16 | 18 | |
| 20 | 43 24 | 44 23 | 45 23 | 46 23 | 47 23 | 48 22 | 49 22 | 50 22 | 51 22 | 20 | 20 | 22 | 24 | 26 | 28 | |
| 30 | 43 37 | 44 37 | 45 37 | 46 36 | 47 36 | 48 36 | 49 36 | 50 35 | 51 35 | 30 | 30 | 32 | 34 | 36 | 38 | |
| 40 | 43 50 | 44 50 | 45 49 | 46 49 | 47 49 | 48 49 | 49 49 | 50 48 | 51 48 | 40 | 40 | 42 | 44 | 46 | 48 | |
| 50 | 44 2 | 45 2 | 46 1 | 47 1 | 48 1 | 49 0 | 50 0 | 51 0 | 52 0 | 50 | 50 | 52 | 54 | 56 | 58 | |
| 6 0 | 44 14 | 45 13 | 46 13 | 47 13 | 48 12 | 49 12 | 50 12 | 51 11 | 52 11 | 0 | 0 | 2 | 4 | 6 | 8 | |
| 10 | 44 24 | 45 24 | 46 24 | 47 23 | 48 23 | 49 23 | 50 22 | 51 22 | 52 22 | 10 | 10 | 12 | 14 | 16 | 18 | |
| 20 | 44 35 | 45 34 | 46 34 | 47 34 | 48 33 | 49 33 | 50 33 | 51 32 | 52 32 | 20 | 20 | 22 | 24 | 26 | 28 | |
| 30 | 44 45 | 45 44 | 46 44 | 47 44 | 48 43 | 49 43 | 50 43 | 51 42 | 52 42 | 30 | 30 | 32 | 34 | 36 | 38 | |
| 40 | 44 54 | 45 54 | 46 53 | 47 53 | 48 53 | 49 52 | 50 52 | 51 52 | 52 52 | 40 | 40 | 42 | 44 | 46 | 48 | |
| 50 | 45 4 | 46 3 | 47 3 | 48 2 | 49 2 | 50 1 | 51 1 | 52 1 | 53 0 | 50 | 50 | 52 | 54 | 56 | 58 | |
| 7 0 | 45 12 | 46 12 | 47 11 | 48 11 | 49 11 | 50 10 | 51 10 | 52 9 | 53 9 | 0 | 0 | 2 | 4 | 6 | 8 | |
| 10 | 45 21 | 46 20 | 47 20 | 48 19 | 49 19 | 50 18 | 51 18 | 52 17 | 53 17 | 10 | 10 | 12 | 14 | 16 | 18 | |
| 20 | 45 29 | 46 28 | 47 28 | 48 27 | 49 27 | 50 26 | 51 26 | 52 25 | 53 25 | 20 | 20 | 22 | 24 | 26 | 28 | |
| 30 | 45 36 | 46 35 | 47 35 | 48 34 | 49 34 | 50 33 | 51 33 | 52 32 | 53 32 | 30 | 30 | 32 | 34 | 36 | 38 | |
| 40 | 45 43 | 46 42 | 47 42 | 48 41 | 49 41 | 50 40 | 51 40 | 52 39 | 53 39 | 40 | 40 | 42 | 44 | 46 | 48 | |
| 50 | 45 49 | 46 49 | 47 48 | 48 48 | 49 47 | 50 47 | 51 46 | 52 45 | 53 45 | 50 | 50 | 52 | 54 | 56 | 58 | add |
| 8 0 | 45 55 | 46 55 | 47 54 | 48 54 | 49 53 | 50 53 | 51 52 | 52 52 | 53 51 | 0 | 0 | 2 | 4 | 6 | 8 | 1′ 1″ |
| 10 | 46 2 | 47 1 | 48 0 | 49 0 | 49 59 | 50 59 | 51 58 | 52 57 | 53 57 | 10 | 10 | 12 | 14 | 16 | 18 | 2 1 |
| 20 | 46 7 | 47 7 | 48 6 | 49 5 | 50 5 | 51 4 | 52 4 | 53 3 | 54 2 | 20 | 20 | 22 | 24 | 26 | 28 | 3 2 |
| 30 | 46 13 | 47 12 | 48 12 | 49 11 | 50 10 | 51 10 | 52 9 | 53 8 | 54 8 | 30 | 30 | 32 | 34 | 36 | 38 | 4 2 |
| 40 | 46 18 | 47 17 | 48 17 | 49 16 | 50 15 | 51 15 | 52 14 | 53 13 | 54 13 | 40 | 40 | 42 | 44 | 46 | 47 | 5 3 |
| 50 | 46 23 | 47 23 | 48 22 | 49 21 | 50 20 | 51 20 | 52 19 | 53 18 | 54 18 | 50 | 49 | 51 | 53 | 55 | 57 | 6 3 |
| 9 0 | 46 28 | 47 27 | 48 27 | 49 26 | 50 25 | 51 24 | 52 24 | 53 23 | 54 22 | 0 | 0 | 2 | 4 | 6 | 8 | 7 4 |
| 10 | 46 33 | 47 32 | 48 31 | 49 31 | 50 30 | 51 29 | 52 28 | 53 28 | 54 27 | 10 | 10 | 12 | 14 | 16 | 18 | 8 4 |
| 20 | 46 37 | 47 36 | 48 36 | 49 36 | 50 35 | 51 34 | 52 34 | 53 33 | 54 32 | 20 | 20 | 22 | 24 | 26 | 28 | 9 5 |
| 30 | 46 41 | 47 41 | 48 40 | 49 39 | 50 38 | 51 37 | 52 37 | 53 36 | 54 35 | 30 | 30 | 32 | 34 | 36 | 37 | |
| 40 | 46 45 | 47 45 | 48 44 | 49 43 | 50 42 | 51 41 | 52 40 | 53 39 | 54 39 | 40 | 39 | 41 | 43 | 45 | 47 | |
| 50 | 46 49 | 47 48 | 48 47 | 49 47 | 50 46 | 51 45 | 52 44 | 53 43 | 54 42 | 50 | 49 | 51 | 53 | 55 | 57 | |

## CORRECTION OF THE MOON'S APPARENT ALTITUDE

**(Barometer, 30 inches. Fahrenheit's Thermometer, 50°)**

| ☽ App. Alt. | Horizontal Parallax 53′ | 54′ | 55′ | 56′ | 57′ | 58′ | 59′ | 60′ | 61′ | ″ of Par. | Corr. for ″ of Par. *add.* 0″ | 2″ | 4″ | 6″ | 8″ | Cor. for ′ of Alt |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10° 0′ | 46′ 53″ | 47′ 52″ | 48′ 51″ | 49′ 50″ | 50′ 49″ | 51′ 48″ | 52′ 47″ | 53′ 46″ | 54′ 46″ | 0″ | 0″ | 2″ | 4″ | 6″ | 8″ | *add* |
| 10 | 46 56 | 47 55 | 48 54 | 49 53 | 50 53 | 51 52 | 52 51 | 53 50 | 54 49 | 10 | 10 | 12 | 14 | 16 | 18 | ′ ″ |
| 20 | 47 0 | 47 59 | 48 58 | 49 57 | 50 56 | 51 55 | 52 54 | 53 53 | 54 52 | 20 | 20 | 22 | 24 | 26 | 28 | 1 0 |
| 30 | 47 3 | 48 2 | 49 1 | 50 0 | 50 59 | 51 58 | 52 57 | 53 56 | 54 55 | 30 | 29 | 31 | 33 | 35 | 37 | 2 0 |
| 40 | 47 6 | 48 5 | 49 4 | 50 2 | 51 1 | 52 0 | 52 59 | 53 58 | 54 57 | 40 | 39 | 41 | 43 | 45 | 47 | 3 1 |
| 50 | 47 8 | 48 7 | 49 6 | 50 5 | 51 4 | 52 3 | 53 2 | 54 1 | 55 0 | 50 | 49 | 51 | 53 | 55 | 57 | 4 1 |
| 11 0 | 47 11 | 48 10 | 49 9 | 50 7 | 51 6 | 52 5 | 53 4 | 54 3 | 55 2 | 0 | 0 | 2 | 4 | 6 | 8 | 5 1 |
| 10 | 47 13 | 48 12 | 49 11 | 50 10 | 51 9 | 52 7 | 53 6 | 54 5 | 55 4 | 10 | 10 | 12 | 14 | 16 | 18 | 6 1 |
| 20 | 47 15 | 48 14 | 49 13 | 50 12 | 51 11 | 52 9 | 53 8 | 54 7 | 55 6 | 20 | 20 | 22 | 24 | 25 | 27 | 7 2 |
| 30 | 47 17 | 48 16 | 49 15 | 50 14 | 51 13 | 52 11 | 53 10 | 54 9 | 55 8 | 30 | 29 | 31 | 33 | 35 | 37 | 8 2 |
| 40 | 47 19 | 48 18 | 49 17 | 50 16 | 51 15 | 52 13 | 53 12 | 54 11 | 55 10 | 40 | 39 | 41 | 43 | 45 | 47 | 9 2 |
| 50 | 47 21 | 48 20 | 49 19 | 50 18 | 51 16 | 52 15 | 53 14 | 54 13 | 55 11 | 50 | 49 | 51 | 53 | 55 | 57 | |
| 12 0 | 47 23 | 48 22 | 49 21 | 50 19 | 51 18 | 52 17 | 53 15 | 54 14 | 55 13 | 0 | 0 | 2 | 4 | 6 | 8 | |
| 10 | 47 25 | 48 24 | 49 22 | 50 21 | 51 20 | 52 18 | 53 17 | 54 16 | 55 14 | 10 | 10 | 12 | 14 | 16 | 18 | |
| 20 | 47 27 | 48 25 | 49 24 | 50 23 | 51 21 | 52 20 | 53 19 | 54 17 | 55 16 | 20 | 20 | 21 | 23 | 25 | 27 | |
| 30 | 47 28 | 48 27 | 49 25 | 50 24 | 51 23 | 52 21 | 53 20 | 54 18 | 55 17 | 30 | 29 | 31 | 33 | 35 | 37 | |
| 40 | 47 30 | 48 28 | 49 27 | 50 25 | 51 24 | 52 22 | 53 21 | 54 20 | 55 18 | 40 | 39 | 41 | 43 | 45 | 47 | |
| 50 | 47 31 | 48 29 | 49 28 | 50 26 | 51 25 | 52 23 | 53 22 | 54 21 | 55 19 | 50 | 49 | 51 | 53 | 55 | 57 | |
| 13 0 | 47 32 | 48 30 | 49 29 | 50 27 | 51 26 | 52 24 | 53 23 | 54 21 | 55 20 | 0 | 0 | 2 | 4 | 6 | 8 | |
| 10 | 47 33 | 48 31 | 49 30 | 50 28 | 15 27 | 52 25 | 53 23 | 54 22 | 55 20 | 10 | 10 | 12 | 14 | 16 | 18 | |
| 20 | 47 34 | 48 32 | 49 31 | 50 29 | 51 27 | 52 26 | 53 24 | 54 22 | 55 21 | 20 | 19 | 21 | 23 | 25 | 27 | |
| 30 | 47 35 | 48 33 | 49 31 | 50 30 | 51 28 | 52 26 | 53 25 | 54 23 | 55 21 | 30 | 29 | 31 | 33 | 35 | 37 | |
| 40 | 47 35 | 48 34 | 49 32 | 50 30 | 51 29 | 52 27 | 53 25 | 54 23 | 55 22 | 40 | 39 | 41 | 43 | 45 | 47 | ′ ″ 1 0 |
| 50 | 47 36 | 48 34 | 49 33 | 50 31 | 51 29 | 52 27 | 53 26 | 54 24 | 55 22 | 50 | 49 | 51 | 53 | 54 | 56 | 2 0 |
| 14 0 | 47 37 | 48 35 | 49 33 | 50 31 | 51 30 | 52 28 | 53 26 | 54 24 | 55 22 | 0 | 0 | 2 | 4 | 6 | 8 | 3 0 |
| 10 | 47 37 | 48 35 | 49 33 | 50 32 | 51 30 | 52 28 | 53 26 | 54 24 | 55 22 | 10 | 10 | 12 | 14 | 15 | 17 | 4 0 |
| 20 | 47 37 | 48 36 | 49 34 | 50 32 | 51 30 | 52 28 | 53 26 | 54 24 | 55 22 | 20 | 19 | 21 | 23 | 25 | 27 | 5 0 |
| 30 | 47 38 | 48 36 | 49 34 | 50 32 | 51 30 | 52 28 | 53 26 | 54 24 | 55 22 | 30 | 29 | 31 | 33 | 35 | 37 | 6 0 |
| 40 | 47 38 | 48 36 | 49 34 | 50 32 | 51 30 | 52 28 | 53 26 | 54 24 | 55 22 | 40 | 39 | 41 | 43 | 45 | 46 | 7 0 |
| 50 | 47 38 | 48 36 | 49 34 | 50 32 | 51 30 | 52 28 | 53 26 | 54 24 | 55 22 | 50 | 48 | 50 | 52 | 54 | 56 | 8 0 |
| 15 0 | 47 38 | 48 36 | 49 34 | 50 32 | 51 30 | 52 28 | 53 26 | 54 24 | 55 22 | 0 | 0 | 2 | 4 | 6 | 8 | 9 0 |
| 10 | 47 38 | 48 36 | 49 34 | 50 32 | 51 30 | 52 28 | 53 26 | 54 24 | 55 22 | 10 | 10 | 12 | 14 | 15 | 17 | |
| 20 | 47 38 | 48 36 | 49 34 | 50 32 | 51 30 | 52 28 | 53 25 | 54 23 | 55 21 | 20 | 19 | 21 | 23 | 25 | 27 | |
| 30 | 47 38 | 48 36 | 49 34 | 50 31 | 51 29 | 52 27 | 53 25 | 54 23 | 55 21 | 30 | 29 | 31 | 33 | 35 | 37 | |
| 40 | 47 38 | 48 36 | 49 33 | 50 31 | 51 29 | 52 27 | 53 24 | 54 22 | 55 20 | 40 | 39 | 40 | 42 | 44 | 46 | |
| 50 | 47 37 | 48 35 | 49 33 | 50 31 | 51 28 | 52 26 | 53 24 | 54 22 | 55 19 | 50 | 48 | 50 | 52 | 54 | 56 | |
| 16 0 | 47 37 | 48 35 | 49 32 | 50 30 | 51 28 | 52 26 | 53 23 | 54 21 | 55 19 | 0 | 0 | 2 | 4 | 6 | 8 | |
| 10 | 47 37 | 48 34 | 49 32 | 50 30 | 51 27 | 52 25 | 53 22 | 54 20 | 55 18 | 10 | 10 | 12 | 13 | 15 | 17 | |
| 20 | 47 36 | 48 34 | 49 31 | 50 29 | 51 26 | 52 24 | 53 22 | 54 19 | 55 17 | 20 | 19 | 21 | 23 | 25 | 27 | |
| 30 | 47 35 | 48 33 | 49 31 | 50 28 | 51 26 | 52 23 | 53 21 | 54 18 | 55 16 | 30 | 29 | 31 | 33 | 35 | 36 | |
| 40 | 47 35 | 48 32 | 49 30 | 50 27 | 51 25 | 52 22 | 53 20 | 54 17 | 55 15 | 40 | 38 | 40 | 42 | 44 | 46 | |
| 50 | 47 34 | 48 32 | 49 29 | 50 26 | 51 24 | 52 21 | 53 19 | 54 16 | 55 14 | 50 | 48 | 50 | 52 | 54 | 56 | |
| 17 0 | 47 33 | 48 31 | 49 28 | 50 26 | 51 23 | 52 20 | 53 18 | 54 15 | 55 13 | 0 | 0 | 2 | 4 | 6 | 8 | *sub.* |
| 10 | 47 33 | 48 30 | 49 27 | 50 25 | 51 22 | 52 19 | 53 17 | 54 14 | 55 11 | 10 | 10 | 12 | 13 | 15 | 17 | ′ ″ |
| 20 | 47 32 | 48 29 | 49 26 | 50 24 | 51 21 | 52 18 | 53 15 | 54 13 | 55 10 | 20 | 19 | 21 | 23 | 25 | 27 | 1 0 |
| 30 | 47 31 | 48 28 | 49 25 | 50 22 | 51 20 | 52 17 | 53 14 | 54 11 | 55 9 | 30 | 29 | 30 | 32 | 34 | 36 | 2 0 |
| 40 | 47 30 | 48 27 | 49 24 | 50 21 | 51 18 | 52 16 | 53 13 | 54 10 | 55 7 | 40 | 38 | 40 | 42 | 44 | 46 | 3 0 |
| 50 | 47 29 | 48 26 | 49 23 | 50 20 | 51 17 | 52 14 | 53 11 | 54 9 | 55 6 | 50 | 48 | 50 | 52 | 53 | 55 | 4 0 |
| 18 0 | 47 28 | 48 25 | 49 22 | 50 19 | 51 16 | 52 13 | 53 10 | 54 7 | 55 4 | 0 | 0 | 2 | 4 | 6 | 8 | 5 0 |
| 10 | 47 26 | 48 23 | 49 20 | 50 17 | 51 15 | 52 12 | 53 9 | 54 6 | 55 3 | 10 | 9 | 11 | 13 | 15 | 17 | 6 0 |
| 20 | 47 25 | 48 22 | 49 19 | 50 16 | 51 14 | 52 10 | 53 7 | 54 4 | 55 1 | 20 | 19 | 21 | 23 | 25 | 27 | 7 0 |
| 30 | 47 24 | 48 21 | 49 18 | 50 15 | 51 12 | 52 9 | 53 5 | 54 2 | 54 59 | 30 | 28 | 30 | 32 | 34 | 36 | 8 0 |
| 40 | 47 23 | 48 20 | 49 16 | 50 13 | 51 10 | 52 7 | 53 4 | 54 1 | 54 58 | 40 | 38 | 40 | 42 | 44 | 46 | 9 1 |
| 50 | 47 21 | 48 18 | 49 15 | 50 12 | 51 8 | 52 5 | 53 2 | 53 59 | 54 56 | 50 | 47 | 49 | 51 | 53 | 55 | |
| 19 0 | 47 20 | 48 17 | 49 13 | 50 10 | 51 7 | 52 4 | 53 0 | 53 57 | 54 54 | 0 | 0 | 2 | 4 | 6 | 8 | |
| 10 | 47 18 | 48 15 | 49 12 | 50 8 | 51 5 | 52 2 | 52 59 | 53 55 | 54 52 | 10 | 9 | 11 | 13 | 15 | 17 | |
| 20 | 47 17 | 48 13 | 49 10 | 50 7 | 51 3 | 52 0 | 52 57 | 53 53 | 54 50 | 20 | 19 | 21 | 23 | 25 | 26 | |
| 30 | 47 15 | 48 12 | 49 8 | 50 5 | 51 2 | 51 58 | 52 55 | 53 51 | 54 48 | 30 | 28 | 30 | 32 | 34 | 36 | |
| 40 | 47 14 | 48 10 | 49 7 | 50 3 | 51 0 | 51 56 | 52 53 | 53 49 | 54 46 | 40 | 38 | 40 | 41 | 43 | 45 | |
| 50 | 47 12 | 48 8 | 49 5 | 50 1 | 50 58 | 51 54 | 52 51 | 53 47 | 54 44 | 50 | 47 | 49 | 51 | 53 | 55 | |

## CORRECTION OF THE MOON'S APPARENT ALTITUDE

(Barometer, 30 inches. Fahrenheit's Thermometer, 50°)

| ☽ App. Alt. | | Horizontal Parallax 53′ | 54′ | 55′ | 56′ | 57′ | 58′ | 59′ | 60′ | 61′ | ″ of Par. | Corr. for ″ of Par. add. 0″ | 2″ | 4″ | 6″ | 8″ | Cor. for ′ of Alt. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° | ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ″ | ″ | ″ | ″ | ″ | ″ | |
| 20 | 0 | 47 10 | 48 7 | 49 3 | 49 59 | 50 56 | 51 52 | 52 49 | 53 45 | 54 41 | 0 | 0 | 2 | 4 | 6 | 7 | sub. |
| | 10 | 47 9 | 48 5 | 49 1 | 49 58 | 50 54 | 51 50 | 52 47 | 53 43 | 54 39 | 10 | 9 | 11 | 13 | 15 | 17 | |
| | 20 | 47 7 | 48 3 | 48 59 | 49 56 | 50 52 | 51 48 | 52 44 | 53 41 | 54 37 | 20 | 19 | 21 | 22 | 24 | 26 | 1′ 0″ |
| | 30 | 47 5 | 48 1 | 48 57 | 49 54 | 50 50 | 51 46 | 52 42 | 53 38 | 54 35 | 30 | 28 | 30 | 32 | 34 | 36 | 2 0 |
| | 40 | 47 3 | 47 59 | 48 55 | 49 51 | 50 48 | 51 44 | 52 40 | 53 36 | 54 32 | 40 | 37 | 39 | 41 | 43 | 45 | 3 1 |
| | 50 | 47 1 | 47 57 | 48 53 | 49 49 | 50 45 | 51 41 | 52 38 | 53 34 | 54 30 | 50 | 47 | 49 | 51 | 52 | 54 | 4 1 |
| 21 | 0 | 46 59 | 47 55 | 48 51 | 49 47 | 50 43 | 51 39 | 52 35 | 53 31 | 54 27 | 0 | 0 | 2 | 4 | 6 | 7 | 5 1 |
| | 10 | 46 57 | 47 53 | 48 49 | 49 45 | 50 41 | 51 37 | 52 33 | 53 29 | 54 25 | 10 | 9 | 11 | 13 | 15 | 17 | 6 1 |
| | 20 | 46 55 | 47 51 | 48 47 | 49 43 | 50 38 | 51 34 | 52 30 | 53 26 | 54 22 | 20 | 19 | 20 | 22 | 24 | 26 | 7 2 |
| | 30 | 46 53 | 47 49 | 48 44 | 49 40 | 50 36 | 51 32 | 52 28 | 53 24 | 54 19 | 30 | 28 | 30 | 32 | 34 | 35 | 8 2 |
| | 40 | 46 51 | 47 46 | 48 42 | 49 38 | 50 34 | 51 29 | 52 25 | 53 21 | 54 17 | 40 | 37 | 39 | 41 | 43 | 45 | 9 2 |
| | 50 | 46 48 | 47 44 | 48 40 | 49 35 | 50 31 | 51 27 | 52 23 | 53 18 | 54 14 | 50 | 47 | 48 | 50 | 52 | 54 | |
| 22 | 0 | 46 46 | 47 42 | 48 37 | 49 33 | 50 29 | 51 24 | 52 20 | 53 16 | 54 11 | 0 | 0 | 2 | 4 | 6 | 7 | |
| | 10 | 46 44 | 47 39 | 48 35 | 49 30 | 50 26 | 51 22 | 52 17 | 53 13 | 54 8 | 10 | 9 | 11 | 13 | 15 | 17 | |
| | 20 | 46 41 | 47 37 | 48 32 | 49 28 | 50 23 | 51 19 | 52 14 | 53 10 | 54 5 | 20 | 18 | 20 | 22 | 24 | 26 | |
| | 30 | 46 39 | 47 34 | 48 30 | 49 25 | 50 21 | 51 16 | 52 12 | 53 7 | 54 3 | 30 | 28 | 30 | 31 | 33 | 35 | |
| | 40 | 46 36 | 47 32 | 48 27 | 49 23 | 50 18 | 51 13 | 52 9 | 53 4 | 54 0 | 40 | 37 | 39 | 41 | 43 | 44 | |
| | 50 | 46 34 | 47 29 | 48 25 | 49 20 | 50 15 | 51 11 | 52 6 | 53 1 | 53 57 | 50 | 46 | 48 | 50 | 52 | 54 | |
| 23 | 0 | 46 32 | 47 27 | 48 22 | 49 17 | 50 12 | 51 8 | 52 3 | 52 58 | 53 53 | 0 | 0 | 2 | 4 | 6 | 7 | |
| | 10 | 46 29 | 47 24 | 48 19 | 49 15 | 50 10 | 51 5 | 52 0 | 52 55 | 53 50 | 10 | 9 | 11 | 13 | 15 | 17 | |
| | 20 | 46 26 | 47 22 | 48 17 | 49 12 | 50 7 | 51 2 | 51 57 | 52 52 | 53 47 | 20 | 18 | 20 | 22 | 24 | 26 | |
| | 30 | 46 24 | 47 19 | 48 14 | 49 9 | 50 4 | 50 59 | 51 54 | 52 49 | 53 44 | 30 | 28 | 29 | 31 | 33 | 35 | |
| | 40 | 46 21 | 47 16 | 48 11 | 49 6 | 50 1 | 50 56 | 51 51 | 52 46 | 53 41 | 40 | 37 | 39 | 40 | 42 | 44 | 1′ 1 |
| | 50 | 46 18 | 47 13 | 48 8 | 49 3 | 49 58 | 50 53 | 51 48 | 52 43 | 53 38 | 50 | 46 | 48 | 50 | 51 | 53 | 2 1 |
| 24 | 0 | 46 16 | 47 11 | 48 5 | 49 0 | 49 55 | 50 50 | 51 45 | 52 39 | 53 34 | 0 | 0 | 2 | 4 | 5 | 7 | 3 1 |
| | 10 | 46 13 | 47 8 | 48 2 | 48 57 | 49 52 | 50 47 | 51 41 | 52 36 | 53 31 | 10 | 9 | 11 | 13 | 15 | 16 | 4 1 |
| | 20 | 46 10 | 47 5 | 47 59 | 48 54 | 49 49 | 50 44 | 51 38 | 52 33 | 53 28 | 20 | 18 | 20 | 22 | 24 | 25 | 5 2 |
| | 30 | 46 7 | 47 2 | 47 56 | 48 51 | 49 46 | 50 40 | 51 35 | 52 30 | 53 24 | 30 | 27 | 29 | 31 | 33 | 35 | 6 2 |
| | 40 | 46 4 | 46 59 | 47 54 | 48 48 | 49 43 | 50 37 | 51 32 | 52 26 | 53 21 | 40 | 36 | 38 | 40 | 42 | 44 | 7 2 |
| | 50 | 46 2 | 46 56 | 47 51 | 48 45 | 49 39 | 50 34 | 51 28 | 52 23 | 53 17 | 50 | 46 | 47 | 49 | 51 | 53 | 8 2 |
| 25 | 0 | 45 59 | 46 53 | 47 47 | 48 42 | 49 36 | 50 31 | 51 25 | 52 19 | 53 14 | 0 | 0 | 2 | 4 | 5 | 7 | 9 3 |
| | 10 | 45 56 | 46 50 | 47 44 | 48 39 | 49 33 | 50 27 | 51 21 | 52 16 | 53 10 | 10 | 9 | 11 | 13 | 14 | 16 | |
| | 20 | 45 53 | 46 47 | 47 41 | 48 35 | 49 29 | 50 24 | 51 18 | 52 12 | 53 6 | 20 | 18 | 20 | 22 | 23 | 25 | |
| | 30 | 45 49 | 46 44 | 47 38 | 48 32 | 49 26 | 50 20 | 51 14 | 52 9 | 53 3 | 30 | 27 | 29 | 31 | 33 | 34 | |
| | 40 | 45 46 | 46 40 | 47 35 | 48 29 | 49 23 | 50 17 | 51 11 | 52 5 | 52 59 | 40 | 36 | 38 | 40 | 42 | 43 | |
| | 50 | 45 43 | 46 37 | 47 31 | 48 25 | 49 19 | 50 13 | 51 7 | 52 1 | 52 55 | 50 | 45 | 47 | 48 | 51 | 52 | |
| 26 | 0 | 45 40 | 46 34 | 47 28 | 48 22 | 49 16 | 50 10 | 51 4 | 51 58 | 52 52 | 0 | 0 | 2 | 4 | 5 | 7 | |
| | 10 | 45 37 | 46 31 | 47 25 | 48 19 | 49 12 | 50 6 | 51 0 | 51 54 | 52 48 | 10 | 9 | 11 | 13 | 14 | 16 | |
| | 20 | 45 34 | 46 27 | 47 21 | 48 15 | 49 9 | 50 3 | 50 56 | 51 50 | 52 44 | 20 | 18 | 20 | 22 | 23 | 25 | |
| | 30 | 45 31 | 46 24 | 47 18 | 48 11 | 49 5 | 49 59 | 50 53 | 51 46 | 52 40 | 30 | 27 | 29 | 30 | 32 | 34 | |
| | 40 | 45 27 | 46 21 | 47 14 | 48 8 | 49 2 | 49 55 | 50 49 | 51 42 | 52 36 | 40 | 36 | 38 | 39 | 41 | 43 | |
| | 50 | 45 24 | 46 17 | 47 11 | 48 4 | 48 58 | 49 51 | 50 45 | 51 38 | 52 32 | 50 | 45 | 47 | 48 | 50 | 52 | |
| 27 | 0 | 45 20 | 46 14 | 47 7 | 48 1 | 48 54 | 49 48 | 50 41 | 51 35 | 52 28 | 0 | 0 | 2 | 4 | 5 | 7 | |
| | 10 | 45 17 | 46 10 | 47 4 | 47 57 | 48 50 | 49 44 | 50 37 | 51 31 | 52 24 | 10 | 9 | 11 | 12 | 14 | 16 | |
| | 20 | 45 13 | 46 7 | 47 0 | 47 53 | 48 47 | 49 40 | 50 33 | 51 27 | 52 20 | 20 | 18 | 20 | 21 | 23 | 25 | 1′ 0″ |
| | 30 | 45 10 | 46 3 | 46 56 | 47 50 | 48 43 | 49 36 | 50 29 | 51 23 | 52 16 | 30 | 27 | 28 | 30 | 32 | 34 | 2 1 |
| | 40 | 45 6 | 46 0 | 46 53 | 47 46 | 48 39 | 49 32 | 50 25 | 51 19 | 52 12 | 40 | 35 | 37 | 39 | 41 | 43 | 3 1 |
| | 50 | 45 3 | 45 56 | 46 49 | 47 42 | 48 35 | 49 28 | 50 21 | 51 14 | 52 7 | 50 | 44 | 46 | 48 | 50 | 52 | 4 2 |
| 28 | 0 | 44 59 | 45 52 | 46 45 | 47 38 | 48 31 | 49 24 | 50 17 | 51 10 | 52 3 | 0 | 0 | 2 | 4 | 5 | 7 | 5 2 |
| | 10 | 44 56 | 45 49 | 46 42 | 47 34 | 48 27 | 49 20 | 50 13 | 51 6 | 51 59 | 10 | 9 | 11 | 12 | 14 | 16 | 6 2 |
| | 20 | 44 52 | 45 45 | 46 38 | 47 31 | 48 23 | 49 16 | 50 9 | 51 2 | 51 55 | 20 | 18 | 19 | 21 | 23 | 25 | 7 3 |
| | 30 | 44 48 | 45 41 | 46 34 | 47 27 | 48 19 | 49 12 | 50 5 | 50 58 | 51 50 | 30 | 26 | 28 | 30 | 32 | 33 | 8 3 |
| | 40 | 44 45 | 45 37 | 46 30 | 47 23 | 48 15 | 49 8 | 50 1 | 50 53 | 51 46 | 40 | 35 | 37 | 39 | 40 | 42 | 9 4 |
| | 50 | 44 41 | 45 34 | 46 26 | 47 19 | 48 11 | 49 4 | 49 56 | 50 49 | 51 42 | 50 | 44 | 46 | 47 | 49 | 51 | |
| 29 | 0 | 44 37 | 45 30 | 46 22 | 47 15 | 48 7 | 49 0 | 49 52 | 50 45 | 51 37 | 0 | 0 | 2 | 3 | 5 | 7 | |
| | 10 | 44 34 | 45 26 | 46 18 | 47 11 | 48 3 | 48 56 | 49 48 | 50 40 | 51 33 | 10 | 9 | 10 | 12 | 14 | 16 | |
| | 20 | 44 30 | 45 22 | 46 14 | 47 7 | 47 59 | 48 51 | 49 44 | 50 36 | 51 28 | 20 | 17 | 19 | 21 | 23 | 24 | |
| | 30 | 44 26 | 45 18 | 46 10 | 47 2 | 47 55 | 48 47 | 49 39 | 50 31 | 51 24 | 30 | 26 | 28 | 30 | 32 | 33 | |
| | 40 | 44 22 | 45 14 | 46 6 | 46 58 | 47 51 | 48 43 | 49 35 | 50 27 | 51 19 | 40 | 35 | 37 | 38 | 40 | 42 | |
| | 50 | 44 18 | 45 10 | 46 2 | 46 54 | 47 46 | 48 38 | 49 30 | 50 22 | 51 15 | 50 | 44 | 45 | 47 | 49 | 50 | |

## CORRECTION OF THE MOON'S APPARENT ALTITUDE

(Barometer, 30 inches. Fahrenheit's Thermometer, 50°)

| ☽ App. Alt. | Horizontal Parallax 53′ | 54′ | 55′ | 56′ | 57′ | 58′ | 59′ | 60′ | 61′ | ″ of Par. | Corr. for ″ of Par. add. 0″ | 2″ | 4″ | 6″ | 8″ | Cor. for ′ of Alt. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° ′ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ″ | ″ | ″ | ″ | ″ | ″ | |
| 30 0 | 44 14 | 45 6 | 45 58 | 46 50 | 47 42 | 48 34 | 49 26 | 50 18 | 51 10 | 0 | 0 | 2 | 3 | 5 | 7 | |
| 10 | 44 10 | 45 2 | 45 54 | 46 46 | 47 38 | 48 30 | 49 21 | 50 13 | 51 5 | 10 | 9 | 10 | 12 | 14 | 16 | sub. |
| 20 | 44 6 | 44 58 | 45 50 | 46 42 | 47 33 | 48 25 | 49 17 | 50 9 | 51 1 | 20 | 17 | 19 | 21 | 22 | 24 | ′ ″ |
| 30 | 44 2 | 44 54 | 45 46 | 46 37 | 47 29 | 48 21 | 49 12 | 50 4 | 50 56 | 30 | 26 | 28 | 29 | 31 | 33 | 1 0 |
| 40 | 43 58 | 44 50 | 45 41 | 46 33 | 47 25 | 48 16 | 49 8 | 49 59 | 50 51 | 40 | 34 | 36 | 38 | 40 | 41 | 2 1 |
| 50 | 43 54 | 44 45 | 45 37 | 46 29 | 47 20 | 48 12 | 49 3 | 49 55 | 50 46 | 50 | 43 | 45 | 47 | 48 | 50 | 3 1 |
| 31 0 | 43 50 | 44 41 | 45 33 | 46 24 | 47 16 | 48 7 | 48 58 | 49 50 | 50 41 | 0 | 0 | 2 | 3 | 5 | 7 | 4 2 |
| 10 | 43 46 | 44 37 | 45 28 | 46 20 | 47 11 | 48 2 | 48 54 | 49 45 | 50 37 | 10 | 9 | 10 | 12 | 14 | 16 | 5 2 |
| 20 | 43 41 | 44 33 | 45 24 | 46 15 | 47 7 | 47 58 | 48 49 | 49 40 | 50 32 | 20 | 17 | 19 | 20 | 22 | 24 | 6 3 |
| 30 | 43 37 | 44 28 | 45 20 | 46 11 | 47 2 | 47 53 | 48 44 | 49 35 | 50 27 | 30 | 26 | 27 | 29 | 31 | 32 | 7 3 |
| 40 | 43 33 | 44 24 | 45 15 | 46 6 | 46 57 | 47 48 | 48 39 | 49 31 | 50 22 | 40 | 34 | 36 | 38 | 39 | 41 | 8 4 |
| 50 | 43 29 | 44 20 | 45 11 | 46 2 | 46 53 | 47 44 | 48 35 | 49 26 | 50 17 | 50 | 43 | 44 | 46 | 48 | 49 | 9 4 |
| 32 0 | 43 24 | 44 15 | 45 6 | 45 57 | 46 48 | 47 39 | 48 30 | 49 21 | 50 12 | 0 | 0 | 2 | 3 | 5 | 7 | |
| 10 | 43 20 | 44 11 | 45 2 | 45 53 | 46 43 | 47 34 | 48 25 | 49 16 | 50 7 | 10 | 8 | 10 | 12 | 13 | 15 | |
| 20 | 43 16 | 44 6 | 44 57 | 45 48 | 46 39 | 47 29 | 48 20 | 49 11 | 50 1 | 20 | 17 | 19 | 20 | 22 | 24 | |
| 30 | 43 11 | 44 2 | 44 53 | 45 43 | 46 34 | 47 24 | 48 15 | 49 6 | 49 56 | 30 | 25 | 27 | 29 | 30 | 32 | |
| 40 | 43 7 | 43 57 | 44 48 | 45 39 | 46 29 | 47 20 | 48 10 | 49 1 | 49 51 | 40 | 34 | 35 | 37 | 39 | 41 | |
| 50 | 43 3 | 43 53 | 44 43 | 45 34 | 46 24 | 47 15 | 48 5 | 48 56 | 49 46 | 50 | 42 | 44 | 46 | 47 | 49 | |
| 33 0 | 42 58 | 43 48 | 44 39 | 45 29 | 46 19 | 47 10 | 48 0 | 48 50 | 49 41 | 0 | 0 | 2 | 3 | 5 | 7 | |
| 10 | 42 54 | 43 44 | 44 34 | 45 24 | 46 15 | 47 5 | 47 55 | 48 45 | 49 36 | 10 | 8 | 10 | 12 | 13 | 15 | |
| 20 | 42 49 | 43 39 | 44 29 | 45 20 | 46 10 | 47 0 | 47 50 | 48 40 | 49 30 | 20 | 17 | 18 | 20 | 22 | 23 | |
| 30 | 42 45 | 43 35 | 44 24 | 45 15 | 46 5 | 46 55 | 47 45 | 48 35 | 49 25 | 30 | 25 | 27 | 28 | 30 | 32 | |
| 40 | 42 40 | 43 30 | 44 19 | 45 10 | 46 0 | 46 50 | 47 40 | 48 30 | 49 20 | 40 | 33 | 35 | 37 | 38 | 40 | |
| 50 | 42 35 | 43 25 | 44 14 | 45 5 | 45 55 | 46 45 | 47 35 | 48 24 | 49 14 | 50 | 42 | 44 | 45 | 47 | 48 | |
| 34 0 | 42 31 | 43 21 | 44 10 | 45 0 | 45 50 | 46 40 | 47 29 | 48 19 | 49 9 | 0 | 0 | 2 | 3 | 5 | 7 | |
| 10 | 42 26 | 43 16 | 44 6 | 44 55 | 45 45 | 46 34 | 47 24 | 48 14 | 49 3 | 10 | 8 | 10 | 12 | 13 | 15 | |
| 20 | 42 21 | 43 11 | 44 1 | 44 50 | 45 40 | 46 29 | 47 19 | 48 8 | 48 58 | 20 | 16 | 18 | 20 | 21 | 23 | |
| 30 | 42 17 | 43 6 | 43 56 | 44 45 | 45 35 | 46 24 | 47 14 | 48 3 | 48 53 | 30 | 25 | 27 | 28 | 30 | 31 | |
| 40 | 42 12 | 43 1 | 43 51 | 44 40 | 45 30 | 46 19 | 47 8 | 47 58 | 48 47 | 40 | 33 | 35 | 36 | 38 | 40 | |
| 50 | 42 7 | 42 57 | 43 46 | 44 35 | 45 24 | 46 14 | 47 3 | 47 52 | 48 41 | 50 | 41 | 43 | 44 | 46 | 48 | |
| 35 0 | 42 3 | 42 52 | 43 41 | 44 30 | 45 19 | 46 8 | 46 57 | 47 47 | 48 36 | 0 | 0 | 2 | 3 | 5 | 7 | |
| 10 | 41 58 | 42 47 | 43 36 | 44 25 | 45 14 | 46 3 | 46 52 | 47 41 | 48 30 | 10 | 8 | 10 | 11 | 13 | 15 | |
| 20 | 41 53 | 42 42 | 43 31 | 44 20 | 45 9 | 45 58 | 46 47 | 46 36 | 48 25 | 20 | 16 | 18 | 20 | 21 | 23 | |
| 30 | 41 48 | 42 37 | 43 26 | 44 15 | 45 3 | 45 52 | 46 41 | 47 30 | 48 19 | 30 | 24 | 26 | 28 | 29 | 31 | |
| 40 | 41 43 | 42 32 | 43 21 | 44 9 | 44 58 | 45 47 | 46 36 | 47 24 | 48 13 | 40 | 33 | 34 | 36 | 38 | 39 | |
| 50 | 41 38 | 42 27 | 43 16 | 44 4 | 44 53 | 45 41 | 46 30 | 47 19 | 48 7 | 50 | 41 | 42 | 44 | 46 | 47 | 1′ 1″ |
| 36 0 | 41 33 | 42 22 | 43 10 | 43 59 | 44 48 | 45 36 | 46 25 | 47 13 | 48 2 | 0 | 0 | 2 | 3 | 5 | 6 | 2 1 |
| 10 | 41 28 | 42 17 | 43 5 | 43 54 | 44 42 | 45 31 | 46 19 | 47 7 | 47 56 | 10 | 8 | 10 | 11 | 13 | 14 | 3 2 |
| 20 | 41 23 | 42 12 | 43 0 | 43 48 | 44 37 | 45 25 | 46 13 | 47 2 | 47 50 | 20 | 16 | 18 | 19 | 21 | 23 | 4 2 |
| 30 | 41 18 | 42 7 | 42 55 | 43 43 | 44 31 | 45 20 | 46 8 | 46 56 | 47 44 | 30 | 24 | 26 | 27 | 29 | 31 | 5 3 |
| 40 | 41 13 | 42 1 | 42 50 | 43 38 | 44 26 | 45 14 | 46 2 | 46 50 | 47 38 | 40 | 32 | 34 | 35 | 37 | 39 | 6 3 |
| 50 | 41 8 | 41 56 | 42 44 | 43 32 | 44 20 | 45 8 | 45 56 | 46 44 | 47 33 | 50 | 40 | 42 | 44 | 45 | 47 | 7 4 |
| 37 0 | 41 3 | 41 51 | 42 39 | 43 27 | 44 15 | 45 3 | 45 51 | 46 39 | 47 27 | 0 | 0 | 2 | 3 | 5 | 6 | 8 4 |
| 10 | 40 58 | 41 46 | 42 34 | 43 22 | 44 9 | 44 57 | 45 45 | 46 33 | 47 21 | 10 | 8 | 10 | 11 | 13 | 14 | 9 5 |
| 20 | 40 53 | 41 41 | 42 28 | 43 16 | 44 4 | 44 52 | 45 39 | 46 27 | 47 15 | 20 | 16 | 17 | 19 | 21 | 22 | |
| 30 | 40 48 | 41 35 | 42 23 | 43 11 | 43 58 | 44 46 | 45 33 | 46 21 | 47 9 | 30 | 24 | 26 | 28 | 29 | 31 | |
| 40 | 40 43 | 41 30 | 42 18 | 43 5 | 43 53 | 44 40 | 45 28 | 46 15 | 47 3 | 40 | 32 | 34 | 35 | 37 | 38 | |
| 50 | 40 37 | 41 25 | 42 12 | 43 0 | 43 47 | 44 34 | 45 22 | 46 9 | 46 57 | 50 | 40 | 41 | 43 | 44 | 46 | |
| 38 0 | 40 32 | 41 19 | 42 7 | 42 54 | 43 41 | 44 29 | 45 16 | 46 3 | 46 51 | 0 | 0 | 2 | 3 | 5 | 6 | |
| 10 | 40 27 | 41 14 | 42 1 | 42 48 | 43 36 | 44 23 | 45 10 | 45 57 | 46 44 | 10 | 8 | 9 | 11 | 12 | 14 | 1′ 1″ |
| 20 | 40 22 | 41 9 | 41 56 | 42 43 | 43 30 | 44 17 | 45 4 | 45 51 | 46 38 | 20 | 16 | 17 | 19 | 20 | 22 | 2 1 |
| 30 | 40 16 | 41 3 | 41 50 | 42 37 | 43 24 | 44 11 | 44 58 | 45 45 | 46 32 | 30 | 23 | 25 | 27 | 28 | 30 | 3 2 |
| 40 | 40 11 | 40 58 | 41 45 | 42 32 | 43 18 | 44 5 | 44 52 | 45 39 | 46 26 | 40 | 31 | 33 | 35 | 36 | 38 | 4 2 |
| 50 | 40 6 | 40 52 | 41 39 | 42 26 | 43 13 | 43 59 | 44 46 | 45 33 | 46 20 | 50 | 39 | 41 | 42 | 44 | 45 | 5 3 |
| 39 0 | 40 0 | 40 47 | 41 33 | 42 20 | 43 7 | 43 53 | 44 40 | 45 27 | 46 13 | 0 | 0 | 2 | 3 | 5 | 6 | 6 3 |
| 10 | 39 55 | 40 41 | 41 28 | 42 14 | 43 1 | 43 47 | 44 34 | 45 21 | 46 7 | 10 | 8 | 9 | 11 | 12 | 14 | 7 4 |
| 20 | 39 49 | 40 36 | 41 22 | 42 9 | 42 55 | 43 41 | 44 28 | 45 14 | 46 [illegible] | 20 | 15 | 17 | 19 | 20 | 22 | 8 5 |
| 30 | 39 44 | 40 30 | 41 17 | 42 3 | 42 49 | 43 35 | 44 22 | 45 8 | 45 54 | 30 | 23 | 25 | 27 | 28 | 30 | 9 5 |
| 40 | 39 38 | 40 25 | 41 11 | 41 57 | 42 43 | 43 29 | 44 16 | 45 2 | 45 48 | 40 | 31 | 32 | 34 | 36 | 37 | |
| 50 | 39 33 | 40 19 | 41 5 | 41 51 | 42 37 | 43 23 | 44 9 | 44 56 | 45 42 | 50 | 39 | 40 | 42 | 43 | 45 | |

## CORRECTION OF THE MOON'S APPARENT ALTITUDE

(Barometer, 30 inches. Fahrenheit's Thermometer, 50°)

| ☽ App. Alt. | Horizontal Parallax 53′ | 54′ | 55′ | 56′ | 57′ | 58′ | 59′ | 60′ | 61′ | ″ of Par. | Corr. for ″ of Par. add. 0″ | 2″ | 4″ | 6″ | 8″ | Cor. for ″ of Alt. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° ′ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ″ | ″ | ″ | ″ | ″ | ″ | |
| 40 0 | 39 27 | 40 13 | 40 59 | 41 45 | 42 31 | 43 17 | 44 3 | 44 49 | 45 35 | 0 | 0 | 1 | 3 | 5 | 6 | |
| 10 | 39 22 | 40 8 | 40 54 | 41 39 | 42 25 | 43 11 | 43 57 | 44 43 | 45 29 | 10 | 8 | 9 | 11 | 12 | 14 | |
| 20 | 39 16 | 40 2 | 40 48 | 41 33 | 42 19 | 43 5 | 43 51 | 44 36 | 45 22 | 20 | 15 | 17 | 18 | 20 | 21 | |
| 30 | 39 11 | 39 56 | 40 42 | 41 28 | 42 13 | 42 59 | 43 44 | 44 30 | 45 16 | 30 | 23 | 24 | 26 | 27 | 29 | |
| 40 | 39 5 | 39 51 | 40 36 | 41 22 | 42 7 | 42 53 | 43 38 | 44 24 | 45 9 | 40 | 30 | 32 | 33 | 35 | 36 | |
| 50 | 38 59 | 39 45 | 40 30 | 41 16 | 42 1 | 42 46 | 43 32 | 44 17 | 45 3 | 50 | 38 | 40 | 41 | 43 | 44 | |
| 41 0 | 38 54 | 39 39 | 40 24 | 41 10 | 41 55 | 42 40 | 43 25 | 44 11 | 44 56 | 0 | 0 | 1 | 3 | 4 | 6 | |
| 10 | 38 48 | 39 33 | 40 18 | 41 4 | 41 49 | 42 34 | 43 19 | 44 4 | 44 49 | 10 | 7 | 9 | 10 | 12 | 14 | |
| 20 | 38 42 | 39 27 | 40 12 | 40 58 | 41 43 | 42 28 | 43 13 | 43 58 | 44 43 | 20 | 15 | 16 | 18 | 19 | 21 | |
| 30 | 38 37 | 39 22 | 40 6 | 40 51 | 41 36 | 42 21 | 43 6 | 43 51 | 44 36 | 30 | 22 | 24 | 25 | 27 | 28 | |
| 40 | 38 31 | 39 16 | 40 0 | 40 45 | 41 30 | 42 15 | 43 0 | 43 45 | 44 30 | 40 | 30 | 31 | 33 | 34 | 36 | |
| 50 | 38 25 | 39 10 | 39 54 | 40 39 | 41 24 | 42 9 | 42 53 | 43 38 | 44 23 | 50 | 37 | 39 | 40 | 42 | 43 | |
| 42 0 | 38 19 | 39 4 | 39 48 | 40 33 | 41 18 | 42 2 | 42 47 | 43 31 | 44 16 | 0 | 0 | 1 | 3 | 4 | 6 | |
| 10 | 38 13 | 38 58 | 39 42 | 40 27 | 41 11 | 41 56 | 42 40 | 43 25 | 44 9 | 10 | 7 | 9 | 10 | 12 | 13 | |
| 20 | 38 8 | 38 52 | 39 36 | 40 21 | 41 5 | 41 49 | 42 34 | 43 18 | 44 3 | 20 | 15 | 16 | 18 | 19 | 21 | |
| 30 | 38 2 | 38 46 | 39 30 | 40 14 | 40 59 | 41 43 | 42 27 | 43 11 | 43 56 | 30 | 22 | 24 | 25 | 27 | 28 | |
| 40 | 37 56 | 38 40 | 39 24 | 40 8 | 40 52 | 41 36 | 42 21 | 43 5 | 43 49 | 40 | 29 | 31 | 32 | 34 | 36 | a.b |
| 50 | 37 50 | 38 34 | 39 18 | 40 2 | 40 46 | 41 30 | 42 14 | 42 58 | 43 42 | 50 | 37 | 38 | 40 | 41 | 43 | |
| 43 0 | 37 44 | 38 28 | 39 12 | 39 56 | 40 40 | 41 23 | 42 7 | 42 51 | 43 35 | 0 | 0 | 1 | 3 | 4 | 6 | 1 1 |
| 10 | 37 38 | 38 22 | 39 6 | 39 49 | 40 33 | 41 17 | 42 1 | 42 44 | 43 28 | 10 | 7 | 9 | 10 | 12 | 13 | 2 1 |
| 20 | 37 32 | 38 16 | 38 59 | 39 43 | 40 27 | 41 10 | 41 54 | 42 38 | 43 21 | 20 | 15 | 16 | 17 | 19 | 21 | 3 2 |
| 30 | 37 26 | 38 10 | 38 53 | 39 37 | 40 20 | 41 4 | 41 47 | 42 31 | 43 14 | 30 | 22 | 23 | 25 | 26 | 28 | 4 3 |
| 40 | 37 20 | 38 3 | 38 47 | 39 30 | 40 14 | 40 57 | 41 40 | 42 24 | 43 7 | 40 | 29 | 30 | 32 | 33 | 35 | 5 3 |
| 50 | 37 14 | 37 57 | 38 41 | 39 24 | 40 7 | 40 50 | 41 34 | 42 17 | 43 0 | 50 | 36 | 38 | 39 | 41 | 42 | 6 4 |
| 44 0 | 37 8 | 37 51 | 38 34 | 39 17 | 40 1 | 40 44 | 41 27 | 42 10 | 42 53 | 0 | 0 | 1 | 3 | 4 | 6 | 7 5 |
| 10 | 37 2 | 37 45 | 38 28 | 39 11 | 39 54 | 40 37 | 41 20 | 42 3 | 42 46 | 10 | 7 | 9 | 10 | 11 | 13 | 8 6 |
| 20 | 36 56 | 37 39 | 38 21 | 39 4 | 39 47 | 40 30 | 41 13 | 41 56 | 42 39 | 20 | 14 | 16 | 17 | 19 | 21 | 9 6 |
| 30 | 36 50 | 37 32 | 38 15 | 38 58 | 39 41 | 40 24 | 41 6 | 41 49 | 42 32 | 30 | 22 | 23 | 24 | 26 | 27 | |
| 40 | 36 43 | 37 26 | 38 9 | 38 51 | 39 34 | 40 17 | 40 59 | 41 42 | 42 25 | 40 | 29 | 30 | 31 | 33 | 34 | |
| 50 | 36 37 | 37 20 | 38 2 | 38 45 | 39 27 | 40 10 | 40 53 | 41 35 | 42 18 | 50 | 36 | 37 | 39 | 40 | 41 | |
| 45 0 | 36 31 | 37 13 | 37 56 | 38 38 | 39 21 | 40 3 | 40 46 | 41 28 | 42 11 | 0 | 0 | 1 | 3 | 4 | 6 | |
| 10 | 36 25 | 37 7 | 37 49 | 38 32 | 39 14 | 39 56 | 40 39 | 41 21 | 42 3 | 10 | 7 | 8 | 10 | 11 | 13 | |
| 20 | 36 19 | 37 1 | 37 43 | 38 25 | 39 7 | 39 50 | 40 32 | 41 14 | 41 56 | 20 | 14 | 15 | 17 | 18 | 20 | |
| 30 | 36 12 | 36 54 | 37 36 | 38 19 | 39 1 | 39 43 | 40 25 | 41 7 | 41 49 | 30 | 21 | 22 | 24 | 25 | 27 | |
| 40 | 36 6 | 36 48 | 37 30 | 38 12 | 38 54 | 39 36 | 40 18 | 41 0 | 41 42 | 40 | 28 | 29 | 31 | 32 | 34 | |
| 50 | 36 0 | 36 42 | 37 23 | 38 5 | 38 47 | 39 29 | 40 11 | 40 52 | 41 34 | 50 | 35 | 36 | 38 | 39 | 41 | |
| 46 0 | 35 53 | 36 35 | 37 17 | 37 59 | 38 40 | 39 22 | 40 4 | 40 45 | 41 27 | 0 | 0 | 1 | 3 | 4 | 6 | |
| 10 | 35 47 | 36 29 | 37 10 | 37 52 | 38 33 | 39 15 | 39 56 | 40 38 | 41 20 | 10 | 7 | 8 | 10 | 11 | 12 | |
| 20 | 35 41 | 36 22 | 37 4 | 37 45 | 38 26 | 39 8 | 39 49 | 40 31 | 41 12 | 20 | 14 | 15 | 17 | 18 | 19 | |
| 30 | 35 34 | 36 16 | 36 57 | 37 38 | 38 20 | 39 1 | 39 42 | 40 24 | 41 5 | 30 | 21 | 22 | 23 | 25 | 26 | |
| 40 | 35 28 | 36 9 | 36 50 | 37 32 | 38 13 | 38 54 | 39 35 | 40 16 | 40 57 | 40 | 28 | 29 | 30 | 32 | 33 | |
| 50 | 35 22 | 36 3 | 36 44 | 37 25 | 38 6 | 38 47 | 39 28 | 40 9 | 40 50 | 50 | 34 | 36 | 37 | 39 | 40 | |
| 47 0 | 35 15 | 35 56 | 36 37 | 37 18 | 37 59 | 38 40 | 39 21 | 40 2 | 40 43 | 0 | 0 | 1 | 3 | 4 | 5 | |
| 10 | 35 9 | 35 49 | 36 30 | 37 11 | 37 52 | 38 33 | 39 13 | 39 54 | 40 35 | 10 | 7 | 8 | 9 | 11 | 12 | |
| 20 | 35 2 | 35 43 | 36 23 | 37 4 | 37 45 | 38 25 | 39 6 | 39 47 | 40 28 | 20 | 14 | 15 | 16 | 18 | 19 | |
| 30 | 34 56 | 35 36 | 36 17 | 36 57 | 37 38 | 38 18 | 38 59 | 39 39 | 40 20 | 30 | 20 | 22 | 23 | 24 | 26 | |
| 40 | 34 49 | 35 29 | 36 10 | 36 50 | 37 31 | 38 11 | 38 52 | 39 32 | 40 12 | 40 | 27 | 28 | 30 | 31 | 32 | |
| 50 | 34 43 | 35 23 | 36 3 | 36 43 | 37 24 | 38 4 | 38 44 | 39 25 | 40 5 | 50 | 34 | 35 | 37 | 38 | 39 | |
| 48 0 | 34 36 | 35 16 | 35 56 | 36 36 | 37 17 | 37 57 | 38 37 | 39 17 | 39 57 | 0 | 0 | 1 | 3 | 4 | 5 | |
| 10 | 34 29 | 35 9 | 35 49 | 36 30 | 37 10 | 37 50 | 38 30 | 39 10 | 39 50 | 10 | 7 | 8 | 9 | 11 | 12 | 1 1 |
| 20 | 34 23 | 35 3 | 35 43 | 36 23 | 37 2 | 37 42 | 38 22 | 39 2 | 39 42 | 20 | 13 | 15 | 16 | 17 | 19 | 2 1 |
| 30 | 34 16 | 34 56 | 35 36 | 36 16 | 36 55 | 37 35 | 38 15 | 38 55 | 39 34 | 30 | 20 | 21 | 23 | 24 | 25 | 3 2 |
| 40 | 34 10 | 34 49 | 35 29 | 36 8 | 36 48 | 37 28 | 38 7 | 38 47 | 39 27 | 40 | 27 | 28 | 29 | 30 | 32 | 4 3 |
| 50 | 34 3 | 34 42 | 35 22 | 36 1 | 36 41 | 37 20 | 38 0 | 38 39 | 39 19 | 50 | 33 | 34 | 36 | 37 | 38 | 5 4 |
| 49 0 | 33 56 | 34 36 | 35 15 | 35 54 | 36 34 | 37 13 | 37 52 | 38 32 | 39 11 | 0 | 0 | 1 | 3 | 4 | 5 | 6 4 |
| 10 | 33 50 | 34 29 | 35 8 | 35 47 | 36 27 | 37 6 | 37 45 | 38 24 | 39 3 | 10 | 6 | 8 | 9 | 10 | 12 | 7 5 |
| 20 | 33 43 | 34 22 | 35 1 | 35 40 | 36 19 | 36 58 | 37 37 | 38 17 | 38 56 | 20 | 13 | 14 | 16 | 17 | 19 | 8 6 |
| 30 | 33 36 | 34 15 | 34 54 | 35 33 | 36 12 | 36 51 | 37 30 | 38 9 | 38 48 | 30 | 20 | 21 | 22 | 23 | 25 | 9 7 |
| 40 | 33 29 | 34 8 | 34 47 | 35 26 | 36 5 | 36 44 | 37 22 | 38 1 | 38 40 | 40 | 26 | 27 | 29 | 30 | 31 | |
| 50 | 33 23 | 34 1 | 34 40 | 35 19 | 35 57 | 36 36 | 37 15 | 37 54 | 38 32 | 50 | 32 | 34 | 35 | 36 | 38 | |

## CORRECTION OF THE MOON'S APPARENT ALTITUDE

(Barometer, 30 inches. Fahrenheit's Thermometer, 50°)

| ☽ App. Alt. | Horizontal Parallax 53′ | 54′ | 55′ | 56′ | 57′ | 58′ | 59′ | 60′ | 61′ | ″ of Par. | Corr. for ″ of Par add. 0″ | 2″ | 4″ | 6″ | 8″ | Cor. for ′ of Alt. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° ′ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ″ | ″ | ″ | ″ | ″ | ″ | |
| 50 0 | 33 16 | 33 54 | 34 33 | 35 11 | 35 50 | 36 29 | 37 7 | 37 46 | 38 24 | 0 | 0 | 1 | 3 | 4 | 5 | |
| 10 | 33 9 | 33 47 | 34 26 | 35 4 | 35 43 | 36 21 | 37 0 | 37 38 | 38 16 | 10 | 6 | 7 | 9 | 10 | 11 | |
| 20 | 33 2 | 33 40 | 34 19 | 34 57 | 35 35 | 36 14 | 36 52 | 37 30 | 38 9 | 20 | 13 | 14 | 15 | 17 | 18 | |
| 30 | 32 55 | 33 33 | 34 12 | 34 50 | 35 28 | 36 6 | 36 44 | 37 22 | 38 1 | 30 | 19 | 20 | 22 | 23 | 24 | sub. |
| 40 | 32 48 | 33 26 | 34 4 | 34 42 | 35 21 | 35 59 | 36 37 | 37 15 | 37 53 | 40 | 25 | 27 | 28 | 29 | 31 | ′ ″ |
| 50 | 32 42 | 33 19 | 33 57 | 34 35 | 35 13 | 35 51 | 36 29 | 37 7 | 37 45 | 50 | 32 | 33 | 34 | 36 | 37 | 1 1 |
| 51 0 | 32 35 | 33 12 | 33 50 | 34 28 | 35 6 | 35 43 | 36 21 | 36 59 | 37 37 | 0 | 0 | 1 | 2 | 4 | 5 | 2 2 |
| 10 | 32 28 | 33 5 | 33 43 | 34 21 | 34 58 | 35 36 | 36 13 | 36 51 | 37 29 | 10 | 6 | 7 | 9 | 10 | 11 | 3 2 |
| 20 | 32 21 | 32 58 | 33 36 | 34 13 | 34 51 | 35 28 | 36 6 | 36 43 | 37 21 | 20 | 12 | 14 | 15 | 16 | 17 | 4 3 |
| 30 | 32 14 | 32 51 | 33 29 | 34 6 | 34 43 | 35 21 | 35 58 | 36 35 | 37 13 | 30 | 19 | 20 | 21 | 22 | 24 | 5 4 |
| 40 | 32 7 | 32 44 | 33 21 | 33 59 | 34 36 | 35 13 | 35 50 | 36 27 | 37 5 | 40 | 25 | 26 | 28 | 29 | 30 | 6 4 |
| 50 | 32 0 | 32 37 | 33 14 | 33 51 | 34 28 | 35 5 | 35 42 | 36 19 | 36 57 | 50 | 31 | 32 | 34 | 35 | 36 | 7 5 |
| 52 0 | 31 53 | 32 30 | 33 7 | 33 44 | 34 21 | 34 58 | 35 35 | 36 11 | 36 48 | 0 | 0 | 1 | 2 | 4 | 5 | 8 6 |
| 10 | 31 46 | 32 23 | 32 59 | 33 36 | 34 13 | 34 50 | 35 27 | 36 3 | 36 40 | 10 | 6 | 7 | 9 | 10 | 11 | 9 7 |
| 20 | 31 39 | 32 15 | 32 52 | 33 29 | 34 5 | 34 42 | 35 19 | 35 55 | 36 32 | 20 | 12 | 13 | 15 | 16 | 17 | |
| 30 | 31 32 | 32 8 | 32 45 | 33 21 | 33 58 | 34 34 | 35 11 | 35 47 | 36 24 | 30 | 18 | 19 | 21 | 22 | 23 | |
| 40 | 31 25 | 32 1 | 32 37 | 33 14 | 33 50 | 34 27 | 35 3 | 35 39 | 36 16 | 40 | 24 | 26 | 27 | 28 | 29 | |
| 50 | 31 17 | 31 54 | 32 30 | 33 6 | 33 43 | 34 19 | 34 55 | 35 31 | 36 8 | 50 | 30 | 32 | 33 | 34 | 35 | |
| 53 0 | 31 10 | 31 47 | 32 23 | 32 59 | 33 35 | 34 11 | 34 47 | 35 23 | 35 59 | 0 | 0 | 1 | 2 | 4 | 5 | |
| 10 | 31 3 | 31 39 | 32 15 | 32 51 | 33 27 | 34 3 | 34 39 | 35 15 | 35 51 | 10 | 6 | 7 | 8 | 10 | 11 | ′ ″ |
| 20 | 30 56 | 31 32 | 32 8 | 32 44 | 33 19 | 33 55 | 34 31 | 35 7 | 35 43 | 20 | 12 | 13 | 14 | 15 | 17 | 1 1 |
| 30 | 30 49 | 31 25 | 32 0 | 32 36 | 33 12 | 33 47 | 34 23 | 34 59 | 35 35 | 30 | 18 | 19 | 20 | 21 | 23 | 2 2 |
| 40 | 30 42 | 31 17 | 31 53 | 32 28 | 33 4 | 33 40 | 34 15 | 34 51 | 35 26 | 40 | 24 | 25 | 26 | 27 | 29 | 3 2 |
| 50 | 30 35 | 31 10 | 31 45 | 32 21 | 32 56 | 33 32 | 34 7 | 34 42 | 35 18 | 50 | 30 | 31 | 32 | 33 | 35 | 4 3 |
| 54 0 | 30 27 | 31 3 | 31 38 | 32 13 | 32 48 | 33 24 | 33 59 | 34 34 | 35 10 | 0 | 0 | 1 | 2 | 3 | 5 | 5 4 |
| 10 | 30 20 | 30 55 | 31 30 | 32 6 | 32 41 | 33 16 | 33 51 | 34 26 | 35 1 | 10 | 6 | 7 | 8 | 9 | 10 | 6 5 |
| 20 | 30 13 | 30 48 | 31 23 | 31 58 | 32 33 | 33 8 | 33 43 | 34 18 | 34 53 | 20 | 12 | 13 | 14 | 15 | 16 | 7 6 |
| 30 | 30 6 | 30 40 | 31 15 | 31 50 | 32 25 | 33 0 | 33 35 | 34 10 | 34 44 | 30 | 17 | 19 | 20 | 21 | 22 | 8 6 |
| 40 | 29 58 | 30 33 | 31 8 | 31 42 | 32 17 | 32 52 | 33 27 | 34 1 | 34 36 | 40 | 23 | 24 | 26 | 27 | 28 | 9 7 |
| 50 | 29 51 | 30 26 | 31 0 | 31 35 | 32 9 | 32 44 | 33 18 | 33 53 | 34 28 | 50 | 29 | 30 | 31 | 32 | 34 | |
| 55 0 | 29 44 | 30 18 | 30 53 | 31 27 | 32 1 | 32 36 | 33 10 | 33 45 | 34 19 | 0 | 0 | 1 | 2 | 3 | 5 | |
| 10 | 29 36 | 30 11 | 30 45 | 31 19 | 31 54 | 32 28 | 33 2 | 33 36 | 34 11 | 10 | 6 | 7 | 8 | 9 | 10 | |
| 20 | 29 29 | 30 3 | 30 37 | 31 11 | 31 46 | 32 20 | 32 54 | 33 28 | 34 2 | 20 | 11 | 12 | 14 | 15 | 16 | |
| 30 | 29 22 | 29 56 | 30 30 | 31 4 | 31 38 | 32 12 | 32 46 | 33 20 | 33 54 | 30 | 17 | 18 | 19 | 20 | 22 | ′ ″ |
| 40 | 29 14 | 29 48 | 30 22 | 30 56 | 31 30 | 32 3 | 32 37 | 33 11 | 33 45 | 40 | 23 | 24 | 25 | 26 | 27 | 1 1 |
| 50 | 29 7 | 29 41 | 30 14 | 30 48 | 31 22 | 31 55 | 32 29 | 33 3 | 33 37 | 50 | 28 | 29 | 31 | 32 | 33 | 2 2 |
| 56 0 | 28 59 | 29 33 | 30 7 | 30 40 | 31 14 | 31 47 | 32 21 | 32 54 | 33 28 | 0 | 0 | 1 | 2 | 3 | 4 | 3 2 |
| 10 | 28 52 | 29 25 | 29 59 | 30 32 | 31 6 | 31 39 | 32 12 | 32 46 | 33 19 | 10 | 6 | 7 | 8 | 9 | 10 | 4 3 |
| 20 | 28 45 | 29 18 | 29 51 | 30 24 | 30 58 | 31 31 | 32 4 | 32 37 | 33 11 | 20 | 11 | 12 | 13 | 14 | 15 | 5 4 |
| 30 | 28 37 | 29 10 | 29 43 | 30 16 | 30 50 | 31 23 | 31 56 | 32 29 | 33 2 | 30 | 17 | 18 | 19 | 20 | 21 | 6 5 |
| 40 | 28 30 | 29 3 | 29 36 | 30 9 | 30 42 | 31 15 | 31 48 | 32 20 | 32 53 | 40 | 22 | 23 | 24 | 25 | 26 | 7 6 |
| 50 | 28 22 | 28 55 | 29 28 | 30 1 | 30 33 | 31 6 | 31 39 | 32 12 | 32 45 | 50 | 28 | 29 | 30 | 31 | 32 | 8 6 |
| 57 0 | 28 15 | 28 47 | 29 20 | 29 53 | 30 25 | 30 58 | 31 31 | 32 3 | 32 36 | 0 | 0 | 1 | 2 | 3 | 4 | 9 7 |
| 10 | 28 7 | 28 40 | 29 12 | 29 45 | 30 17 | 30 50 | 31 22 | 31 55 | 32 27 | 10 | 5 | 7 | 8 | 9 | 10 | |
| 20 | 28 0 | 28 32 | 29 4 | 29 37 | 30 9 | 30 42 | 31 14 | 31 46 | 32 19 | 20 | 11 | 12 | 13 | 14 | 15 | |
| 30 | 27 52 | 28 24 | 28 56 | 29 29 | 30 1 | 30 33 | 31 5 | 31 38 | 32 10 | 30 | 16 | 17 | 18 | 19 | 20 | |
| 40 | 27 44 | 28 17 | 28 49 | 29 21 | 29 53 | 30 25 | 30 57 | 31 29 | 32 1 | 40 | 21 | 22 | 23 | 24 | 26 | |
| 50 | 27 37 | 28 9 | 28 41 | 29 13 | 29 45 | 30 17 | 30 49 | 31 20 | 31 52 | 50 | 27 | 28 | 29 | 30 | 31 | ′ ″ |
| 58 0 | 27 29 | 28 1 | 28 33 | 29 5 | 29 36 | 30 8 | 30 40 | 31 12 | 31 44 | 0 | 0 | 1 | 2 | 3 | 4 | 1 1 |
| 10 | 27 22 | 27 53 | 28 25 | 28 57 | 29 28 | 30 0 | 30 32 | 31 3 | 31 35 | 10 | 5 | 6 | 7 | 8 | 9 | 2 2 |
| 20 | 27 14 | 27 45 | 28 17 | 28 48 | 29 20 | 29 51 | 30 23 | 30 55 | 31 26 | 20 | 10 | 11 | 13 | 14 | 15 | 3 2 |
| 30 | 27 6 | 27 38 | 28 9 | 28 40 | 29 12 | 29 43 | 30 14 | 30 46 | 31 17 | 30 | 16 | 17 | 18 | 19 | 20 | 4 3 |
| 40 | 26 59 | 27 30 | 28 1 | 28 32 | 29 3 | 29 35 | 30 6 | 30 37 | 31 8 | 40 | 21 | 22 | 23 | 24 | 25 | 5 4 |
| 50 | 26 51 | 27 22 | 27 53 | 28 24 | 28 55 | 29 26 | 29 57 | 30 28 | 30 59 | 50 | 26 | 27 | 28 | 29 | 30 | 6 5 |
| 59 0 | 26 43 | 27 14 | 27 45 | 28 16 | 28 47 | 29 18 | 29 49 | 30 20 | 30 51 | 0 | 0 | 1 | 2 | 3 | 4 | 7 6 |
| 10 | 26 36 | 27 6 | 27 37 | 28 8 | 28 39 | 29 9 | 29 40 | 30 11 | 30 42 | 10 | 5 | 6 | 7 | 8 | 9 | 8 7 |
| 20 | 26 28 | 26 58 | 27 29 | 28 0 | 28 30 | 29 1 | 29 32 | 30 2 | 30 33 | 20 | 10 | 11 | 12 | 13 | 14 | 9 7 |
| 30 | 26 20 | 26 51 | 27 21 | 27 52 | 28 22 | 28 52 | 29 23 | 29 53 | 30 24 | 30 | 15 | 16 | 17 | 18 | 19 | |
| 40 | 26 12 | 26 43 | 27 13 | 27 43 | 28 14 | 28 44 | 29 14 | 29 45 | 30 15 | 40 | 20 | 21 | 22 | 23 | 24 | |
| 50 | 26 5 | 26 35 | 27 5 | 27 35 | 28 5 | 28 35 | 29 6 | 29 36 | 30 6 | 50 | 25 | 26 | 27 | 28 | 29 | |

## CORRECTION OF THE MOON'S APPARENT ALTITUDE

(Barometer, 30 inches  Fahrenheit's Thermometer, 50°)

| ☽ App. Alt | Horizontal Parallax 53' | 54' | 55' | 56' | 57' | 58' | 59' | 60' | 61' | " of Par. | Corr. for " of Par add. 0" | 2" | 4" | 6" | 8" | Cor. for ' of Alt. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° ' | ' " | ' " | ' " | ' " | ' " | ' " | ' " | ' " | ' " | " | " | " | " | " | " | |
| 60 0 | 25 57 | 26 27 | 26 57 | 27 27 | 27 57 | 28 27 | 28 57 | 29 27 | 29 57 | 0 | 0 | 1 | 2 | 3 | 4 | |
| 10 | 25 49 | 26 19 | 26 49 | 27 19 | 27 48 | 28 18 | 28 48 | 29 18 | 29 48 | 10 | 5 | 6 | 7 | 8 | 9 | |
| 20 | 25 41 | 26 11 | 26 41 | 27 10 | 27 40 | 28 10 | 28 39 | 29 9 | 29 39 | 20 | 10 | 11 | 12 | 13 | 14 | |
| 30 | 25 33 | 26 3 | 26 32 | 27 2 | 27 32 | 28 1 | 28 31 | 29 0 | 29 30 | 30 | 15 | 16 | 17 | 18 | 19 | |
| 40 | 25 26 | 25 55 | 26 24 | 26 54 | 27 23 | 27 53 | 28 22 | 28 51 | 29 21 | 40 | 20 | 21 | 22 | 23 | 24 | |
| 50 | 25 18 | 25 47 | 26 16 | 26 45 | 27 15 | 27 44 | 28 13 | 28 42 | 29 12 | 50 | 25 | 26 | 27 | 28 | 29 | |
| 61 0 | 25 10 | 25 39 | 26 8 | 26 37 | 27 6 | 27 35 | 28 4 | 28 34 | 29 3 | 0 | 0 | 1 | 2 | 3 | 4 | |
| 10 | 25 2 | 25 31 | 26 0 | 26 29 | 26 58 | 27 27 | 27 56 | 28 25 | 28 54 | 10 | 5 | 6 | 7 | 8 | 9 | |
| 20 | 24 54 | 25 23 | 25 52 | 26 20 | 26 49 | 27 18 | 27 47 | 28 16 | 28 44 | 20 | 10 | 10 | 11 | 12 | 13 | |
| 30 | 24 46 | 25 15 | 25 43 | 26 12 | 26 41 | 27 9 | 27 38 | 28 7 | 28 35 | 30 | 14 | 15 | 16 | 17 | 18 | |
| 40 | 24 38 | 25 7 | 25 35 | 26 4 | 26 32 | 27 1 | 27 29 | 27 58 | 28 26 | 40 | 19 | 20 | 21 | 22 | 23 | |
| 50 | 24 30 | 24 59 | 25 27 | 25 55 | 26 24 | 26 52 | 27 20 | 27 49 | 28 17 | 50 | 24 | 25 | 26 | 27 | 28 | |
| 62 0 | 24 22 | 24 51 | 25 19 | 25 47 | 26 15 | 26 43 | 27 11 | 27 40 | 28 8 | 0 | 0 | 1 | 2 | 3 | 4 | |
| 10 | 24 14 | 24 42 | 25 10 | 25 38 | 26 6 | 26 35 | 27 3 | 27 31 | 27 59 | 10 | 5 | 6 | 6 | 7 | 8 | |
| 20 | 24 6 | 24 34 | 25 2 | 25 30 | 25 58 | 26 26 | 26 54 | 27 22 | 27 49 | 20 | 9 | 10 | 11 | 12 | 13 | |
| 30 | 23 58 | 24 26 | 24 54 | 25 22 | 25 49 | 26 17 | 26 45 | 27 12 | 27 40 | 30 | 14 | 15 | 16 | 17 | 18 | |
| 40 | 23 50 | 24 18 | 24 46 | 25 13 | 25 41 | 26 8 | 26 36 | 27 3 | 27 31 | 40 | 18 | 19 | 20 | 21 | 22 | |
| 50 | 23 42 | 24 10 | 24 37 | 25 5 | 25 32 | 25 59 | 26 27 | 26 54 | 27 22 | 50 | 23 | 24 | 25 | 26 | 27 | |
| 63 0 | 23 34 | 24 2 | 24 29 | 24 56 | 25 23 | 25 51 | 26 18 | 26 45 | 27 12 | 0 | 0 | 1 | 2 | 3 | 4 | |
| 10 | 23 26 | 23 53 | 24 21 | 24 48 | 25 15 | 25 42 | 26 9 | 26 36 | 27 3 | 10 | 4 | 5 | 6 | 7 | 8 | |
| 20 | 23 18 | 23 45 | 24 12 | 24 39 | 25 6 | 25 33 | 26 0 | 26 27 | 26 54 | 20 | 9 | 10 | 11 | 12 | 13 | sub. |
| 30 | 23 10 | 23 37 | 24 4 | 24 31 | 24 57 | 25 24 | 25 51 | 26 18 | 26 44 | 30 | 13 | 14 | 15 | 16 | 17 | ' " |
| 40 | 23 2 | 23 29 | 23 55 | 24 22 | 24 49 | 25 15 | 25 42 | 26 9 | 26 35 | 40 | 18 | 19 | 20 | 21 | 21 | 1 1 |
| 50 | 22 54 | 23 21 | 23 47 | 24 14 | 24 40 | 25 6 | 25 33 | 25 59 | 26 26 | 50 | 22 | 23 | 24 | 25 | 26 | 2 2 |
| 64 0 | 22 46 | 23 12 | 23 39 | 24 5 | 24 31 | 24 58 | 25 24 | 25 50 | 26 16 | 0 | 0 | 1 | 2 | 3 | 3 | 3 3 |
| 10 | 22 38 | 23 4 | 23 30 | 23 56 | 24 22 | 24 49 | 25 15 | 25 41 | 26 7 | 10 | 4 | 5 | 6 | 7 | 8 | 4 4 |
| 20 | 22 30 | 22 56 | 23 22 | 23 48 | 24 14 | 24 40 | 25 6 | 25 32 | 25 58 | 20 | 9 | 9 | 10 | 11 | 12 | 5 4 |
| 30 | 22 22 | 22 47 | 23 13 | 23 39 | 24 5 | 24 31 | 24 57 | 25 23 | 25 48 | 30 | 13 | 14 | 15 | 15 | 16 | 6 5 |
| 40 | 22 13 | 22 39 | 23 5 | 23 31 | 23 56 | 24 22 | 24 48 | 25 13 | 25 39 | 40 | 17 | 18 | 19 | 20 | 21 | 7 6 |
| 50 | 22 5 | 22 31 | 22 56 | 23 22 | 23 47 | 24 13 | 24 38 | 25 4 | 25 29 | 50 | 22 | 22 | 23 | 24 | 25 | 8 7 |
| 65 0 | 21 57 | 22 22 | 22 48 | 23 13 | 23 39 | 24 4 | 24 29 | 24 55 | 25 20 | 0 | 0 | 1 | 2 | 2 | 3 | 9 8 |
| 10 | 21 49 | 22 14 | 22 39 | 23 5 | 23 30 | 23 55 | 24 20 | 24 45 | 25 11 | 10 | 4 | 5 | 6 | 7 | 7 | |
| 20 | 21 41 | 22 6 | 22 31 | 22 56 | 23 21 | 23 46 | 24 11 | 24 36 | 25 1 | 20 | 8 | 9 | 10 | 11 | 12 | |
| 30 | 21 33 | 21 57 | 22 22 | 22 47 | 23 12 | 23 37 | 24 2 | 24 27 | 24 52 | 30 | 12 | 13 | 14 | 15 | 16 | |
| 40 | 21 24 | 21 49 | 22 14 | 22 39 | 23 3 | 23 28 | 23 53 | 24 17 | 24 42 | 40 | 17 | 17 | 18 | 19 | 20 | |
| 50 | 21 16 | 21 41 | 22 5 | 22 30 | 22 54 | 23 19 | 23 44 | 24 8 | 24 33 | 50 | 21 | 21 | 22 | 23 | 24 | |
| 66 0 | 21 8 | 21 32 | 21 57 | 22 21 | 22 46 | 23 10 | 23 34 | 23 59 | 24 23 | 0 | 0 | 1 | 2 | 2 | 3 | |
| 10 | 21 0 | 21 24 | 21 49 | 22 12 | 22 37 | 23 1 | 23 25 | 23 49 | 24 14 | 10 | 4 | 5 | 6 | 6 | 7 | |
| 20 | 20 51 | 21 15 | 21 40 | 22 4 | 22 28 | 22 52 | 23 16 | 23 40 | 24 4 | 20 | 8 | 9 | 10 | 10 | 11 | |
| 30 | 20 43 | 21 7 | 21 31 | 21 55 | 22 19 | 22 43 | 23 7 | 23 31 | 23 55 | 30 | 12 | 13 | 14 | 14 | 15 | |
| 40 | 20 35 | 20 59 | 21 22 | 21 46 | 22 10 | 22 34 | 22 57 | 23 21 | 23 45 | 40 | 16 | 17 | 18 | 18 | 19 | |
| 50 | 20 27 | 20 50 | 21 14 | 21 37 | 22 1 | 22 25 | 22 48 | 23 12 | 23 35 | 50 | 20 | 21 | 21 | 22 | 23 | |
| 67 0 | 20 18 | 20 42 | 21 5 | 21 29 | 21 52 | 22 15 | 22 39 | 23 2 | 23 26 | 0 | 0 | 1 | 2 | 2 | 3 | |
| 10 | 20 10 | 20 33 | 20 56 | 21 20 | 21 43 | 22 6 | 22 30 | 22 53 | 23 16 | 10 | 4 | 5 | 5 | 6 | 7 | |
| 20 | 20 2 | 20 25 | 20 48 | 21 11 | 21 34 | 21 57 | 22 20 | 22 43 | 23 7 | 20 | 8 | 8 | 9 | 10 | 11 | |
| 30 | 19 53 | 20 16 | 20 39 | 21 2 | 21 25 | 21 48 | 22 11 | 22 34 | 22 57 | 30 | 11 | 12 | 13 | 14 | 14 | |
| 40 | 19 45 | 20 8 | 20 30 | 20 53 | 21 16 | 21 39 | 22 2 | 22 24 | 22 47 | 40 | 15 | 16 | 17 | 18 | 18 | |
| 50 | 19 36 | 19 59 | 20 22 | 20 44 | 21 7 | 21 30 | 21 52 | 22 15 | 22 38 | 50 | 19 | 20 | 21 | 21 | 22 | |
| 68 0 | 19 28 | 19 51 | 20 13 | 20 36 | 20 58 | 21 21 | 21 43 | 22 5 | 22 28 | 0 | 0 | 1 | 2 | 2 | 3 | |
| 10 | 19 20 | 19 42 | 20 4 | 20 27 | 20 49 | 21 11 | 21 34 | 21 56 | 22 18 | 10 | 4 | 4 | 5 | 6 | 7 | |
| 20 | 19 11 | 19 33 | 19 56 | 20 18 | 20 40 | 21 2 | 21 24 | 21 46 | 22 9 | 20 | 7 | 8 | 9 | 10 | 10 | |
| 30 | 19 3 | 19 25 | 19 47 | 20 9 | 20 31 | 20 53 | 21 15 | 21 37 | 21 59 | 30 | 11 | 12 | 12 | 13 | 14 | |
| 40 | 18 54 | 19 16 | 19 38 | 20 0 | 20 22 | 20 44 | 21 5 | 21 27 | 21 49 | 40 | 15 | 15 | 16 | 17 | 17 | |
| 50 | 18 46 | 19 8 | 19 29 | 19 51 | 20 13 | 20 34 | 20 56 | 21 18 | 21 39 | 50 | 18 | 19 | 20 | 20 | 21 | |
| 69 0 | 18 38 | 18 59 | 19 21 | 19 42 | 20 4 | 20 25 | 20 47 | 21 8 | 21 30 | 0 | 0 | 1 | 1 | 2 | 3 | |
| 10 | 18 29 | 18 50 | 19 12 | 19 33 | 19 54 | 20 16 | 20 37 | 20 59 | 21 20 | 10 | 4 | 4 | 5 | 6 | 6 | |
| 20 | 18 21 | 18 42 | 19 3 | 19 24 | 19 45 | 20 7 | 20 28 | 20 49 | 21 10 | 20 | 7 | 8 | 8 | 9 | 10 | |
| 30 | 18 12 | 18 33 | 18 54 | 19 15 | 19 36 | 19 57 | 20 18 | 20 39 | 21 0 | 30 | 11 | 11 | 12 | 13 | 13 | |
| 40 | 18 4 | 18 25 | 18 45 | 19 6 | 19 27 | 19 48 | 20 9 | 20 30 | 20 51 | 40 | 14 | 15 | 15 | 16 | 17 | |
| 50 | 17 55 | 18 16 | 18 37 | 18 57 | 19 18 | 19 39 | 19 59 | 20 20 | 20 41 | 50 | 18 | 18 | 15 | 20 | 20 | |

## CORRECTION OF THE MOON'S APPARENT ALTITUDE

(Barometer, 30 inches. Fahrenheit's Thermometer, 50°)

| ☽ App. Alt. | Horizontal Parallax 53′ | 54′ | 55′ | 56′ | 57′ | 58′ | 59′ | 60′ | 61′ | ″ of Par. | Corr. for ″ of Par. add. 0″ | 2″ | 4″ | 6″ | 8″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° ′ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ″ | ″ | ″ | ″ | ″ | ″ |
| 70 0 | 17 47 | 18 7 | 18 28 | 18 48 | 19 9 | 19 29 | 19 50 | 20 10 | 20 31 | 0 | 0 | 1 | 1 | 2 | 3 |
| 10 | 17 38 | 17 59 | 18 19 | 18 39 | 19 0 | 19 20 | 19 40 | 20 1 | 20 21 | 10 | 3 | 4 | 5 | 5 | 6 |
| 20 | 17 30 | 17 50 | 18 10 | 18 30 | 18 51 | 19 11 | 19 31 | 19 51 | 20 11 | 20 | 7 | 7 | 8 | 9 | 9 |
| 30 | 17 21 | 17 41 | 18 1 | 18 21 | 18 41 | 19 1 | 19 21 | 19 41 | 20 1 | 30 | 10 | 11 | 11 | 12 | 13 |
| 40 | 17 13 | 17 33 | 17 52 | 18 12 | 18 32 | 18 52 | 19 12 | 19 32 | 19 52 | 40 | 13 | 14 | 15 | 15 | 16 |
| 50 | 17 4 | 17 24 | 17 44 | 18 3 | 18 23 | 18 43 | 19 2 | 19 22 | 19 42 | 50 | 17 | 17 | 18 | 19 | 19 |
| 71 0 | 16 56 | 17 15 | 17 35 | 17 54 | 18 14 | 18 33 | 18 53 | 19 12 | 19 32 | 0 | 0 | 1 | 1 | 2 | 3 |
| 10 | 16 47 | 17 6 | 17 26 | 17 45 | 18 4 | 18 24 | 18 43 | 19 3 | 19 22 | 10 | 3 | 4 | 4 | 5 | 6 |
| 20 | 16 38 | 16 58 | 17 17 | 17 36 | 17 55 | 18 15 | 18 34 | 18 53 | 19 12 | 20 | 6 | 7 | 8 | 8 | 9 |
| 30 | 16 30 | 16 49 | 17 8 | 17 27 | 17 46 | 18 5 | 18 24 | 18 43 | 19 2 | 30 | 10 | 10 | 11 | 11 | 12 |
| 40 | 16 21 | 16 40 | 16 59 | 17 18 | 17 37 | 17 56 | 18 15 | 18 33 | 18 52 | 40 | 13 | 13 | 14 | 15 | 15 |
| 50 | 16 13 | 16 31 | 16 50 | 17 9 | 17 28 | 17 46 | 18 5 | 18 24 | 18 42 | 50 | 16 | 16 | 17 | 18 | 18 |
| 72 0 | 16 4 | 16 23 | 16 41 | 17 0 | 17 18 | 17 37 | 17 55 | 18 14 | 18 32 | 0 | 0 | 1 | 1 | 2 | 2 |
| 10 | 15 55 | 16 14 | 16 32 | 16 51 | 17 9 | 17 27 | 17 46 | 18 4 | 18 22 | 10 | 3 | 4 | 4 | 5 | 5 |
| 20 | 15 47 | 16 5 | 16 23 | 16 41 | 17 0 | 17 18 | 17 36 | 17 54 | 18 13 | 20 | 6 | 7 | 7 | 8 | 8 |
| 30 | 15 38 | 15 56 | 16 14 | 16 32 | 16 50 | 17 8 | 17 26 | 17 44 | 18 3 | 30 | 9 | 10 | 10 | 11 | 11 |
| 40 | 15 29 | 15 47 | 16 5 | 16 23 | 16 41 | 16 59 | 17 17 | 17 35 | 17 53 | 40 | 12 | 13 | 13 | 14 | 14 |
| 50 | 15 21 | 15 39 | 15 56 | 16 14 | 16 32 | 16 49 | 17 7 | 17 25 | 17 43 | 50 | 15 | 16 | 16 | 17 | 17 |
| 73 0 | 15 12 | 15 30 | 15 47 | 16 5 | 16 22 | 16 40 | 16 57 | 17 15 | 17 33 | 0 | 0 | 1 | 1 | 2 | 2 |
| 10 | 15 3 | 15 21 | 15 38 | 15 56 | 16 13 | 16 30 | 16 48 | 17 5 | 17 23 | 10 | 3 | 3 | 4 | 5 | 5 |
| 20 | 14 55 | 15 12 | 15 29 | 15 46 | 16 4 | 16 21 | 16 38 | 16 55 | 17 13 | 20 | 6 | 6 | 7 | 7 | 8 |
| 30 | 14 46 | 15 3 | 15 20 | 15 37 | 15 54 | 16 11 | 16 28 | 16 45 | 17 3 | 30 | 9 | 9 | 10 | 10 | 11 |
| 40 | 14 37 | 14 54 | 15 11 | 15 28 | 15 45 | 16 2 | 16 19 | 16 36 | 16 52 | 40 | 11 | 12 | 12 | 13 | 14 |
| 50 | 14 29 | 14 45 | 15 2 | 15 19 | 15 36 | 15 52 | 16 9 | 16 26 | 16 42 | 50 | 14 | 15 | 15 | 16 | 16 |
| 74 0 | 14 20 | 14 37 | 14 53 | 15 10 | 15 26 | 15 43 | 15 59 | 16 16 | 16 32 | 0 | 0 | 1 | 1 | 2 | 2 |
| 10 | 14 11 | 14 28 | 14 44 | 15 0 | 15 17 | 15 33 | 15 50 | 16 6 | 16 22 | 10 | 3 | 3 | 4 | 4 | 5 |
| 20 | 14 3 | 14 19 | 14 35 | 14 51 | 15 7 | 15 24 | 15 40 | 15 56 | 16 12 | 20 | 5 | 6 | 6 | 7 | 7 |
| 30 | 13 54 | 14 10 | 14 26 | 14 42 | 14 58 | 15 14 | 15 30 | 15 46 | 16 2 | 30 | 8 | 9 | 9 | 10 | 10 |
| 40 | 13 45 | 14 1 | 14 17 | 14 33 | 14 49 | 15 4 | 15 20 | 15 36 | 15 52 | 40 | 11 | 11 | 12 | 12 | 13 |
| 50 | 13 36 | 13 52 | 14 8 | 14 24 | 14 39 | 14 55 | 15 11 | 15 26 | 15 42 | 50 | 13 | 14 | 14 | 15 | 15 |
| 75 0 | 13 28 | 13 43 | 13 59 | 14 14 | 14 30 | 14 45 | 15 1 | 15 16 | 15 32 | 0 | 0 | 1 | 1 | 2 | 2 |
| 10 | 13 19 | 13 34 | 13 50 | 14 5 | 14 20 | 14 36 | 14 51 | 15 6 | 15 22 | 10 | 3 | 3 | 4 | 4 | 5 |
| 20 | 13 10 | 13 25 | 13 41 | 13 56 | 14 11 | 14 26 | 14 41 | 14 56 | 15 12 | 20 | 5 | 6 | 6 | 7 | 7 |
| 30 | 13 1 | 13 16 | 13 31 | 13 46 | 14 1 | 14 16 | 14 32 | 14 47 | 15 2 | 30 | 8 | 8 | 9 | 9 | 10 |
| 40 | 12 53 | 13 7 | 13 22 | 13 37 | 13 52 | 14 7 | 14 22 | 14 37 | 14 51 | 40 | 10 | 11 | 11 | 12 | 12 |
| 50 | 12 44 | 12 58 | 13 13 | 13 28 | 13 43 | 13 57 | 14 12 | 14 27 | 14 41 | 50 | 13 | 13 | 14 | 14 | 15 |
| 76 0 | 12 35 | 12 50 | 13 4 | 13 19 | 13 33 | 13 48 | 14 2 | 14 17 | 14 31 | 0 | 0 | 0 | 1 | 1 | 2 |
| 10 | 12 26 | 12 41 | 12 55 | 13 9 | 13 24 | 13 38 | 13 52 | 14 7 | 14 21 | 10 | 2 | 3 | 3 | 4 | 4 |
| 20 | 12 17 | 12 32 | 12 46 | 13 0 | 13 14 | 13 28 | 13 42 | 13 57 | 14 11 | 20 | 5 | 5 | 6 | 6 | 7 |
| 30 | 12 9 | 12 23 | 12 37 | 12 51 | 13 5 | 13 19 | 13 33 | 13 47 | 14 1 | 30 | 7 | 7 | 8 | 8 | 9 |
| 40 | 12 0 | 12 14 | 12 27 | 12 41 | 12 55 | 13 9 | 13 23 | 13 37 | 13 50 | 40 | 9 | 10 | 10 | 11 | 11 |
| 50 | 11 51 | 12 5 | 12 18 | 12 32 | 12 46 | 12 59 | 13 13 | 13 27 | 13 40 | 50 | 12 | 12 | 13 | 13 | 14 |
| 77 0 | 11 42 | 11 56 | 12 9 | 12 23 | 12 36 | 12 50 | 13 3 | 13 17 | 13 30 | 0 | 0 | 0 | 1 | 1 | 2 |
| 10 | 11 33 | 11 47 | 12 0 | 12 13 | 12 27 | 12 40 | 12 53 | 13 6 | 13 20 | 10 | 2 | 3 | 3 | 4 | 4 |
| 20 | 11 24 | 11 37 | 11 51 | 12 4 | 12 17 | 12 30 | 12 43 | 12 56 | 13 10 | 20 | 4 | 5 | 5 | 6 | 6 |
| 30 | 11 15 | 11 28 | 11 41 | 11 54 | 12 7 | 12 20 | 12 33 | 12 46 | 12 59 | 30 | 7 | 7 | 7 | 8 | 8 |
| 40 | 11 7 | 11 19 | 11 32 | 11 45 | 11 58 | 12 11 | 12 24 | 12 36 | 12 49 | 40 | 9 | 9 | 10 | 10 | 10 |
| 50 | 10 58 | 11 10 | 11 23 | 11 36 | 11 48 | 12 1 | 12 14 | 12 26 | 12 39 | 50 | 11 | 11 | 12 | 12 | 13 |
| 78 0 | 10 49 | 11 1 | 11 14 | 11 26 | 11 39 | 11 51 | 12 4 | 12 16 | 12 29 | 0 | 0 | 0 | 1 | 1 | 2 |
| 10 | 10 40 | 10 52 | 11 5 | 11 17 | 11 29 | 11 42 | 11 54 | 12 6 | 12 19 | 10 | 2 | 2 | 3 | 3 | 4 |
| 20 | 10 31 | 10 43 | 10 55 | 11 8 | 11 20 | 11 32 | 11 44 | 11 56 | 12 8 | 20 | 4 | 4 | 5 | 5 | 6 |
| 30 | 10 22 | 10 34 | 10 46 | 10 58 | 11 10 | 11 22 | 11 34 | 11 46 | 11 58 | 30 | 6 | 6 | 7 | 7 | 8 |
| 40 | 10 13 | 10 25 | 10 37 | 10 49 | 11 1 | 11 12 | 11 24 | 11 36 | 11 48 | 40 | 8 | 8 | 9 | 9 | 10 |
| 50 | 10 5 | 10 16 | 10 28 | 10 39 | 10 51 | 11 3 | 11 14 | 11 26 | 11 38 | 50 | 10 | 10 | 11 | 11 | 12 |
| 79 0 | 9 56 | 10 7 | 10 19 | 10 30 | 10 41 | 10 53 | 11 4 | 11 16 | 11 27 | 0 | 0 | 0 | 1 | 1 | 1 |
| 10 | 9 47 | 9 58 | 10 9 | 10 21 | 10 32 | 10 43 | 10 54 | 11 6 | 11 17 | 10 | 2 | 2 | 3 | 3 | 3 |
| 20 | 9 38 | 9 49 | 10 0 | 10 11 | 10 22 | 10 33 | 10 44 | 10 56 | 11 7 | 20 | 4 | 4 | 4 | 5 | 5 |
| 30 | 9 29 | 9 40 | 9 51 | 10 2 | 10 13 | 10 24 | 10 34 | 10 45 | 10 56 | 30 | 5 | 6 | 6 | 7 | 7 |
| 40 | 9 20 | 9 31 | 9 41 | 9 52 | 10 3 | 10 14 | 10 25 | 10 35 | 10 46 | 40 | 7 | 8 | 8 | 8 | 9 |
| 50 | 9 11 | 9 22 | 9 32 | 9 43 | 9 53 | 10 4 | 10 15 | 10 25 | 10 36 | 50 | 9 | 9 | 10 | 10 | 11 |

Cor. for ′ of Alt. sub.

| ′ | ″ |
|---|---|
| 1 | 1 |
| 2 | 2 |
| 3 | 3 |
| 4 | 4 |
| 5 | 5 |
| 6 | 6 |
| 7 | 7 |
| 8 | 8 |
| 9 | 9 |

## CORRECTION OF THE MOON'S APPARENT ALTITUDE

(Barometer, 30 inches. Fahrenheit's Thermometer, 50°)

| ☽ App. Alt. | Horizontal Parallax 53′ | 54′ | 55′ | 56′ | 57′ | 58′ | 59′ | 60′ | 61′ | ″ of Par. | Corr. for ″ of Par. add. 0″ | 2″ | 4″ | 6″ | 8″ | Cor. for ′ of Alt. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° ′ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ″ | ″ | ″ | ″ | ″ | ″ | |
| 80 0 | 9 2 | 9 12 | 9 23 | 9 33 | 9 44 | 9 54 | 10 5 | 10 15 | 10 25 | 0 | 0 | 0 | 1 | 1 | 1 | |
| 10 | 8 53 | 9 3 | 9 14 | 9 24 | 9 34 | 9 44 | 9 55 | 10 5 | 10 15 | 10 | 2 | 2 | 2 | 3 | 3 | |
| 20 | 8 44 | 8 54 | 9 4 | 9 14 | 9 24 | 9 35 | 9 45 | 9 55 | 10 5 | 20 | 3 | 4 | 4 | 4 | 5 | |
| 30 | 8 35 | 8 45 | 8 55 | 9 5 | 9 15 | 9 25 | 9 35 | 9 45 | 9 54 | 30 | 5 | 5 | 6 | 6 | 6 | |
| 40 | 8 26 | 8 36 | 8 46 | 8 55 | 9 5 | 9 15 | 9 25 | 9 34 | 9 44 | 40 | 7 | 7 | 7 | 8 | 8 | |
| 50 | 8 17 | 8 27 | 8 36 | 8 46 | 8 56 | 9 5 | 9 15 | 9 24 | 9 34 | 50 | 8 | 9 | 9 | 9 | 10 | |
| 81 0 | 8 8 | 8 18 | 8 27 | 8 37 | 8 46 | 8 55 | 9 5 | 9 14 | 9 24 | 0 | 0 | 0 | 1 | 1 | 1 | |
| 10 | 7 59 | 8 9 | 8 18 | 8 27 | 8 36 | 8 45 | 8 55 | 9 4 | 9 13 | 10 | 1 | 2 | 2 | 2 | 3 | |
| 20 | 7 50 | 7 59 | 8 9 | 8 18 | 8 27 | 8 36 | 8 45 | 8 54 | 9 3 | 20 | 3 | 3 | 4 | 4 | 4 | |
| 30 | 7 41 | 7 50 | 7 59 | 8 8 | 8 17 | 8 26 | 8 35 | 8 44 | 8 52 | 30 | 4 | 5 | 5 | 5 | 6 | |
| 40 | 7 32 | 7 41 | 7 50 | 7 59 | 8 7 | 8 16 | 8 25 | 8 33 | 8 42 | 40 | 6 | 6 | 7 | 7 | 7 | |
| 50 | 7 24 | 7 32 | 7 41 | 7 49 | 7 58 | 8 6 | 8 15 | 8 23 | 8 32 | 50 | 7 | 8 | 8 | 8 | 9 | |
| 82 0 | 7 14 | 7 23 | 7 31 | 7 40 | 7 48 | 7 56 | 8 5 | 8 13 | 8 21 | 0 | 0 | 0 | 1 | 1 | 1 | |
| 10 | 7 5 | 7 14 | 7 22 | 7 30 | 7 38 | 7 46 | 7 55 | 8 3 | 8 11 | 10 | 1 | 2 | 2 | 2 | 2 | |
| 20 | 6 57 | 7 5 | 7 13 | 7 21 | 7 29 | 7 37 | 7 45 | 7 53 | 8 1 | 20 | 3 | 3 | 3 | 3 | 4 | |
| 30 | 6 48 | 6 55 | 7 3 | 7 11 | 7 19 | 7 27 | 7 34 | 7 42 | 7 50 | 30 | 4 | 4 | 4 | 5 | 5 | |
| 40 | 6 38 | 6 46 | 6 54 | 7 1 | 7 9 | 7 17 | 7 24 | 7 32 | 7 40 | 40 | 5 | 5 | 6 | 6 | 6 | |
| 50 | 6 29 | 6 37 | 6 44 | 6 52 | 6 59 | 7 7 | 7 14 | 7 22 | 7 29 | 50 | 6 | 7 | 7 | 7 | 8 | sub. |
| 83 0 | 6 20 | 6 28 | 6 35 | 6 42 | 6 50 | 6 57 | 7 4 | 7 12 | 7 19 | 0 | 0 | 0 | 0 | 1 | 1 | ′ ″ 1 1 |
| 10 | 6 11 | 6 19 | 6 26 | 6 33 | 6 40 | 6 47 | 6 54 | 7 1 | 7 9 | 10 | 1 | 1 | 2 | 2 | 2 | 2 2 |
| 20 | 6 2 | 6 9 | 6 16 | 6 23 | 6 30 | 6 37 | 6 44 | 6 51 | 6 58 | 20 | 2 | 2 | 3 | 3 | 3 | 3 3 |
| 30 | 5 53 | 6 0 | 6 7 | 6 14 | 6 21 | 6 27 | 6 34 | 6 41 | 6 48 | 30 | 3 | 4 | 4 | 4 | 4 | 4 4 |
| 40 | 5 44 | 5 51 | 5 58 | 6 4 | 6 11 | 6 18 | 6 24 | 6 31 | 6 37 | 40 | 5 | 5 | 5 | 5 | 5 | 5 5 |
| 50 | 5 35 | 5 42 | 5 48 | 5 55 | 6 1 | 6 8 | 6 14 | 6 21 | 6 27 | 50 | 6 | 6 | 6 | 6 | 7 | 6 6 |
| 84 0 | 5 26 | 5 33 | 5 39 | 5 45 | 5 51 | 5 58 | 6 4 | 6 10 | 6 17 | 0 | 0 | 0 | 0 | 0 | 1 | 7 7 |
| 10 | 5 17 | 5 23 | 5 30 | 5 36 | 5 42 | 5 48 | 5 54 | 6 0 | 6 6 | 10 | 1 | 1 | 1 | 1 | 2 | 8 8 |
| 20 | 5 8 | 5 14 | 5 20 | 5 26 | 5 32 | 5 38 | 5 44 | 5 50 | 5 56 | 20 | 2 | 2 | 2 | 2 | 3 | 9 9 |
| 30 | 4 59 | 5 5 | 5 11 | 5 17 | 5 22 | 5 28 | 5 34 | 5 40 | 5 45 | 30 | 3 | 3 | 3 | 3 | 4 | |
| 40 | 4 50 | 4 56 | 5 1 | 5 7 | 5 13 | 5 18 | 5 24 | 5 29 | 5 35 | 40 | 4 | 4 | 4 | 4 | 5 | |
| 50 | 4 41 | 4 47 | 4 52 | 4 57 | 5 3 | 5 8 | 5 14 | 5 19 | 5 24 | 50 | 5 | 5 | 5 | 5 | 6 | |
| 85 0 | 4 32 | 4 37 | 4 43 | 4 48 | 4 53 | 4 58 | 5 4 | 5 9 | 5 14 | 0 | 0 | 0 | 0 | 0 | 1 | |
| 10 | 4 23 | 4 28 | 4 33 | 4 38 | 4 43 | 4 48 | 4 53 | 4 58 | 5 4 | 10 | 1 | 1 | 1 | 1 | 1 | |
| 20 | 4 14 | 4 19 | 4 24 | 4 29 | 4 34 | 4 38 | 4 43 | 4 48 | 4 53 | 20 | 2 | 2 | 2 | 2 | 2 | |
| 30 | 4 5 | 4 10 | 4 14 | 4 19 | 4 24 | 4 28 | 4 33 | 4 38 | 4 43 | 30 | 2 | 2 | 3 | 3 | 3 | |
| 40 | 3 56 | 4 0 | 4 5 | 4 10 | 4 14 | 4 19 | 4 23 | 4 28 | 4 32 | 40 | 3 | 3 | 3 | 4 | 4 | |
| 50 | 3 47 | 3 51 | 3 56 | 4 0 | 4 4 | 4 9 | 4 13 | 4 17 | 4 22 | 50 | 4 | 4 | 4 | 4 | 5 | |
| 86 0 | 3 38 | 3 42 | 3 46 | 3 50 | 3 55 | 3 59 | 4 3 | 4 7 | 4 11 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 10 | 3 29 | 3 33 | 3 37 | 3 41 | 3 45 | 3 49 | 3 53 | 3 57 | 4 1 | 10 | 1 | 1 | 1 | 1 | 1 | |
| 20 | 3 20 | 3 23 | 3 27 | 3 31 | 3 35 | 3 39 | 3 43 | 3 47 | 3 50 | 20 | 1 | 1 | 1 | 2 | 2 | |
| 30 | 3 11 | 3 14 | 3 18 | 3 22 | 3 25 | 3 29 | 3 33 | 3 36 | 3 40 | 30 | 2 | 2 | 2 | 2 | 2 | |
| 40 | 3 2 | 3 5 | 3 9 | 3 12 | 3 15 | 3 19 | 3 22 | 3 26 | 3 29 | 40 | 2 | 3 | 3 | 3 | 3 | |
| 50 | 2 53 | 2 56 | 2 59 | 3 2 | 3 6 | 3 9 | 3 12 | 3 16 | 3 19 | 50 | 3 | 3 | 3 | 3 | 4 | |
| 87 0 | 2 43 | 2 47 | 2 50 | 2 53 | 2 56 | 2 59 | 3 2 | 3 5 | 3 8 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 10 | 2 34 | 2 37 | 2 40 | 2 43 | 2 46 | 2 49 | 2 52 | 2 55 | 2 58 | 10 | 0 | 1 | 1 | 1 | 1 | |
| 20 | 2 25 | 2 28 | 2 31 | 2 34 | 2 36 | 2 39 | 2 42 | 2 45 | 2 48 | 20 | 1 | 1 | 1 | 1 | 1 | |
| 30 | 2 16 | 2 19 | 2 21 | 2 24 | 2 27 | 2 29 | 2 32 | 2 35 | 2 37 | 30 | 1 | 1 | 1 | 2 | 2 | |
| 40 | 2 7 | 2 10 | 2 12 | 2 14 | 2 17 | 2 19 | 2 22 | 2 24 | 2 27 | 40 | 2 | 2 | 2 | 2 | 2 | |
| 50 | 1 58 | 2 0 | 2 3 | 2 5 | 2 7 | 2 9 | 2 12 | 2 14 | 2 16 | 50 | 2 | 2 | 2 | 2 | 3 | |
| 88 0 | 1 49 | 1 51 | 1 53 | 1 55 | 1 57 | 1 59 | 2 2 | 2 4 | 2 6 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 10 | 1 40 | 1 42 | 1 44 | 1 46 | 1 48 | 1 50 | 1 51 | 1 53 | 1 55 | 10 | 0 | 0 | 0 | 0 | 0 | |
| 20 | 1 31 | 1 33 | 1 34 | 1 36 | 1 38 | 1 40 | 1 41 | 1 43 | 1 45 | 20 | 1 | 1 | 1 | 1 | 1 | |
| 30 | 1 22 | 1 23 | 1 25 | 1 26 | 1 28 | 1 30 | 1 31 | 1 33 | 1 34 | 30 | 1 | 1 | 1 | 1 | 1 | |
| 40 | 1 13 | 1 14 | 1 15 | 1 17 | 1 18 | 1 20 | 1 21 | 1 22 | 1 24 | 40 | 1 | 1 | 1 | 1 | 1 | |
| 50 | 1 4 | 1 5 | 1 6 | 1 7 | 1 9 | 1 10 | 1 11 | 1 12 | 1 13 | 50 | 1 | 1 | 1 | 1 | 2 | |
| 89 0 | 0 54 | 0 56 | 0 57 | 0 58 | 0 59 | 1 0 | 1 1 | 1 2 | 1 3 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 10 | 0 45 | 0 46 | 0 47 | 0 48 | 0 49 | 0 50 | 0 51 | 0 52 | 0 52 | 10 | 0 | 0 | 0 | 0 | 0 | |
| 20 | 0 36 | 0 37 | 0 38 | 0 38 | 0 39 | 0 40 | 0 41 | 0 41 | 0 42 | 20 | 0 | 0 | 0 | 0 | 0 | |
| 30 | 0 27 | 0 28 | 0 28 | 0 29 | 0 29 | 0 30 | 0 30 | 0 31 | 0 31 | 30 | 0 | 0 | 0 | 0 | 0 | |
| 40 | 0 18 | 0 19 | 0 19 | 0 19 | 0 20 | 0 20 | 0 20 | 0 21 | 0 21 | 40 | 0 | 0 | 0 | 0 | 0 | |
| 50 | 0 9 | 0 9 | 0 9 | 0 10 | 0 10 | 0 10 | 0 10 | 0 10 | 0 10 | 50 | 1 | 1 | 1 | 1 | 1 | |

## TABLE 40.

CORRESPONDING
**HOR. PARALLAX AND SEMIDIAM. OF THE MOON.**

| H. Par. | Semid. | H. Par. | Semid. | H. Par. | Semid |
|---|---|---|---|---|---|
| 53′ 29″ | 14′ 36″ | 57′ 10″ | 15′ 36″ | 60′ 50″ | 16′ 36″ |
| 53 33 | 14 37 | 57 13 | 15 37 | 60 53 | 16 37 |
| 53 37 | 14 38 | 57 17 | 15 38 | 60 57 | 16 38 |
| 53 40 | 14 39 | 57 21 | 15 39 | 61 1 | 16 39 |
| 53 44 | 14 40 | 57 24 | 15 40 | 61 4 | 16 40 |
| 53 48 | 14 41 | 57 28 | 15 41 | 61 8 | 16 41 |
| 53 51 | 14 42 | 57 32 | 15 42 | 61 12 | 16 42 |
| 53 55 | 14 43 | 57 35 | 15 43 | 61 15 | 16 43 |
| 53 59 | 14 44 | 57 39 | 15 44 | 61 19 | 16 44 |
| 54 3 | 14 45 | 57 43 | 15 45 | 61 23 | 16 45 |
| 54 6 | 14 46 | 57 46 | 15 46 | 61 26 | 16 46 |
| 54 10 | 14 47 | 57 50 | 15 47 | 61 30 | 16 47 |
| 54 14 | 14 48 | 57 54 | 15 48 | 61 34 | 16 48 |
| 54 17 | 14 49 | 57 57 | 15 49 | 61 37 | 16 49 |
| 54 21 | 14 50 | 58 1 | 15 50 | 61 41 | 16 50 |
| 54 25 | 14 51 | 58 5 | 15 51 | | |
| 54 28 | 14 52 | 58 8 | 15 52 | | |
| 54 32 | 14 53 | 58 12 | 15 53 | | |
| 54 36 | 14 54 | 58 16 | 15 54 | | |
| 54 39 | 14 55 | 58 19 | 15 55 | | |
| 54 43 | 14 56 | 58 23 | 15 56 | | |
| 54 47 | 14 57 | 58 27 | 15 57 | | |
| 54 50 | 14 58 | 58 30 | 15 58 | | |
| 54 54 | 14 59 | 58 34 | 15 59 | | |
| 54 58 | 15 0 | 58 38 | 16 0 | | |
| 55 1 | 15 1 | 58 41 | 16 1 | | |
| 55 5 | 15 2 | 58 45 | 16 2 | | |
| 55 9 | 15 3 | 58 49 | 16 3 | | |
| 55 12 | 15 4 | 58 52 | 16 4 | | |
| 55 16 | 15 5 | 58 56 | 16 5 | | |
| 55 20 | 15 6 | 59 0 | 16 6 | | |
| 55 23 | 15 7 | 59 3 | 16 7 | | |
| 55 27 | 15 8 | 59 7 | 16 8 | | |
| 55 31 | 15 9 | 59 11 | 16 9 | | |
| 55 34 | 15 10 | 59 14 | 16 10 | | |
| 55 38 | 15 11 | 59 18 | 16 11 | | |
| 55 42 | 15 12 | 59 22 | 16 12 | | |
| 55 45 | 15 13 | 59 25 | 16 13 | | |
| 55 49 | 15 14 | 59 29 | 16 14 | | |
| 55 53 | 15 15 | 59 33 | 16 15 | | |
| 55 56 | 15 16 | 59 36 | 16 16 | | |
| 56 0 | 15 17 | 59 40 | 16 17 | | |
| 56 4 | 15 18 | 59 44 | 16 18 | | |
| 56 7 | 15 19 | 59 47 | 16 19 | | |
| 56 11 | 15 20 | 59 51 | 16 20 | | |
| 56 15 | 15 21 | 59 55 | 16 21 | | |
| 56 18 | 15 22 | 59 58 | 16 22 | | |
| 56 22 | 15 23 | 60 2 | 16 23 | | |
| 56 26 | 15 24 | 60 6 | 16 24 | | |
| 56 29 | 15 25 | 60 9 | 16 25 | | |
| 56 33 | 15 26 | 60 13 | 16 26 | | |
| 56 37 | 15 27 | 60 17 | 16 27 | | |
| 56 40 | 15 28 | 60 20 | 16 28 | | |
| 56 44 | 15 29 | 60 24 | 16 29 | | |
| 56 48 | 15 30 | 60 28 | 16 30 | | |
| 56 51 | 15 31 | 60 31 | 16 31 | | |
| 56 55 | 15 32 | 60 35 | 16 32 | | |
| 56 59 | 15 33 | 60 39 | 16 33 | | |
| 57 2 | 15 34 | 60 42 | 16 34 | | |
| 57 6 | 15 35 | 60 46 | 16 35 | | |

## TABLE 41

**CORRECTION**

OF THE MOON'S EQUATORIAL PARALLAX FOR THE FIGURE OF THE EARTH.

Compression $\frac{1}{293}$, (Clarke)

| Lat. | Horizontal Parallax | | | | |
|---|---|---|---|---|---|
| | 54′ | 56′ | 58′ | 60′ | 62′ |
| 0° | ″·0 | ″·0 | ″·0 | ″·0 | ″·0 |
| 8 | 0·2 | 0·2 | 0·2 | 0·2 | 0·2 |
| 16 | 0·8 | 0·9 | 0·9 | 0·9 | 0·9 |
| 20 | 1·3 | 1·4 | 1·4 | 1·4 | 1·5 |
| 24 | 1·8 | 1·9 | 2·0 | 2·0 | 2·1 |
| 28 | 2·4 | 2·5 | 2·6 | 2·7 | 2·8 |
| 32 | 3·1 | 3·2 | 3·4 | 3·5 | 3·6 |
| 36 | 3·8 | 4·0 | 4·1 | 4·2 | 4·4 |
| 40 | 4·6 | 4·7 | 4·9 | 5·1 | 5·2 |
| 44 | 5·3 | 5·5 | 5·7 | 5·9 | 6·1 |
| 48 | 6·1 | 6·3 | 6·6 | 6·8 | 7·0 |
| 52 | 6·9 | 7·1 | 7·4 | 7·6 | 7·9 |
| 56 | 7·6 | 7·9 | 8·2 | 8·4 | 8·7 |
| 60 | 8·3 | 8·6 | 8·9 | 9·2 | 9·5 |
| 64 | 8·9 | 9·3 | 9·6 | 9·9 | 10·2 |
| 68 | 9·5 | 9·9 | 10·2 | 10·6 | 10·9 |
| 72 | 10·0 | 10·4 | 10·7 | 11·1 | 11·5 |
| 76 | 10·4 | 10·8 | 11·2 | 11·6 | 12·0 |
| 80 | 10·7 | 11·1 | 11·5 | 11·9 | 12·3 |

## TABLE 42

**AUGMENTATION OF THE MOON'S SEMIDIAMETER**

| App. Alt. | Semidiameter | | | | | |
|---|---|---|---|---|---|---|
| | 14′ | 15′ | | 16′ | | 17′ |
| | 30″ | 0″ | 30″ | 0″ | 30″ | 0″ |
| 0° | 0″·1 | 0″·1 | 0″·1 | 0″·1 | 0″·1 | 0″·1 |
| 2 | 0·6 | 0·6 | 0·7 | 0·7 | 0·8 | 0·8 |
| 4 | 1·0 | 1·1 | 1·2 | 1·3 | 1·4 | 1·5 |
| 6 | 1·5 | 1·6 | 1·7 | 1·9 | 2·0 | 2·1 |
| 8 | 2·0 | 2·1 | 2·2 | 2·4 | 2·5 | 2·7 |
| 10 | 2·4 | 2·7 | 2·8 | 3·0 | 3·2 | 3·3 |
| 12 | 2·9 | 3·2 | 3·3 | 3·5 | 3·7 | 4·0 |
| 14 | 3·4 | 3·6 | 3·8 | 4·1 | 4·4 | 4·6 |
| 16 | 3·9 | 4·1 | 4·4 | 4·7 | 5·0 | 5·2 |
| 18 | 4·3 | 4·6 | 4·9 | 5·2 | 5·5 | 5·9 |
| 21 | 4·9 | 5·3 | 5·7 | 6·0 | 6·4 | 6·7 |
| 24 | 5·6 | 6·0 | 6·4 | 6·8 | 7·2 | 7·7 |
| 27 | 6·2 | 6·7 | 7·2 | 7·6 | 8·1 | 8·6 |
| 30 | 6·9 | 7·4 | 7·9 | 8·4 | 8·9 | 9·4 |
| 33 | 7·5 | 8·0 | 8·6 | 9·1 | 9·6 | 10·3 |
| 36 | 8·0 | 8·6 | 9·2 | 9·8 | 10·4 | 11·1 |
| 39 | 8·6 | 9·2 | 9·9 | 10·5 | 11·1 | 11·8 |
| 42 | 9·1 | 9·8 | 10·4 | 11·2 | 11·8 | 12·6 |
| 45 | 9·7 | 10·3 | 11·0 | 11·8 | 12·5 | 13·3 |
| 48 | 10·2 | 10·9 | 11·6 | 12·4 | 13·1 | 14·0 |
| 51 | 10·6 | 11·3 | 12·1 | 12·9 | 13·7 | 14·6 |
| 54 | 11·1 | 11·8 | 12·6 | 13·5 | 14·3 | 15·2 |
| 57 | 11·5 | 12·3 | 13·1 | 14·0 | 14·8 | 15·7 |
| 63 | 12·2 | 13·0 | 13·9 | 14·8 | 15·7 | 16·7 |
| 70 | 12·7 | 13·7 | 14·7 | 15·7 | 16·6 | 17·6 |
| 78 | 13·3 | 14·3 | 15·3 | 16·3 | 17·3 | 18·4 |
| 90 | 13·5 | 14·6 | 15·6 | 16·7 | 17·6 | 18·6 |

## TABLE 43

### CORRECTION

**FOR REDUCING THE TRUE ALTITUDE OF THE SUN OR A STAR TO THE APPARENT ALTITUDE**

| Alt. | Corr. | Alt. | Corr. |
|---|---|---|---|
| | *sub.* | | *sub.* |
| 5° 0′ | 0′ 16″ | 7° 30′ | 0′ 6″ |
| 5 20 | 0 15 | 8 0 | 0 5 |
| 5 40 | 0 12 | 9 0 | 0 3 |
| 6 0 | 0 11 | 10 0 | 0 2 |
| 6 20 | 0 9 | 13 0 | 0 1 |
| 6 40 | 0 8 | 25 0 | 0 0 |
| 7 0 | 0 7 | | |

## TABLE 44

### CORRECTION

**FOR REDUCING THE TRUE ALTITUDE OF THE MOON TO THE APPARENT ALTITUDE**

| Alt. | Horizontal Parallax | | |
|---|---|---|---|
| | 54′ | 58′ | 61′ |
| | *add.* | *add.* | *add.* |
| 5° 0′ | 1′ 14 | 1′ 22′ | 1′ 28′ |
| 5 10 | 1 10 | 1 18 | 1 23 |
| 5 20 | 1 7 | 1 15 | 1 19 |
| 5 30 | 1 5 | 1 11 | 1 16 |
| 5 40 | 1 3 | 1 8 | 1 13 |
| 5 50 | 1 0 | 1 5 | 1 10 |
| 6 0 | 0 57 | 1 3 | 1 7 |
| 6 20 | 0 52 | 0 57 | 1 2 |
| 6 40 | 0 47 | 0 51 | 0 54 |
| 7 0 | 0 45 | 0 47 | 0 51 |
| 7 20 | 0 41 | 0 44 | 0 47 |
| 7 40 | 0 37 | 0 40 | 0 42 |
| 8 0 | 0 34 | 0 36 | 0 38 |
| 8 30 | 0 30 | 0 32 | 0 33 |
| 9 0 | 0 26 | 0 28 | 0 29 |
| 9 30 | 0 22 | 0 24 | 0 25 |
| 10 0 | 0 19 | 0 20 | 0 20 |
| 10 30 | 0 16 | 0 17 | 0 18 |
| 11 0 | 0 14 | 0 14 | 0 14 |
| 11 30 | 0 12 | 0 12 | 0 11 |
| 12 0 | 0 9 | 0 9 | 0 9 |
| 13 0 | 0 6 | 0 6 | 0 7 |
| 14 0 | 0 4 | 0 3 | 0 2 |
| 15 0 | 0 0 | 0 0 | 0 0 |
| | *sub.* | *sub.* | *sub.* |
| 16 0 | 0 0 | 0 2 | 0 3 |
| 17 0 | 0 3 | 0 4 | 0 6 |
| 18 0 | 0 5 | 0 6 | 0 8 |
| 20 0 | 0 8 | 0 9 | 0 11 |
| 22 0 | 0 10 | 0 14 | 0 15 |
| 24 0 | 0 13 | 0 15 | 0 18 |
| 26 0 | 0 15 | 0 17 | 0 19 |
| 28 0 | 0 17 | 0 20 | 0 21 |
| 30 0 | 0 18 | 0 22 | 0 24 |
| 34 0 | 0 20 | 0 24 | 0 27 |
| 40 0 | 0 23 | 0 27 | 0 30 |
| 50 0 | 0 24 | 0 27 | 0 30 |
| 60 0 | 0 21 | 0 24 | 0 27 |
| 65 0 | 0 18 | 0 21 | 0 23 |
| 70 0 | 0 16 | 0 18 | 0 20 |
| 74 0 | 0 13 | 0 16 | 0 18 |
| 78 0 | 0 10 | 0 12 | 0 13 |
| 80 0 | 0 8 | 0 10 | 0 11 |
| 82 0 | 0 6 | 0 8 | 0 9 |
| 84 0 | 0 5 | 0 6 | 0 6 |
| 86 0 | 0 4 | 0 4 | 0 4 |
| 88 0 | 0 2 | 0 2 | 0 2 |
| 90 0 | 0 0 | 0 0 | 0 0 |

## TABLE 45

### PARALLAX IN ALTITUDE OF A PLANET

| Alt. | Planet's Horizontal Parallax | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 20″ | 30″ |
| 5° | 1″0 | 2″0 | 3″0 | 4″0 | 5″0 | 6″0 | 7″0 | 8″0 | 9″0 | 10″0 | 19″9 | 29″9 |
| 10 | 1·0 | 2·0 | 2·9 | 3·9 | 4·9 | 5·9 | 6·9 | 7·9 | 8·9 | 9·8 | 19·7 | 29·5 |
| 15 | 1 0 | 2·0 | 2·9 | 3·8 | 4·8 | 5·8 | 6·8 | 7·7 | 8·7 | 9·7 | 19·3 | 29·0 |
| 20 | 0·9 | 1·9 | 2·8 | 3·7 | 4·6 | 5·6 | 6·5 | 7·5 | 8·5 | 9·4 | 18·8 | 28·2 |
| 25 | 0·9 | 1·9 | 2·7 | 3·6 | 4·5 | 5·4 | 6.3 | 7·3 | 8·2 | 9·1 | 18·1 | 27·2 |
| 30 | 0·9 | 1·8 | 2·6 | 3·5 | 4·3 | 5·2 | 6·1 | 7·0 | 7·8 | 8·7 | 17·3 | 26·0 |
| 35 | 0·8 | 1·6 | 2·5 | 3·3 | 4·1 | 4·9 | 5·7 | 6·6 | 7·4 | 8·2 | 16·4 | 24·6 |
| 40 | 0·8 | 1·5 | 2·3 | 3·1 | 3·8 | 4·6 | 5·4 | 6·1 | 6·9 | 7·7 | 15·3 | 23·0 |
| 45 | 0·7 | 1·4 | 2·1 | 2·8 | 3·5 | 4·2 | 4·9 | 5·7 | 6·4 | 7·1 | 14·1 | 21·2 |
| 50 | 0·7 | 1·3 | 2·0 | 2·5 | 3·2 | 3·9 | 4·5 | 5·1 | 5·8 | 6·4 | 12·9 | 19·3 |
| 55 | 0·6 | 1·1 | 1·7 | 2·3 | 2·8 | 3·4 | 4·0 | 4·6 | 5·2 | 5·7 | 11·5 | 17·2 |
| 60 | 0·5 | 1·0 | 1·5 | 2·0 | 2·5 | 3·0 | 3·5 | 4·0 | 4·5 | 5·0 | 10·0 | 15·0 |
| 62 | 0·5 | 0·9 | 1·4 | 1·9 | 2·3 | 2·8 | 3·3 | 3·8 | 4·2 | 4·7 | 9·4 | 14·1 |
| 64 | 0·4 | 0·9 | 1·3 | 1·8 | 2·2 | 2·6 | 3·1 | 3·5 | 3·9 | 4·4 | 8·8 | 13·1 |
| 66 | 0·4 | 0·8 | 1·2 | 1·6 | 2·0 | 2·4 | 2·8 | 3·3 | 3·7 | 4·1 | 8·1 | 12·2 |
| 68 | 0·4 | 0·7 | 1·1 | 1·5 | 1·8 | 2·2 | 2·6 | 3·0 | 3·4 | 3·7 | 7·5 | 11·2 |
| 70 | 0·3 | 0·7 | 1·0 | 1·4 | 1·7 | 2·1 | 2·4 | 2·7 | 3·1 | 3·4 | 6·8 | 10·3 |
| 72 | 0·3 | 0·6 | 0·9 | 1·2 | 1·5 | 1·9 | 2·2 | 2·5 | 2·8 | 3·1 | 6·2 | 9·3 |
| 74 | 0·3 | 0 6 | 0·8 | 1·1 | 1·3 | 1·7 | 1·9 | 2·2 | 2·5 | 2·7 | 5·5 | 8·3 |
| 76 | 0·2 | 0·5 | 0·7 | 0·9 | 1·2 | 1·5 | 1·7 | 1·9 | 2·2 | 2·4 | 4·8 | 7·3 |
| 78 | 0·2 | 0·4 | 0·6 | 0·8 | 1·0 | 1·2 | 1·4 | 1·7 | 1·9 | 2·1 | 4·2 | 6·2 |
| 80 | 0·2 | 0·3 | 0·5 | 0·7 | 0·8 | 1·0 | 1·2 | 1·4 | 1·6 | 1·7 | 3·5 | 5·2 |
| 82 | 0·1 | 0·3 | 0·4 | 0·6 | 0·7 | 0·8 | 1·0 | 1·1 | 1·2 | 1·4 | 2·8 | 4·2 |
| 84 | 0·1 | 0·2 | 0·3 | 0·4 | 0·5 | 0·6 | 0·7 | 0·8 | 0·9 | 1·0 | 2·1 | 3·1 |
| 86 | 0·1 | 0·1 | 0·2 | 0·3 | 0·3 | 0·4 | 0·5 | 0·6 | 0·6 | 0·7 | 1·4 | 2·1 |
| 88 | 0·0 | 0·1 | 0·1 | 0·1 | 0·1 | 0·2 | 0·2 | 0·3 | 0·3 | 0·3 | 0·7 | 1·0 |
| 90 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

## AZIMUTH, AND CORRESPONDING CHANGE OF ALTITUDE IN $1^m$ OF TIME

| Lat. | Change of Altitude in $1^m$ | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0′ | 1′ | 2′ | 3′ | 4′ | 5′ | 6′ | 7′ | 8′ | 9′ | 10′ | 11′ | 12′ | 13′ | 14′ | 15′ |
| 0° | 0° | 4° | 8° | 12° | 15° | 19° | 24° | 28° | 32° | 37° | 42° | 47° | 53° | 60° | 69° | 87° |
| 2 | 0 | 4 | 8 | 12 | 15 | 19 | 24 | 28 | 32 | 37 | 42 | 47 | 53 | 60 | 69 | 87 |
| 4 | 0 | 4 | 8 | 12 | 15 | 20 | 24 | 28 | 32 | 37 | 42 | 47 | 53 | 60 | 69 | |
| 6 | 0 | 4 | 8 | 12 | 16 | 20 | 24 | 28 | 32 | 37 | 42 | 48 | 54 | 61 | 70 | |
| 8 | 0 | 4 | 8 | 12 | 16 | 20 | 24 | 28 | 33 | 37 | 42 | 48 | 54 | 61 | 71 | |
| 10 | 0 | 4 | 8 | 12 | 16 | 20 | 24 | 28 | 33 | 38 | 43 | 48 | 54 | 62 | 71 | |
| 11 | 0 | 4 | 8 | 12 | 16 | 20 | 24 | 28 | 33 | 38 | 43 | 48 | 55 | 62 | 72 | |
| 12 | 0 | 4 | 8 | 12 | 16 | 20 | 24 | 28 | 33 | 38 | 43 | 49 | 55 | 62 | 73 | |
| 13 | 0 | 4 | 8 | 12 | 16 | 20 | 24 | 29 | 33 | 38 | 43 | 49 | 55 | 63 | 73 | |
| 14 | 0 | 4 | 8 | 12 | 16 | 20 | 24 | 29 | 33 | 38 | 43 | 49 | 56 | 63 | 74 | |
| 15 | 0 | 4 | 8 | 12 | 16 | 20 | 24 | 29 | 34 | 38 | 44 | 49 | 56 | 64 | 75 | |
| 16 | 0 | 4 | 8 | 12 | 16 | 20 | 25 | 29 | 34 | 39 | 44 | 50 | 56 | 64 | 76 | |
| 17 | 0 | 4 | 8 | 12 | 16 | 20 | 25 | 29 | 34 | 39 | 44 | 50 | 57 | 65 | 77 | |
| 18 | 0 | 4 | 8 | 12 | 16 | 21 | 25 | 29 | 34 | 39 | 44 | 50 | 57 | 66 | 79 | |
| 19 | 0 | 4 | 8 | 12 | 16 | 21 | 25 | 30 | 34 | 39 | 45 | 51 | 58 | 66 | 81 | |
| 20 | 0 | 4 | 8 | 12 | 16 | 21 | 25 | 30 | 35 | 40 | 45 | 51 | 58 | 67 | 83 | |
| 21 | 0 | 4 | 8 | 12 | 17 | 21 | 25 | 30 | 35 | 40 | 46 | 52 | 59 | 68 | 89 | |
| 22 | 0 | 4 | 8 | 12 | 17 | 21 | 26 | 30 | 35 | 40 | 46 | 52 | 60 | 69 | | |
| 23 | 0 | 4 | 8 | 13 | 17 | 21 | 26 | 30 | 35 | 41 | 46 | 53 | 60 | 70 | | |
| 24 | 0 | 4 | 8 | 13 | 17 | 21 | 26 | 31 | 36 | 41 | 47 | 53 | 61 | 72 | | |
| 25 | 0 | 4 | 8 | 13 | 17 | 22 | 26 | 31 | 36 | 41 | 47 | 54 | 62 | 73 | | |
| 26 | 0 | 4 | 9 | 13 | 17 | 22 | 26 | 31 | 36 | 42 | 48 | 55 | 63 | 75 | | |
| 27 | 0 | 4 | 9 | 13 | 17 | 22 | 27 | 32 | 37 | 42 | 48 | 55 | 64 | 77 | | |
| 28 | 0 | 4 | 9 | 13 | 18 | 22 | 27 | 32 | 37 | 43 | 49 | 56 | 65 | 79 | | |
| 29 | 0 | 4 | 9 | 13 | 18 | 22 | 27 | 32 | 37 | 43 | 50 | 57 | 66 | 82 | | |
| 30 | 0 | 4 | 9 | 13 | 18 | 23 | 27 | 33 | 38 | 44 | 50 | 58 | 67 | | | |
| 31 | 0 | 4 | 9 | 13 | 18 | 23 | 28 | 33 | 38 | 44 | 51 | 59 | 69 | | | |
| 32 | 0 | 5 | 9 | 14 | 18 | 23 | 28 | 33 | 39 | 45 | 52 | 60 | 71 | | | |
| 33 | 0 | 5 | 9 | 14 | 19 | 23 | 28 | 34 | 39 | 46 | 53 | 61 | 73 | | | |
| 34 | 0 | 5 | 9 | 14 | 19 | 24 | 29 | 34 | 40 | 46 | 54 | 62 | 75 | | | |
| 35 | 0 | 5 | 9 | 14 | 19 | 24 | 29 | 35 | 41 | 47 | 54 | 64 | 78 | | | |
| 36 | 0 | 5 | 9 | 14 | 19 | 24 | 30 | 35 | 41 | 48 | 55 | 65 | 81 | | | |
| 37 | 0 | 5 | 10 | 14 | 19 | 25 | 30 | 36 | 42 | 49 | 57 | 67 | | | | |
| 38 | 0 | 5 | 10 | 15 | 20 | 25 | 30 | 36 | 43 | 49 | 58 | 69 | | | | |
| 39 | 0 | 5 | 10 | 15 | 20 | 25 | 31 | 37 | 43 | 51 | 59 | 71 | | | | |
| 40 | 0 | 5 | 10 | 15 | 20 | 26 | 31 | 38 | 44 | 52 | 60 | 73 | | | | |
| 41 | 0 | 5 | 10 | 15 | 21 | 26 | 32 | 38 | 45 | 53 | 62 | 76 | | | | |
| 42 | 0 | 5 | 10 | 16 | 21 | 27 | 33 | 39 | 46 | 54 | 64 | 81 | | | | |
| 43 | 0 | 5 | 10 | 16 | 21 | 27 | 33 | 40 | 47 | 55 | 66 | | | | | |
| 44 | 0 | 5 | 11 | 16 | 22 | 28 | 34 | 40 | 48 | 57 | 68 | | | | | |
| 45 | 0 | 5 | 11 | 16 | 22 | 28 | 34 | 41 | 49 | 58 | 71 | | | | | |
| 46 | 0 | 5 | 11 | 17 | 23 | 29 | 35 | 42 | 50 | 60 | 74 | | | | | |
| 47 | 0 | 6 | 11 | 17 | 23 | 29 | 36 | 43 | 51 | 62 | 78 | | | | | |
| 48 | 0 | 6 | 11 | 17 | 23 | 30 | 37 | 44 | 53 | 64 | 85 | | | | | |
| 49 | 0 | 6 | 12 | 18 | 24 | 31 | 38 | 45 | 54 | 66 | | | | | | |
| 50 | 0 | 6 | 12 | 18 | 25 | 31 | 38 | 47 | 56 | 69 | | | | | | |
| 51 | 0 | 6 | 12 | 19 | 25 | 32 | 39 | 48 | 58 | 72 | | | | | | |
| 52 | 0 | 6 | 12 | 19 | 26 | 33 | 41 | 49 | 60 | 77 | | | | | | |
| 53 | 0 | 6 | 13 | 19 | 26 | 34 | 42 | 51 | 62 | 85 | | | | | | |
| 54 | 0 | 7 | 13 | 20 | 27 | 35 | 43 | 53 | 65 | | | | | | | |
| 55 | 0 | 7 | 13 | 20 | 28 | 36 | 44 | 54 | 68 | | | | | | | |
| 56 | 0 | 7 | 14 | 21 | 28 | 37 | 46 | 57 | 73 | | | | | | | |
| 57 | 0 | 7 | 14 | 22 | 29 | 38 | 47 | 59 | 78 | | | | | | | |
| 58 | 0 | 7 | 15 | 22 | 30 | 40 | 49 | 62 | | | | | | | | |
| 59 | 0 | 7 | 15 | 23 | 31 | 40 | 51 | 65 | | | | | | | | |
| 60 | 0 | 8 | 15 | 24 | 32 | 42 | 53 | 69 | | | | | | | | |
| 61 | 0 | 8 | 16 | 24 | 33 | 43 | 56 | 74 | | | | | | | | |
| 62 | 0 | 8 | 16 | 25 | 35 | 45 | 58 | 84 | | | | | | | | |
| 63 | 0 | 8 | 17 | 26 | 36 | 47 | 62 | | | | | | | | | |
| 64 | 0 | 9 | 18 | 27 | 37 | 49 | 66 | | | | | | | | | |
| 65 | 0 | 9 | [illegible] | 28 | 39 | 52 | 70 | | | | | | | | | |
| 66 | 0 | 9 | 19 | 29 | 41 | 55 | 80 | | | | | | | | | |

## LIMITS, AT SEA, OF THE REDUCTION TO THE MERIDIAN.

| Lat. | 0° | 5° | 10° | 15° | 20° | 23° |
|---|---|---|---|---|---|---|
| | **Declination of the same Name as the Lat.** | | | | | |
| 0° | 0h 0m | 0h 3m | 0h 5m | 0h 8m | 0h 11m | 0h 14m |
| 5 | 0 3 | 0 0 | 0 3 | 0 5 | 0 8 | 0 10 |
| 10 | 0 5 | 0 3 | 0 0 | 0 3 | 0 6 | 0 7 |
| 15 | 0 8 | 0 5 | 0 3 | 0 0 | 0 3 | 0 5 |
| 20 | 0 11 | 0 8 | 0 6 | 0 3 | 0 0 | 0 0 |
| 25 | 0 14 | 0 11 | 0 9 | 0 6 | 0 3 | 0 0 |
| 30 | 0 17 | 0 15 | 0 12 | 0 9 | 0 6 | 0 5 |
| 35 | 0 21 | 0 18 | 0 16 | 0 13 | 0 10 | 0 8 |
| 40 | 0 25 | 0 23 | 0 20 | 0 17 | 0 14 | 0 12 |
| 44 | 0 29 | 0 26 | 0 24 | 0 21 | 0 18 | 0 16 |
| 48 | 0 33 | 0 31 | 0 28 | 0 25 | 0 22 | 0 20 |
| 52 | 0 38 | 0 36 | 0 33 | 0 30 | 0 27 | 0 26 |
| 56 | 0 44 | 0 42 | 0 39 | 0 36 | 0 34 | 0 32 |
| 60 | 0 52 | 0 49 | 0 47 | 0 44 | 0 41 | 0 39 |
| 64 | 1 0 | 0 57 | 0 55 | 0 52 | 0 49 | 0 47 |
| 68 | 1 10 | 1 8 | 1 6 | 1 3 | 1 1 | 0 58 |
| | **Declination of *contrary* Name to the Lat.** | | | | | |
| 0 | 0 0 | 0 3 | 0 5 | 0 8 | 0 11 | 0 13 |
| 5 | 0 3 | 0 5 | 0 8 | 0 11 | 0 14 | 0 16 |
| 10 | 0 5 | 0 8 | 0 11 | 0 13 | 0 16 | 0 18 |
| 15 | 0 8 | 0 11 | 0 13 | 0 16 | 0 19 | 0 21 |
| 20 | 0 11 | 0 14 | 0 16 | 0 19 | 0 22 | 0 24 |
| 25 | 0 14 | 0 17 | 0 19 | 0 22 | 0 25 | 0 27 |
| 30 | 0 17 | 0 20 | 0 23 | 0 25 | 0 28 | 0 30 |
| 35 | 0 21 | 0 24 | 0 26 | 0 29 | 0 32 | 0 34 |
| 40 | 0 25 | 0 28 | 0 30 | 0 33 | 0 36 | 0 38 |
| 44 | 0 29 | 0 32 | 0 34 | 0 37 | 0 40 | 0 42 |
| 48 | 0 33 | 0 36 | 0 39 | 0 41 | 0 44 | 0 46 |
| 52 | 0 38 | 0 41 | 0 44 | 0 46 | 0 49 | 0 51 |
| 56 | 0 44 | 0 47 | 0 50 | 0 52 | 0 55 | 0 57 |
| 60 | 0 52 | 0 55 | 0 57 | 1 00 | 1 3 | 1 5 |
| 64 | 1 0 | 1 3 | 1 6 | while visible. | | |
| 68 | 1 10 | 1 13 | 1 16 | | | |



## VALUE OF THE REDUCTION. AT WHICH THE 2d RED^n AMOUNTS TO 1'.

| Mer. Alt. | Reduc. | Mer. Alt. | Reduc |
|---|---|---|---|
| 5° | 4°40' | 45° | 1°23' |
| 6 | 4 16 | 46 | 1 21 |
| 7 | 3 57 | 47 | 1 20 |
| 8 | 3 41 | 48 | 1 19 |
| 9 | 3 28 | 49 | 1 17 |
| 10 | 3 18 | 50 | 1 16 |
| 11 | 3 8 | 51 | 1 15 |
| 12 | 3 0 | 52 | 1 13 |
| 13 | 2 53 | 53 | 1 12 |
| 14 | 2 46 | 54 | 1 11 |
| 15 | 2 40 | 55 | 1 9 |
| 16 | 2 35 | 56 | 1 8 |
| 17 | 2 30 | 57 | 1 7 |
| 18 | 2 25 | 58 | 1 6 |
| 19 | 2 21 | 59 | 1 4 |
| 20 | 2 17 | 60 | 1 3 |
| 21 | 2 14 | 61 | 1 2 |
| 22 | 2 10 | 62 | 1 0 |
| 23 | 2 7 | 63 | 0 59 |
| 24 | 2 4 | 64 | 0 58 |
| 25 | 2 2 | 65 | 0 57 |
| 26 | 1 59 | 66 | 0 55 |
| 27 | 1 56 | 67 | 0 54 |
| 28 | 1 54 | 68 | 0 53 |
| 29 | 1 51 | 69 | 0 52 |
| 30 | 1 49 | 70 | 0 50 |
| 31 | 1 47 | 71 | 0 49 |
| 32 | 1 45 | 72 | 0 47 |
| 33 | 1 43 | 73 | 0 46 |
| 34 | 1 41 | 74 | 0 44 |
| 35 | 1 39 | 75 | 0 43 |
| 36 | 1 37 | 76 | 0 41 |
| 37 | 1 36 | 77 | 0 40 |
| 38 | 1 34 | 78 | 0 38 |
| 39 | 1 32 | 79 | 0 37 |
| 40 | 1 31 | 80 | 0 35 |
| 41 | 1 29 | 81 | 0 33 |
| 42 | 1 27 | 82 | 0 31 |
| 43 | 1 26 | 83 | 0 29 |
| 44 | 1 24 | 84 | 0 27 |

## FOR COMPUTING THE REDUCTION TO THE MERIDIAN IN SECONDS

0 Hours

| s. | 0m | 1m | 2m | 3m | 4m | 5m | 6m | 7m | 8m | 9m | 10m | 11m | 12m | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0″.0 | 2″.0 | 7″.8 | 17″.7 | 31″.4 | 49″.1 | 70″.7 | 96″.2 | 125″.7 | 159″.0 | 196″.3 | 237″.5 | 282″.7 | 60 |
| 1 | 0.0 | 2.0 | 8.0 | 17.9 | 31.7 | 49.4 | 71.1 | 96.6 | 126.2 | 159.6 | 197.0 | 238.3 | 283.5 | 59 |
| 2 | 0.0 | 2.1 | 8.1 | 18.1 | 31.9 | 49.7 | 71.5 | 97.1 | 126.7 | 160.2 | 197.6 | 239.0 | 284.2 | 58 |
| 3 | 0.0 | 2.2 | 8.2 | 18.3 | 32.2 | 50.1 | 71.9 | 97.6 | 127.2 | 160.8 | 198.3 | 239.7 | 285.0 | 57 |
| 4 | 0.0 | 2.2 | 8.4 | 18.5 | 32.5 | 50.4 | 72.3 | 98.1 | 127.8 | 161.4 | 198 9 | 240.4 | 285.8 | 56 |
| 5 | 0.0 | 2.3 | 8.5 | 18.7 | 32.7 | 50.7 | 72.7 | 98.5 | 128.3 | 162.0 | 195 6 | 241.2 | 286.6 | 55 |
| 6 | 0.0 | 2.4 | 8.7 | 18.9 | 33.0 | 51.1 | 73.1 | 99.0 | 128.8 | 162.6 | 200.3 | 241.9 | 287.4 | 54 |
| 7 | 0.0 | 2.4 | 8.8 | 19.1 | 33.3 | 51.4 | 73.5 | 99.4 | 129.4 | 163.2 | 200.9 | 242.6 | 288.2 | 53 |
| 8 | 0.0 | 2.5 | 8.9 | 19.3 | 33.5 | 51.7 | 73.9 | 99.9 | 129.9 | 163.8 | 201.6 | 243.3 | 289.0 | 52 |
| 9 | 0.0 | 2 6 | 9.1 | 19.5 | 33.8 | 52.1 | 74.3 | 100.4 | 130.4 | 164.4 | 202.2 | 244.1 | 289.8 | 51 |
| 10 | 0.0 | 2.7 | 9.2 | 19.7 | 34.1 | 52.4 | 74.7 | 100.8 | 131.0 | 165.0 | 202.9 | 244.8 | 290.6 | 50 |
| 11 | 0.1 | 2.7 | 9.4 | 19.9 | 34.4 | 52.7 | 75.1 | 101.3 | 131.5 | 165.6 | 203.6 | 245.5 | 291.4 | 49 |
| 12 | 0.1 | 2.8 | 9.5 | 20.1 | 34.6 | 53.1 | 75.5 | 101.8 | 132.0 | 166.2 | 204.2 | 246.2 | 292.2 | 48 |
| 13 | 0.1 | 2.9 | 9.6 | 20.3 | 34.9 | 53.4 | 75.9 | 102.3 | 132.6 | 166.8 | 204.9 | 247.0 | 293.0 | 47 |
| 14 | 0.1 | 3.0 | 9.8 | 20.5 | 35.2 | 53.8 | 76.3 | 102.7 | 133.1 | 167.4 | 205.6 | 247.7 | 293.8 | 46 |
| 15 | 0.1 | 3.1 | 9.9 | 20.7 | 35.5 | 54.1 | 76.7 | 103.2 | 133.6 | 168.0 | 206.3 | 248.5 | 294.6 | 45 |
| 16 | 0.1 | 3.1 | 10.1 | 20.9 | 35.7 | 54.5 | 77.1 | 103.7 | 134.2 | 168.6 | 206.9 | 249.2 | 295.4 | 44 |
| 17 | 0.2 | 3.2 | 10.2 | 21.2 | 36.0 | 54.8 | 77.5 | 104.2 | 134.7 | 169.2 | 207.6 | 249.9 | 296.2 | 43 |
| 18 | 0.2 | 3.3 | 10.4 | 21.4 | 36.3 | 55.1 | 77.9 | 104.6 | 135.3 | 169.8 | 208.3 | 250.7 | 297.0 | 42 |
| 19 | 0.2 | 3.4 | 10.5 | 21.6 | 36.6 | 55.5 | 78.3 | 105.1 | 135.8 | 170.4 | 208.9 | 251.4 | 297.8 | 41 |
| 20 | 0.2 | 3.5 | 10.7 | 21.8 | 36.9 | 55.8 | 78.8 | 105.6 | 136.4 | 171.0 | 209.6 | 252.2 | 298.6 | 40 |
| 21 | 0.3 | 3.6 | 10.8 | 22.0 | 37.2 | 56.2 | 79.2 | 106.1 | 136.9 | 171.6 | 210.3 | 252.9 | 299.4 | 39 |
| 22 | 0.3 | 3.7 | 11.0 | 22.3 | 37.4 | 56.5 | 79.6 | 106.6 | 137.4 | 172.2 | 211.0 | 253.6 | 300.2 | 38 |
| 23 | 0.3 | 3.8 | 11.1 | 22.5 | 37.7 | 56.9 | 80.0 | 107.0 | 138.0 | 172.9 | 211.6 | 254.4 | 301.0 | 37 |
| 24 | 0.3 | 3.8 | 11.3 | 22.7 | 38.0 | 57.3 | 80.4 | 107.5 | 138.5 | 173.5 | 212.3 | 255.1 | 301.8 | 36 |
| 25 | 0.3 | 3.9 | 11.5 | 22.9 | 38.3 | 57.6 | 80.8 | 108.0 | 139.1 | 174.1 | 213.0 | 255.9 | 302.6 | 35 |
| 26 | 0.4 | 4.0 | 11.6 | 23.1 | 38.6 | 58.0 | 81.3 | 108.5 | 139.6 | 174.7 | 213.7 | 256.6 | 303.5 | 34 |
| 27 | 0.4 | 4.1 | 11.8 | 23.4 | 38.9 | 58.3 | 81.7 | 109.0 | 140.2 | 175.3 | 214.4 | 257.4 | 304.3 | 33 |
| 28 | 0.4 | 4.2 | 11.9 | 23.6 | 39.2 | 58.7 | 82.1 | 109.5 | 140.7 | 175.9 | 215.1 | 258.[illegible] | 305.1 | 32 |
| 29 | 0.5 | 4.3 | 12.1 | 23.8 | 39.5 | 59.0 | 82.5 | 110.0 | 141.3 | 176.6 | 215.8 | 258 9 | 305.9 | 31 |
| 30 | 0.5 | 4.4 | 12.3 | 24.0 | 39.8 | 59.4 | 83.0 | 110.4 | 141.8 | 177.2 | 216.4 | 259.6 | 306.7 | 30 |
| 31 | 0.5 | 4.5 | 12.4 | 24.3 | 40.1 | 59.8 | 83.4 | 110.9 | 142.4 | 177.8 | 217.1 | 260.4 | 307.5 | 29 |
| 32 | 0.6 | 4.6 | 12.6 | 24.5 | 40.3 | 60.1 | 83.8 | 111.4 | 143.0 | 178.4 | 217.8 | 261.1 | 308.4 | 28 |
| 33 | 0.6 | 4.7 | 12.8 | 24.7 | 40.6 | 60.5 | 84.2 | 111.9 | 143.5 | 179.0 | 218.5 | 261.9 | 309.2 | 27 |
| 34 | 0.6 | 4.8 | 12.9 | 25.0 | 40.9 | 60.8 | 84.7 | 112.4 | 144.1 | 179.7 | 219.2 | 262.6 | 310.0 | 26 |
| 35 | 0.7 | 4.9 | 13.1 | 25.2 | 41.2 | 61.2 | 85.1 | 112.9 | 144.6 | 180.3 | 219.9 | 263.4 | 310.8 | 25 |
| 36 | 0.7 | 5.0 | 13.3 | 25.4 | 41.5 | 61.6 | 85.5 | 113.4 | 145.2 | 180.9 | 220.6 | 264.1 | 311.6 | 24 |
| 37 | 0.7 | 5.1 | 13.4 | 25.7 | 41.8 | 61.9 | 86.0 | 113.9 | 145.8 | 181.6 | 221.3 | 264.9 | 312.5 | 23 |
| 38 | 0.8 | 5.2 | 13.6 | 25.9 | 42.1 | 62.3 | 86.4 | 114.4 | 146.3 | 182.2 | 222.0 | 265.7 | 313.3 | 22 |
| 39 | 0.8 | 5.3 | 13.8 | 26.2 | 42.5 | 62.7 | 86.8 | 114.9 | 146.9 | 182.8 | 222.7 | 266.4 | 314.2 | 21 |
| 40 | 0.9 | 5.4 | 14.0 | 26.4 | 42.8 | 63.0 | 87.3 | 115.4 | 147.5 | 183.4 | 223.4 | 267.2 | 315.0 | 20 |
| 41 | 0.9 | 5.6 | 14.1 | 26.6 | 43.1 | 63.4 | 87.7 | 115.9 | 148.0 | 184.1 | 224.1 | 267.9 | 315.8 | 19 |
| 42 | 1.0 | 5.7 | 14.3 | 26.9 | 43.4 | 63.8 | 88.1 | 116.4 | 148.6 | 184.7 | 224.8 | 268.7 | 316.6 | 18 |
| 43 | 1.0 | 5.8 | 14.5 | 27.1 | 43.7 | 64.2 | 88.6 | 116.9 | 149.2 | 185.4 | 225.5 | 269.5 | 317.4 | 17 |
| 44 | 1.1 | 5.9 | 14.7 | 27.4 | 44.0 | 64.5 | 89.0 | 117.4 | 149.7 | 186.0 | 226.2 | 270.2 | 318.3 | 16 |
| 45 | 1.1 | 6.0 | 14.8 | 27.6 | 44.3 | 64.9 | 89.5 | 117.9 | 150.3 | 186.6 | 226.9 | 271.0 | 319.1 | 15 |
| 46 | 1.2 | 6.1 | 15.0 | 27.9 | 44.6 | 65.3 | 89.9 | 118.4 | 150.9 | 187.3 | 227.6 | 271.8 | 319.9 | 14 |
| 47 | 1.2 | 6.2 | 15.2 | 28.1 | 44.9 | 65.7 | 90.3 | 118.9 | 151.5 | 187.9 | 228.3 | 272.6 | 320.8 | 13 |
| 48 | 1.3 | 6.4 | 15.4 | 28.3 | 45.2 | 66.0 | 90.8 | 119.5 | 152.0 | 188.5 | 229.0 | 273.3 | 321.6 | 12 |
| 49 | 1.3 | 6.5 | 15.6 | 28.6 | 45.5 | 66.4 | 91.2 | 120.0 | 152.6 | 189.2 | 229.7 | 274.1 | 322.4 | 11 |
| 50 | 1.4 | 6.6 | 15.8 | 28.8 | 45.9 | 66.8 | 91.7 | 120.5 | 153.2 | 189.8 | 230.4 | 274.9 | 323.3 | 10 |
| 51 | 1.4 | 6.7 | 15.9 | 29.1 | 46.2 | 67.2 | 92.1 | 121.0 | 153.8 | 190.5 | 231.1 | 275.6 | 324.1 | 9 |
| 52 | 1.5 | 6.8 | 16.1 | 29.4 | 46.5 | 67.6 | 92.6 | 121.5 | 154.4 | 191.1 | 231.8 | 276.4 | 325.0 | 8 |
| 53 | 1.5 | 7.0 | 16.3 | 29.6 | 46.8 | 68.0 | 93.0 | 122.0 | 154.9 | 191.8 | 232.5 | 277.2 | 325.8 | 7 |
| 54 | 1.6 | 7.1 | 16.5 | 29.9 | 47.1 | 68.3 | 93.5 | 122.5 | 155.5 | 192.4 | 233.3 | 278.0 | 326.7 | 6 |
| 55 | 1.6 | 7.2 | 16.7 | 30.1 | 47.5 | 68.7 | 93.9 | 123.1 | 156.1 | 193.1 | 234.0 | 278.9 | 327.5 | 5 |
| 56 | 1.7 | 7.3 | 16.9 | 30.4 | 47.8 | 69.1 | 94.4 | 123.6 | 156.7 | 193.7 | 234.7 | 279.5 | 328.4 | 4 |
| 57 | 1.8 | 7.5 | 17.1 | 30.6 | 48.1 | 69.5 | 94.8 | 124.1 | 157.3 | 194.4 | 235.4 | 280.3 | 329.2 | 3 |
| 58 | 1.8 | 7.6 | 17.3 | 30.9 | 48.4 | 69.9 | 95.3 | 124.6 | 157.8 | 195.0 | 236.1 | 281.1 | 330.0 | 2 |
| 59 | 1.9 | 7.7 | 17.5 | 31.1 | 48.8 | 70.3 | 95.7 | 125.1 | 158.4 | 195.7 | 236.8 | 281.9 | 330.9 | 1 |
| 60 | 2.0 | 7.8 | 17.7 | 31.4 | 49.1 | 70.7 | 96.2 | 125.7 | 159.0 | 196.3 | 237.5 | 282.7 | 331.8 | 0 |
| | 59m | 58m | 57m | 56m | 55m | 54m | 53m | 52m | 51m | 50m | 49m | 48m | 47m | s. |

11 Hours

## LIMITS, AT SEA, OF THE REDUCTION TO THE MERIDIAN.

| Lat. | Declination of the *same* Name as the Lat. 0° | 5° | 10° | 15° | 20° | 23° |
|---|---|---|---|---|---|---|
| 0° | 0h 0m | 0h 3m | 0h 5m | 0h 8m | 0h 11m | 0h 14m |
| 5 | 0 3 | 0 0 | 0 3 | 0 5 | 0 8 | 0 10 |
| 10 | 0 5 | 0 3 | 0 0 | 0 3 | 0 6 | 0 7 |
| 15 | 0 8 | 0 5 | 0 3 | 0 0 | 0 3 | 0 5 |
| 20 | 0 11 | 0 8 | 0 6 | 0 3 | 0 0 | 0 0 |
| 25 | 0 14 | 0 11 | 0 9 | 0 6 | 0 3 | 0 0 |
| 30 | 0 17 | 0 15 | 0 12 | 0 9 | 0 6 | 0 5 |
| 35 | 0 21 | 0 18 | 0 16 | 0 13 | 0 10 | 0 8 |
| 40 | 0 25 | 0 23 | 0 20 | 0 17 | 0 14 | 0 12 |
| 44 | 0 29 | 0 26 | 0 24 | 0 21 | 0 18 | 0 16 |
| 48 | 0 33 | 0 31 | 0 28 | 0 25 | 0 22 | 0 20 |
| 52 | 0 38 | 0 36 | 0 33 | 0 30 | 0 27 | 0 26 |
| 56 | 0 44 | 0 42 | 0 39 | 0 36 | 0 34 | 0 32 |
| 60 | 0 52 | 0 49 | 0 47 | 0 44 | 0 41 | 0 39 |
| 64 | 1 0 | 0 57 | 0 55 | 0 52 | 0 49 | 0 47 |
| 68 | 1 10 | 1 8 | 1 6 | 1 3 | 1 1 | 0 58 |

| Lat. | Declination of *contrary* Name to the Lat. | | | | | |
|---|---|---|---|---|---|---|
| 0 | 0 0 | 0 3 | 0 5 | 0 8 | 0 11 | 0 13 |
| 5 | 0 3 | 0 5 | 0 8 | 0 11 | 0 14 | 0 16 |
| 10 | 0 5 | 0 8 | 0 11 | 0 13 | 0 16 | 0 18 |
| 15 | 0 8 | 0 11 | 0 13 | 0 16 | 0 19 | 0 21 |
| 20 | 0 11 | 0 14 | 0 16 | 0 19 | 0 22 | 0 24 |
| 25 | 0 14 | 0 17 | 0 19 | 0 22 | 0 25 | 0 27 |
| 30 | 0 17 | 0 20 | 0 23 | 0 25 | 0 28 | 0 30 |
| 35 | 0 21 | 0 24 | 0 26 | 0 29 | 0 32 | 0 34 |
| 40 | 0 25 | 0 28 | 0 30 | 0 33 | 0 36 | 0 38 |
| 44 | 0 29 | 0 32 | 0 34 | 0 37 | 0 40 | 0 42 |
| 48 | 0 33 | 0 36 | 0 39 | 0 41 | 0 44 | 0 46 |
| 52 | 0 38 | 0 41 | 0 44 | 0 46 | 0 49 | 0 51 |
| 56 | 0 44 | 0 47 | 0 50 | 0 52 | 0 55 | 0 57 |
| 60 | 0 52 | 0 55 | 0 57 | 1 00 | 1 3 | 1 5 |
| 64 | 1 0 | 1 3 | 1 6 | while visible. | | |
| 68 | 1 10 | 1 13 | 1 16 | | | |

## VALUE OF THE REDUCTION, AT WHICH THE 2nd RED^n AMOUNTS TO 1″.

| Mer. Alt. | Reduc. | Mer. Alt. | Reduc |
|---|---|---|---|
| 5° | 4° 40′ | 45° | 1° 23′ |
| 6 | 4 16 | 46 | 1 21 |
| 7 | 3 57 | 47 | 1 20 |
| 8 | 3 41 | 48 | 1 19 |
| 9 | 3 28 | 49 | 1 17 |
| 10 | 3 18 | 50 | 1 16 |
| 11 | 3 8 | 51 | 1 15 |
| 12 | 3 0 | 52 | 1 13 |
| 13 | 2 53 | 53 | 1 12 |
| 14 | 2 46 | 54 | 1 11 |
| 15 | 2 40 | 55 | 1 9 |
| 16 | 2 35 | 56 | 1 8 |
| 17 | 2 30 | 57 | 1 7 |
| 18 | 2 25 | 58 | 1 6 |
| 19 | 2 21 | 59 | 1 4 |
| 20 | 2 17 | 60 | 1 3 |
| 21 | 2 14 | 61 | 1 2 |
| 22 | 2 10 | 62 | 1 0 |
| 23 | 2 7 | 63 | 0 59 |
| 24 | 2 4 | 64 | 0 58 |
| 25 | 2 2 | 65 | 0 57 |
| 26 | 1 59 | 66 | 0 55 |
| 27 | 1 56 | 67 | 0 54 |
| 28 | 1 54 | 68 | 0 53 |
| 29 | 1 51 | 69 | 0 52 |
| 30 | 1 49 | 70 | 0 50 |
| 31 | 1 47 | 71 | 0 49 |
| 32 | 1 45 | 72 | 0 47 |
| 33 | 1 43 | 73 | 0 46 |
| 34 | 1 41 | 74 | 0 44 |
| 35 | 1 39 | 75 | 0 43 |
| 36 | 1 37 | 76 | 0 41 |
| 37 | 1 36 | 77 | 0 40 |
| 38 | 1 34 | 78 | 0 38 |
| 39 | 1 32 | 79 | 0 37 |
| 40 | 1 31 | 80 | 0 35 |
| 41 | 1 29 | 81 | 0 33 |
| 42 | 1 27 | 82 | 0 31 |
| 43 | 1 26 | 83 | 0 29 |
| 44 | 1 24 | 84 | 0 27 |

## FOR COMPUTING THE REDUCTION TO THE MERIDIAN IN SECONDS

0 Hours

| s. | $0^m$ | $1^m$ | $2^m$ | $3^m$ | $4^m$ | $5^m$ | $6^m$ | $7^m$ | $8^m$ | $9^m$ | $10^m$ | $11^m$ | $12^m$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0″·0 | 2″·0 | 7″·8 | 17″·7 | 31″·4 | 49″·1 | 70″·7 | 96″·2 | 125″·7 | 159″·0 | 196″·3 | 237″·5 | 282″·7 | 60 |
| 1 | 0·0 | 2·0 | 8·0 | 17·9 | 31·7 | 49·4 | 71·1 | 96·6 | 126·2 | 159·6 | 197·0 | 238·3 | 283·5 | 59 |
| 2 | 0·0 | 2·1 | 8·1 | 18·1 | 31·9 | 49·7 | 71·5 | 97·1 | 126·7 | 160·2 | 197·6 | 239·0 | 284·2 | 58 |
| 3 | 0·0 | 2·2 | 8·2 | 18·3 | 32·2 | 50·1 | 71·9 | 97·6 | 127·2 | 160·8 | 198·3 | 239·7 | 285·0 | 57 |
| 4 | 0·0 | 2·2 | 8·4 | 18·5 | 32·5 | 50·4 | 72·3 | 98·1 | 127·8 | 161·4 | 198·9 | 240·4 | 285·8 | 56 |
| 5 | 0·0 | 2·3 | 8·5 | 18·7 | 32·7 | 50·7 | 72·7 | 98·5 | 128·3 | 162·0 | 199·6 | 241·2 | 286·6 | 55 |
| 6 | 0·0 | 2·4 | 8·7 | 18·9 | 33·0 | 51·1 | 73·1 | 99·0 | 128·8 | 162·6 | 200·3 | 241·9 | 287·4 | 54 |
| 7 | 0·0 | 2·4 | 8·8 | 19·1 | 33·3 | 51·4 | 73·5 | 99·4 | 129·4 | 163·2 | 200·9 | 242·6 | 288·2 | 53 |
| 8 | 0·0 | 2·5 | 8·9 | 19·3 | 33·5 | 51·7 | 73·9 | 99·9 | 129·9 | 163·8 | 201·6 | 243·3 | 289·0 | 52 |
| 9 | 0·0 | 2·6 | 9·1 | 19·5 | 33·8 | 52·1 | 74·3 | 100·4 | 130·4 | 164·4 | 202·2 | 244·1 | 289·8 | 51 |
| 10 | 0·0 | 2·7 | 9·2 | 19·7 | 34·1 | 52·4 | 74·7 | 100·8 | 131·0 | 165·0 | 202·9 | 244·8 | 290·6 | 50 |
| 11 | 0·1 | 2·7 | 9·4 | 19·9 | 34·4 | 52·7 | 75·1 | 101·3 | 131·5 | 165·6 | 203·6 | 245·5 | 291·4 | 49 |
| 12 | 0·1 | 2·8 | 9·5 | 20·1 | 34·6 | 53·1 | 75·5 | 101·8 | 132·0 | 166·2 | 204·2 | 246·2 | 292·2 | 48 |
| 13 | 0·1 | 2·9 | 9·6 | 20·3 | 34·9 | 53·4 | 75·9 | 102·3 | 132·6 | 166·8 | 204·9 | 247·0 | 293·0 | 47 |
| 14 | 0·1 | 3·0 | 9·8 | 20·5 | 35·2 | 53·8 | 76·3 | 102·7 | 133·1 | 167·4 | 205·6 | 247·7 | 293·8 | 46 |
| 15 | 0·1 | 3·1 | 9·9 | 20·7 | 35·5 | 54·1 | 76·7 | 103·2 | 133·6 | 168·0 | 206·3 | 248·5 | 294·6 | 45 |
| 16 | 0·1 | 3·1 | 10·1 | 20·9 | 35·7 | 54·5 | 77·1 | 103·7 | 134·2 | 168·6 | 206·9 | 249·2 | 295·4 | 44 |
| 17 | 0·2 | 3·2 | 10·2 | 21·2 | 36·0 | 54·8 | 77·5 | 104·2 | 134·7 | 169·2 | 207·6 | 249·9 | 296·2 | 43 |
| 18 | 0·2 | 3·3 | 10·4 | 21·4 | 36·3 | 55·1 | 77·9 | 104·6 | 135·3 | 169·8 | 208·3 | 250·7 | 297·0 | 42 |
| 19 | 0·2 | 3·4 | 10·5 | 21·6 | 36·6 | 55·5 | 78·3 | 105·1 | 135·8 | 170·4 | 208·9 | 251·4 | 297·8 | 41 |
| 20 | 0·2 | 3·5 | 10·7 | 21·8 | 36·9 | 55·8 | 78·8 | 105·6 | 136·4 | 171·0 | 209·6 | 252·2 | 298·6 | 40 |
| 21 | 0·3 | 3·6 | 10·8 | 22·0 | 37·2 | 56·2 | 79·2 | 106·1 | 136·9 | 171·6 | 210·3 | 252·9 | 299·4 | 39 |
| 22 | 0·3 | 3·7 | 11·0 | 22·3 | 37·4 | 56·5 | 79·6 | 106·6 | 137·4 | 172·2 | 211·0 | 253·6 | 300·2 | 38 |
| 23 | 0·3 | 3·8 | 11·1 | 22·5 | 37·7 | 56·9 | 80·0 | 107·0 | 138·0 | 172·9 | 211·6 | 254·4 | 301·0 | 37 |
| 24 | 0·3 | 3·8 | 11·3 | 22·7 | 38·0 | 57·3 | 80·4 | 107·5 | 138·5 | 173·5 | 212·3 | 255·1 | 301·8 | 36 |
| 25 | 0·3 | 3·9 | 11·5 | 22·9 | 38·3 | 57·6 | 80·8 | 108·0 | 139·1 | 174·1 | 213·0 | 255·9 | 302·6 | 35 |
| 26 | 0·4 | 4·0 | 11·6 | 23·1 | 38·6 | 58·0 | 81·3 | 108·5 | 139·6 | 174·7 | 213·7 | 256·6 | 303·5 | 34 |
| 27 | 0·4 | 4·1 | 11·8 | 23·4 | 38·9 | 58·3 | 81·7 | 109·0 | 140·2 | 175·3 | 214·4 | 257·4 | 304·3 | 33 |
| 28 | 0·4 | 4·2 | 11·9 | 23·6 | 39·2 | 58·7 | 82·1 | 109·5 | 140·7 | 175·9 | 215·1 | 258·[illegible] | 305·1 | 32 |
| 29 | 0·5 | 4·3 | 12·1 | 23·8 | 39·5 | 59·0 | 82·5 | 110·0 | 141·3 | 176·6 | 215·8 | 258·9 | 305·9 | 31 |
| 30 | 0·5 | 4·4 | 12·3 | 24·0 | 39·8 | 59·4 | 83·0 | 110·4 | 141·8 | 177·2 | 216·4 | 259·6 | 306·7 | 30 |
| 31 | 0·5 | 4·5 | 12·4 | 24·3 | 40·1 | 59·8 | 83·4 | 110·9 | 142·4 | 177·8 | 217·1 | 260·4 | 307·5 | 29 |
| 32 | 0·6 | 4·6 | 12·6 | 24·5 | 40·3 | 60·1 | 83·8 | 111·4 | 143·0 | 178·4 | 217·8 | 261·1 | 308·4 | 28 |
| 33 | 0·6 | 4·7 | 12·8 | 24·7 | 40·6 | 60·5 | 84·2 | 111·9 | 143·5 | 179·0 | 218·5 | 261·9 | 309·2 | 27 |
| 34 | 0·6 | 4·8 | 12·9 | 25·0 | 40·9 | 60·8 | 84·7 | 112·4 | 144·1 | 179·7 | 219·2 | 262·6 | 310·0 | 26 |
| 35 | 0·7 | 4·9 | 13·1 | 25·2 | 41·2 | 61·2 | 85·1 | 112·9 | 144·6 | 180·3 | 219·9 | 263·4 | 310·8 | 25 |
| 36 | 0·7 | 5·0 | 13·3 | 25·4 | 41·5 | 61·6 | 85·5 | 113·4 | 145·2 | 180·9 | 220·6 | 264·1 | 311·6 | 24 |
| 37 | 0·7 | 5·1 | 13·4 | 25·7 | 41·8 | 61·9 | 86·0 | 113·9 | 145·8 | 181·6 | 221·3 | 264·9 | 312·5 | 23 |
| 38 | 0·8 | 5·2 | 13·6 | 25·9 | 42·1 | 62·3 | 86·4 | 114·4 | 146·3 | 182·2 | 222·0 | 265·7 | 313·3 | 22 |
| 39 | 0·8 | 5·3 | 13·8 | 26·2 | 42·5 | 62·7 | 86·8 | 114·9 | 146·9 | 182·8 | 222·7 | 266·4 | 314·2 | 21 |
| 40 | 0·9 | 5·4 | 14·0 | 26·4 | 42·8 | 63·0 | 87·3 | 115·4 | 147·5 | 183·4 | 223·4 | 267·2 | 315·0 | 20 |
| 41 | 0·9 | 5·6 | 14·1 | 26·6 | 43·1 | 63·4 | 87·7 | 115·9 | 148·0 | 184·1 | 224·1 | 267·9 | 315·8 | 19 |
| 42 | 1·0 | 5·7 | 14·3 | 26·9 | 43·4 | 63·8 | 88·1 | 116·4 | 148·6 | 184·7 | 224·8 | 268·7 | 316·6 | 18 |
| 43 | 1·0 | 5·8 | 14·5 | 27·1 | 43·7 | 64·2 | 88·6 | 116·9 | 149·2 | 185·4 | 225·5 | 269·5 | 317·4 | 17 |
| 44 | 1·1 | 5·9 | 14·7 | 27·4 | 44·0 | 64·5 | 89·0 | 117·4 | 149·7 | 186·0 | 226·2 | 270·2 | 318·3 | 16 |
| 45 | 1·1 | 6·0 | 14·8 | 27·6 | 44·3 | 64·9 | 89·5 | 117·9 | 150·3 | 186·6 | 226·9 | 271·0 | 319·1 | 15 |
| 46 | 1·2 | 6·1 | 15·0 | 27·9 | 44·6 | 65·3 | 89·9 | 118·4 | 150·9 | 187·3 | 227·6 | 271·8 | 319·9 | 14 |
| 47 | 1·2 | 6·2 | 15·2 | 28·1 | 44·9 | 65·7 | 90·3 | 118·9 | 151·5 | 187·9 | 228·3 | 272·6 | 320·8 | 13 |
| 48 | 1·3 | 6·4 | 15·4 | 28·3 | 45·2 | 66·0 | 90·8 | 119·5 | 152·0 | 188·5 | 229·0 | 273·3 | 321·6 | 12 |
| 49 | 1·3 | 6·5 | 15·6 | 28·6 | 45·5 | 66·4 | 91·2 | 120·0 | 152·6 | 189·2 | 229·7 | 274·1 | 322·4 | 11 |
| 50 | 1·4 | 6·6 | 15·8 | 28·8 | 45·9 | 66·8 | 91·7 | 120·5 | 153·2 | 189·8 | 230·4 | 274·9 | 323·3 | 10 |
| 51 | 1·4 | 6·7 | 15·9 | 29·1 | 46·2 | 67·2 | 92·1 | 121·0 | 153·8 | 190·5 | 231·1 | 275·6 | 324·1 | 9 |
| 52 | 1·5 | 6·8 | 16·1 | 29·4 | 46·5 | 67·6 | 92·6 | 121·5 | 154·4 | 191·1 | 231·8 | 276·4 | 325·0 | 8 |
| 53 | 1·5 | 7·0 | 16·3 | 29·6 | 46·8 | 68·0 | 93·0 | 122·0 | 154·9 | 191·8 | 232·5 | 277·2 | 325·8 | 7 |
| 54 | 1·6 | 7·1 | 16·5 | 29·9 | 47·1 | 68·3 | 93·5 | 122·5 | 155·5 | 192·4 | 233·3 | 278·0 | 326·7 | 6 |
| 55 | 1·6 | 7·2 | 16·7 | 30·1 | 47·5 | 68·7 | 93·9 | 123·1 | 156·1 | 193·1 | 234·0 | 278·9 | 327·5 | 5 |
| 56 | 1·7 | 7·3 | 16·9 | 30·4 | 47·8 | 69·1 | 94·4 | 123·6 | 156·7 | 193·7 | 234·7 | 279·5 | 328·4 | 4 |
| 57 | 1·8 | 7·5 | 17·1 | 30·6 | 48·1 | 69·5 | 94·8 | 124·1 | 157·3 | 194·4 | 235·4 | 280·3 | 329·2 | 3 |
| 58 | 1·8 | 7·6 | 17·3 | 30·9 | 48·4 | 69·9 | 95·3 | 124·6 | 157·8 | 195·0 | 236·1 | 281·1 | 330·0 | 2 |
| 59 | 1·9 | 7·7 | 17·5 | 31·1 | 48·8 | 70·3 | 95·7 | 125·1 | 158·4 | 195·7 | 236·8 | 281·9 | 330·9 | 1 |
| 60 | 2·0 | 7·8 | 17·7 | 31·4 | 49·1 | 70·7 | 96·2 | 125·7 | 159·0 | 196·3 | 237·5 | 282·7 | 331·8 | 0 |
| | $59^m$ | $58^m$ | $57^m$ | $56^m$ | $55^m$ | $54^m$ | $53^m$ | $52^m$ | $51^m$ | $50^m$ | $49^m$ | $48^m$ | $47^m$ | s. |

11 Hours

## FOR COMPUTING THE REDUCTION TO THE MERIDIAN IN SECONDS

**0 Hours**

| s. | 13m | 14m | 15m | 16m | 17m | 18m | 19m | 20m | 21m | 22m | 23m | 24m | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 331″·8 | 384″·7 | 441″·6 | 502″·5 | 567″·1 | 635″·8 | 708″·3 | 784″·9 | 865″·3 | 949″·6 | 1037″·8 | 1129″·9 | 60 |
| 1 | 332·6 | 385·6 | 442·6 | 503·5 | 568·2 | 636·9 | 709·5 | 786·2 | 866·6 | 951·0 | 1039·3 | 1131·4 | 59 |
| 2 | 333·4 | 386·5 | 443·6 | 504·6 | 569·3 | 638·1 | 710·8 | 787·5 | 868·0 | 952·4 | 1040·8 | 1133·0 | 58 |
| 3 | 334·3 | 387·5 | 444·6 | 505·6 | 570·4 | 639·3 | 712·1 | 788·8 | 869·4 | 953·8 | 1042·3 | 1134·6 | 57 |
| 4 | 335·2 | 388·4 | 445·6 | 506·7 | 571·6 | 640·5 | 713·4 | 790·1 | 870·8 | 955·3 | 1043·8 | 1136·2 | 56 |
| 5 | 336·0 | 389·3 | 446·5 | 507·7 | 572·7 | 641·7 | 714·6 | 791·4 | 872·1 | 956·7 | 1045·3 | 1137·8 | 55 |
| 6 | 336·9 | 390·2 | 447·5 | 508·8 | 573·8 | 642·9 | 715·9 | 792·7 | 873·5 | 958·2 | 1046·8 | 1139·3 | 54 |
| 7 | 337·7 | 391·1 | 448·5 | 509·8 | 574·9 | 644·1 | 717·1 | 794·0 | 874·9 | 959·6 | 1048·3 | 1140·9 | 53 |
| 8 | 338·6 | 392·1 | 449·5 | 510·9 | 576·1 | 645·3 | 718·4 | 795·4 | 876·3 | 961·1 | 1049·8 | 1142·5 | 52 |
| 9 | 339·4 | 393·0 | 450·5 | 511·9 | 577·2 | 646·4 | 719·6 | 796·7 | 877·6 | 962·5 | 1051·3 | 1144·0 | 51 |
| 10 | 340·3 | 393·9 | 451·5 | 513·0 | 578·3 | 647·6 | 720·9 | 798·0 | 879·0 | 963·9 | 1052·8 | 1145·6 | 50 |
| 11 | 341·2 | 394·8 | 452·5 | 514·0 | 579·4 | 648·8 | 722·1 | 799·3 | 880·4 | 965·4 | 1054·3 | 1147·2 | 49 |
| 12 | 342·0 | 395·8 | 453·5 | 515·1 | 580·6 | 650·0 | 723·4 | 800·7 | 881·8 | 966·9 | 1055·9 | 1148·8 | 48 |
| 13 | 342·9 | 396·7 | 454·5 | 516·1 | 581·7 | 651·2 | 724·6 | 802·0 | 883·2 | 968·3 | 1057·4 | 1150·4 | 47 |
| 14 | 343·7 | 397·6 | 455·5 | 517·2 | 582·8 | 652·4 | 725·9 | 803·3 | 884·6 | 969·8 | 1058·9 | 1152·0 | 46 |
| 15 | 344·6 | 398·6 | 456·5 | 518·3 | 583·9 | 653·6 | 727·1 | 804·6 | 886·0 | 971·2 | 1060·4 | 1153·6 | 45 |
| 16 | 345·5 | 399·5 | 457·5 | 519·4 | 585·1 | 654·8 | 728·4 | 806·0 | 887·4 | 972·7 | 1062·0 | 1155·2 | 44 |
| 17 | 346·3 | 400·5 | 458·5 | 520·4 | 586·2 | 656·0 | 729·6 | 807·3 | 888·8 | 974·1 | 1063·5 | 1156·8 | 43 |
| 18 | 347·2 | 401·4 | 459·5 | 521·4 | 587·3 | 657·2 | 730·9 | 808·6 | 890·2 | 975·5 | 1065·0 | 1158·3 | 42 |
| 19 | 348·1 | 402·3 | 460·5 | 522·5 | 588·4 | 658·4 | 732·2 | 809·9 | 891·6 | 977·0 | 1066·5 | 1159·9 | 41 |
| 20 | 349·0 | 403·3 | 461·5 | 523·5 | 589·6 | 659·6 | 733·5 | 811·3 | 893·0 | 978·5 | 1068·1 | 1161·5 | 40 |
| 21 | 349·8 | 404·2 | 462·5 | 524·6 | 590·7 | 660·8 | 734·7 | 812·6 | 894·4 | 979·9 | 1069·6 | 1163·1 | 39 |
| 22 | 350·7 | 405·1 | 463·5 | 525·7 | 591·9 | 662·0 | 736·0 | 813·9 | 895·8 | 981·4 | 1071·1 | 1164·7 | 38 |
| 23 | 351·6 | 406·0 | 464·5 | 526·8 | 593·0 | 663·2 | 737·2 | 815·2 | 897·2 | 982·9 | 1072·6 | 1166·3 | 37 |
| 24 | 352·5 | 407·0 | 465·5 | 527·9 | 594·1 | 664·4 | 738·5 | 816·6 | 898·6 | 984·4 | 1074·2 | 1167·9 | 36 |
| 25 | 353·3 | 408·0 | 466·5 | 528·9 | 595·2 | 665·6 | 739·7 | 817·9 | 900·0 | 985·8 | 1075·7 | 1169·5 | 35 |
| 26 | 354·2 | 408·9 | 467·5 | 530·0 | 596·4 | 666·8 | 741·0 | 819·2 | 901·4 | 987·3 | 1077·2 | 1171·1 | 34 |
| 27 | 355·1 | 409·9 | 468·5 | 531·1 | 597·5 | 668·0 | 742·3 | 820·5 | 902·8 | 988·8 | 1078·7 | 1172·7 | 33 |
| 28 | 356·0 | 410·8 | 469·5 | 532·2 | 598·7 | 669·2 | 743·6 | 821·9 | 904·2 | 990·3 | 1080·3 | 1174·8 | 32 |
| 29 | 356·9 | 411·7 | 470·5 | 533·2 | 599·8 | 670·4 | 744·8 | 823·2 | 905·6 | 991·8 | 1081·8 | 1175·9 | 31 |
| 30 | 357·7 | 412·7 | 471·5 | 534·3 | 601·0 | 671·6 | 745·[illegible] | 824·6 | 907·0 | 993·2 | 1083·3 | 1177·5 | 30 |
| 31 | 358·6 | 413·6 | 472·6 | 535·4 | 602·1 | 672·8 | 747·4 | 825·9 | 908·4 | 994·7 | 1084·8 | 1179·1 | 29 |
| 32 | 359·5 | 414·6 | 473·6 | 536·5 | 603·3 | 674·1 | 748·7 | 827·3 | 909·8 | 996·2 | 1086·4 | 1180·7 | 28 |
| 33 | 360·3 | 415·6 | 474·6 | 537·5 | 604·4 | 675·3 | 749·9 | 828·6 | 911·2 | 997·6 | 1087·9 | 1182·3 | 27 |
| 34 | 361·2 | 416·6 | 475·6 | 538·6 | 605·6 | 676·5 | 751·2 | 829·9 | 912·6 | 999·1 | 1089·5 | 1183·9 | 26 |
| 35 | 362·1 | 417·5 | 476·6 | 539·7 | 606·7 | 677·7 | 752·5 | 831·2 | 914·0 | 1000·6 | 1091·0 | 1185·5 | 25 |
| 36 | 363·0 | 418·4 | 477·6 | 540·8 | 607·9 | 678·9 | 753·8 | 832·6 | 915·5 | 1002·1 | 1092·6 | 1187·1 | 24 |
| 37 | 363·9 | 419·4 | 478·7 | 541·9 | 609·0 | 680·1 | 755·0 | 833·9 | 916·9 | 1003·5 | 1094·1 | 1188·7 | 23 |
| 38 | 364·8 | 420·3 | 479·7 | 543·0 | 610·2 | 681·3 | 756·3 | 835·3 | 918·3 | 1005·0 | 1095·7 | 1190·3 | 22 |
| 39 | 365·7 | 421·3 | 480·7 | 544·1 | 611·3 | 682·5 | 757·6 | 836·6 | 919·7 | 1006·5 | 109[illegible]·2 | 1191·9 | 21 |
| 40 | 366·5 | 422·2 | 481·7 | 545·2 | 612·5 | 683·8 | 758·9 | 838·0 | 921·1 | 1008·0 | 1098·8 | 1193·5 | 20 |
| 41 | 367·5 | 423·2 | 482·8 | 546·2 | 613·6 | 685·0 | 760·2 | 839·3 | 922·5 | 1009·4 | 1100·3 | 1195·1 | 19 |
| 42 | 368·4 | 424·2 | 483·8 | 547·3 | 614·8 | 686·2 | 761·5 | 840·7 | 923·9 | 1010·9 | 1101·9 | 1196·7 | 18 |
| 43 | 369·3 | 425·1 | 484·8 | 548·4 | 615·9 | 687·4 | 762·8 | 842·0 | 925·3 | 1012·4 | 1103·4 | 1198·3 | 17 |
| 44 | 370·2 | 426·1 | 485·8 | 549·5 | 617·1 | 688·7 | 764·0 | 843·4 | 926·8 | 1013·9 | 1105·0 | 1199·9 | 16 |
| 45 | 371·1 | 427·0 | 486·9 | 550·6 | 618·2 | 689·9 | 765·3 | 844·7 | 928·2 | 1015·4 | 1106·5 | 1201·5 | 15 |
| 46 | 372·0 | 428·0 | 487·9 | 551·7 | 619·4 | 691·1 | 766·6 | 846·1 | 929·6 | 1016·9 | 1108·1 | 1203·1 | 14 |
| 47 | 372·9 | 429·0 | 488·9 | 552·8 | 620·5 | 692·3 | 767·9 | 847·5 | 931·0 | 1018·4 | 1109·6 | 1204·7 | 13 |
| 48 | 373·8 | 430·0 | 490·0 | 553·9 | 621·7 | 693·6 | 769·2 | 848·9 | 932·4 | 1019·9 | 1111·2 | 1206·4 | 12 |
| 49 | 374·7 | 430·9 | 491·0 | 55[illegible]·0 | 622·8 | 694·8 | 770·5 | 850·2 | 933·8 | 1021·4 | 1112·7 | 1208·0 | 11 |
| 50 | 375·6 | 431·9 | 492·0 | 556·1 | 624·0 | 696·0 | 771·8 | 851·6 | 935·2 | 1022·8 | 1114·3 | 1209·6 | 10 |
| 51 | 376·5 | 432·8 | 493·1 | 557·2 | 625·2 | 697·2 | 773·1 | 852·9 | 936·6 | 1024·3 | 1115·8 | 1211·2 | 9 |
| 52 | 377·4 | 433·8 | 494·1 | 558·3 | 626·4 | 698·4 | 774·5 | 854·3 | 938·1 | 1025·8 | 1117·4 | 1212·0 | 8 |
| 53 | 378·3 | 434·8 | 495·2 | 559·4 | 627·5 | 699·6 | 775·8 | 855·6 | 939·5 | 1027·3 | 1118·9 | 1214·5 | 7 |
| 54 | 379·2 | 435·7 | 496·2 | 560·5 | 628·7 | 700·9 | 777·1 | 857·1 | 940·9 | 1028·8 | 1120·5 | 1216·1 | 6 |
| 55 | 380·2 | 436·7 | 497·2 | 561·6 | 629·9 | 702·2 | 778·4 | 858·4 | 942·3 | 1030·3 | 1122·0 | 1217·7 | 5 |
| 56 | 381·1 | 437·7 | 498·2 | 562·7 | 631·1 | 703·5 | 779·7 | 859·8 | 943·8 | 1031·8 | 1123·6 | 1218·4 | 4 |
| 57 | 382·0 | 438·7 | 499·2 | 563·8 | 632·2 | 704·7 | 781·0 | 861·1 | 945·2 | 1033·3 | 1125·1 | 1221·0 | 3 |
| 58 | 382·9 | 439·6 | 500·3 | 564·9 | 633·4 | 705·9 | 782·3 | 862·5 | 946·6 | 1034·8 | 1126·7 | 1222·6 | 2 |
| 59 | 383·8 | 440·6 | 501·4 | 566·0 | 634·6 | 707·1 | 783·6 | 863·9 | 948·1 | 1036·3 | 1128·3 | 1224·2 | 1 |
| 60 | 384·7 | 441·6 | 502·5 | 567·1 | 635·8 | 708·3 | 784·9 | 865·3 | 949·6 | 1037·8 | 1129·9 | 1225·9 | 0 |
| | 46m | 45m | 44m | 43m | 42m | 41m | 40m | 39m | 38m | 37m | 36m | 35m | s. |

**11 Hours**

## TABLE 49

**For Computing the Red^n to the Mer^n in Sec^ds.**

**0 Hours**

| s. | 25m | 26m | 27m | 28m | 29m | 30m | |
|---|---|---|---|---|---|---|---|
| 0 | 1225·9 | 1325·9 | 1429·7 | 1537·5 | 1649·0 | 1764·6 | 60 |
| 1 | 1227·5 | 1327·6 | 1431·4 | 1539·3 | 1650·9 | 1766·6 | 59 |
| 2 | 1229·2 | 1329·3 | 1433·2 | 1541·1 | 1652·8 | 1768·5 | 58 |
| 3 | 1230·8 | 1331·0 | 1434·9 | 1542·9 | 1654·7 | 1770·5 | 57 |
| 4 | 1232·5 | 1332·7 | 1436·7 | 1544·8 | 1656·6 | 1772·4 | 56 |
| 5 | 1234·1 | 1334·4 | 1438·5 | 1546·6 | 1658·5 | 1774·4 | 55 |
| 6 | 1235·7 | 1336·1 | 1440·3 | 1548·4 | 1660·4 | 1776·3 | 54 |
| 7 | 1237·3 | 1337·8 | 1442·1 | 1550·2 | 1662·3 | 1778·3 | 53 |
| 8 | 1239·0 | 1339·5 | 1443·9 | 1552·1 | 1664·2 | 1780·3 | 52 |
| 9 | 1240·6 | 1341·2 | 1445·6 | 1553·9 | 1666·1 | 1782·3 | 51 |
| 10 | 1242·3 | 1342·9 | 1447·4 | 1555·8 | 1668·0 | 1784·2 | 50 |
| 11 | 1243·9 | 1344·6 | 1449·2 | 1557·6 | 1669·9 | 1786·2 | 49 |
| 12 | 1245·6 | 1346·3 | 1451·0 | 1559·5 | 1671·9 | 1788·2 | 48 |
| 13 | 1247·2 | 1348·0 | 1452·8 | 1561·3 | 1673·8 | 1790·1 | 47 |
| 14 | 1248·9 | 1349·7 | 1454·5 | 1563·2 | 1675·7 | 1792·1 | 46 |
| 15 | 1250·5 | 1351·4 | 1456·3 | 1565·0 | 1677·6 | 1794·1 | 45 |
| 16 | 1252·2 | 1353·2 | 1458·1 | 1566·9 | 1679·5 | 1796·1 | 44 |
| 17 | 1253·8 | 1354·9 | 1459·9 | 1568·7 | 1681·4 | 1798·1 | 43 |
| 18 | 1255·5 | 1356·6 | 1461·6 | 1570·5 | 1683·3 | 1800·0 | 42 |
| 19 | 1257·1 | 1358·3 | 1463·4 | 1572·4 | 1685·2 | 1802·0 | 41 |
| 20 | 1258·8 | 1360·1 | 1465·2 | 1574·3 | 1687·2 | 1804·0 | 40 |
| 21 | 1260·4 | 1361·8 | 1466·9 | 1576·1 | 1689·1 | 1805·9 | 39 |
| 22 | 1262·1 | 1363·5 | 1468·7 | 1578·0 | 1691·0 | 1807·9 | 38 |
| 23 | 1263·7 | 1365·2 | 1470·5 | 1579·8 | 1692·9 | 1809·9 | 37 |
| 24 | 1265·4 | 1367·0 | 1472·3 | 1581·7 | 1694·8 | 1811·9 | 36 |
| 25 | 1267·0 | 1368·7 | 1474·0 | 1583·5 | 1696·7 | 1813·9 | 35 |
| 26 | 1268·7 | 1370·4 | 1475·9 | 1585·3 | 1698·6 | 1815·8 | 34 |
| 27 | 1270·3 | 1372·1 | 1477·7 | 1587·2 | 1700·5 | 1817·8 | 33 |
| 28 | 1272·0 | 1373·9 | 1479·5 | 1589·1 | 1702·5 | 1819·8 | 32 |
| 29 | 1273·7 | 1375·6 | 1481·3 | 1590·9 | 1704·4 | 1821·8 | 31 |
| 30 | 1275·4 | 1377·4 | 1483·1 | 1592·7 | 1706·3 | 1823·8 | 30 |
| 31 | 1277·1 | 1379·1 | 1484·9 | 1594·6 | 1708·2 | 1825·8 | 29 |
| 32 | 1278·8 | 1380·8 | 1486·7 | 1596·5 | 1710·2 | 1827·8 | 28 |
| 33 | 1280·4 | 1382·5 | 1488·5 | 1598·3 | 1712·1 | 1829·8 | 27 |
| 34 | 1282·1 | 1384·2 | 1490·3 | 1600·2 | 1714·0 | 1831·8 | 26 |
| 35 | 1283·8 | 1385·9 | 1492·1 | 1602·1 | 1715·9 | 1833·8 | 25 |
| 36 | 1285·5 | 1387·7 | 1493·9 | 1604·0 | 1717·9 | 1835·8 | 24 |
| 37 | 1287·1 | 1389·4 | 1495·7 | 1605·9 | 1719·8 | 1837·8 | 23 |
| 38 | 1288·8 | 1391·2 | 1497·5 | 1607·7 | 1721·7 | 1839·8 | 22 |
| 39 | 1290·5 | 1392·9 | 1499·3 | 1609·6 | 1723·6 | 1841·8 | 21 |
| 40 | 1292·2 | 1394·7 | 1501·1 | 1611·5 | 1725·6 | 1843·8 | 20 |
| 41 | 1293·8 | 1396·4 | 1502·9 | 1613·3 | 1727·5 | 1845·8 | 19 |
| 42 | 1295·5 | 1398·2 | 1504·7 | 1615·2 | 1729·5 | 1847·8 | 18 |
| 43 | 1297·2 | 1399·9 | 1506·5 | 1617·1 | 1731·5 | 1849·8 | 17 |
| 44 | 1298·9 | 1401·7 | 1508·4 | 1619·0 | 1733·4 | 1851·8 | 16 |
| 45 | 1300·5 | 1403·4 | 1510·2 | 1620·8 | 1735·3 | 1853·8 | 15 |
| 46 | 1302·2 | 1405·2 | 1512·0 | 1622·7 | 1737·2 | 1855·8 | 14 |
| 47 | 1303·9 | 1406·9 | 1513·8 | 1624·6 | 1739·2 | 1857·8 | 13 |
| 48 | 1305·6 | 1408·7 | 1515·6 | 1626·5 | 1741·2 | 1859·8 | 12 |
| 49 | 1307·3 | 1410·4 | 1517·4 | 1628·3 | 1743·1 | 1861·8 | 11 |
| 50 | 1309·0 | 1412·2 | 1519·2 | 1630·2 | 1745·1 | 1863·8 | 10 |
| 51 | 1310·7 | 1413·9 | 1521·0 | 1632·1 | 1747·0 | 1865·8 | 9 |
| 52 | 1312·4 | 1415·7 | 1522·9 | 1634·0 | 1749·0 | 1867·8 | 8 |
| 53 | 1314·1 | 1417·4 | 1524·7 | 1635·9 | 1750·9 | 1869·8 | 7 |
| 54 | 1315·7 | 1419·2 | 1526·5 | 1637·7 | 1752·9 | 1871·8 | 6 |
| 55 | 1317·4 | 1420·9 | 1528·3 | 1639·6 | 1754·8 | 1873·8 | 5 |
| 56 | 1319·1 | 1422·7 | 1530·2 | 1641·5 | 1756·8 | 1875·9 | 4 |
| 57 | 1320·8 | 1424·4 | 1532·0 | 1643·3 | 1758·7 | 1877·9 | 3 |
| 58 | 1322·5 | 1426·2 | 1533·8 | 1645·2 | 1760·7 | 1879·9 | 2 |
| 59 | 1324·2 | 1427·9 | 1535·6 | 1647·1 | 1762·6 | 1882·0 | 1 |
| 60 | 1325·9 | 1429·7 | 1537·5 | 1649·0 | 1764·6 | 1884·0 | 0 |
| | 31m | 33m | 32m | 31m | 30m | 29m | s. |

**11 Hours**

## TABLE 50

**For COMPUTING THE 2d REDUCTION IN SECONDS**

| Hour Angle. | 2nd Red. | Hour Angle. | 2nd Red. |
|---|---|---|---|
| 10m 0s | 0·1 | 23m 50s | 3·0 |
| 11 0 | 0·1 | 24 0 | 3·1 |
| 11 30 | 0·2 | 24 10 | 3·2 |
| 12 0 | 0·2 | 24 20 | 3·3 |
| 12 30 | 0·2 | 24 30 | 3·4 |
| 13 0 | 0·3 | 24 40 | 3·4 |
| 13 30 | 0·3 | 24 50 | 3·5 |
| 14 0 | 0·4 | 25 0 | 3·6 |
| 14 30 | 0·4 | 25 10 | 3·7 |
| 15 0 | 0·5 | 25 20 | 3·8 |
| 15 30 | 0·5 | 25 30 | 3·9 |
| 16 0 | 0·6 | 25 40 | 4·0 |
| 16 30 | 0·7 | 25 50 | 4·1 |
| 17 0 | 0·8 | 26 0 | 4·3 |
| 17 30 | 0·9 | 26 10 | 4·4 |
| 18 0 | 1·0 | 26 20 | 4·5 |
| 18 30 | 1·1 | 26 30 | 4·6 |
| 19 0 | 1·2 | 26 40 | 4·7 |
| 19 30 | 1·3 | 26 50 | 4·8 |
| 19 40 | 1·4 | 27 0 | 5·0 |
| 19 50 | 1·4 | 27 10 | 5·1 |
| 20 0 | 1·5 | 27 20 | 5·2 |
| 20 10 | 1·5 | 27 30 | 5·3 |
| 20 20 | 1·6 | 27 40 | 5·5 |
| 20 30 | 1·6 | 27 50 | 5·6 |
| 20 40 | 1·7 | 28 0 | 5·7 |
| 20 50 | 1·8 | 28 10 | 5·9 |
| 21 0 | 1·8 | 28 20 | 6·0 |
| 21 10 | 1·9 | 28 30 | 6·1 |
| 21 20 | 1·9 | 28 40 | 6·3 |
| 21 30 | 2·0 | 28 50 | 6·4 |
| 21 40 | 2·1 | 29 0 | 6·6 |
| 21 50 | 2·1 | 29 10 | 6·7 |
| 22 0 | 2·2 | 29 20 | 6·9 |
| 22 10 | 2·2 | 29 30 | 7·1 |
| 22 20 | 2·3 | 29 40 | 7·2 |
| 22 30 | 2·4 | 29 50 | 7·4 |
| 22 40 | 2·5 | 30 0 | 7·5 |
| 22 50 | 2·5 | 30 10 | 7·6 |
| 23 0 | 2·6 | 30 20 | 7·9 |
| 23 10 | 2·7 | 30 30 | 8·1 |
| 23 20 | 2·8 | 30 40 | 8·2 |
| 23 30 | 2·8 | 30 50 | 8·4 |
| 23 40 | 2·9 | 31 0 | 8·6 |

CORRECTION OF THE ALTITUDE OF THE POLE-STAR FOR 1890.

| R.A. Mer. | Altitudes 0° | 30° | 50° | 70° | 80° | R.A. Mer. | Altitudes 0° | 30° | 50° | 70° | 80° | Var. in 10 Years. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| h m | sub. | sub. | sub. | sub. | sub. | h m | add | add | add | add | add | sub. |
| 0 0 | 1°13′ | 1°13′ | 1°13′ | 1°13′ | 1°13′ | 12 0 | 1°13′ | 1°13′ | 1°13′ | 1°14′ | 1°14′ | 3′ |
| 0 30 | 1 15 | 1 15 | 1 15 | 1 15 | 1 15 | 12 30 | 1 15 | 1 15 | 1 15 | 1 15 | 1 16 | 3 |
| 1 0 | 1 17 | 1 17 | 1 17 | 1 17 | 1 17 | 13 0 | 1 17 | 1 17 | 1 17 | 1 17 | 1 17 | 3 |
| 1 30 | 1 17 | 1 17 | 1 17 | 1 17 | 1 17 | 13 30 | 1 17 | 1 17 | 1 17 | 1 17 | 1 17 | 3 |
| 2 0 | 1 16 | 1 16 | 1 16 | 1 16 | 1 16 | 14 0 | 1 16 | 1 16 | 1 16 | 1 16 | 1 16 | 3 |
| 2 20 | 1 14 | 1 14 | 1 14 | 1 14 | 1 13 | 14 20 | 1 14 | 1 14 | 1 14 | 1 14 | 1 14 | 3 |
| 2 40 | 1 12 | 1 12 | 1 12 | 1 12 | 1 11 | 14 40 | 1 12 | 1 12 | 1 12 | 1 12 | 1 13 | 3 |
| 3 0 | 1 9 | 1 9 | 1 9 | 1 9 | 1 8 | 15 0 | 1 9 | 1 9 | 1 9 | 1 10 | 1 10 | 2 |
| 3 10 | 1 7 | 1 7 | 1 7 | 1 7 | 1 6 | 15 10 | 1 7 | 1 8 | 1 8 | 1 8 | 1 9 | 2 |
| 3 20 | 1 6 | 1 5 | 1 5 | 1 5 | 1 4 | 15 20 | 1 6 | 1 6 | 1 6 | 1 6 | 1 7 | 2 |
| 3 30 | 1 5 | 1 4 | 1 4 | 1 4 | 1 3 | 15 30 | 1 5 | 1 5 | 1 5 | 1 5 | 1 6 | 2 |
| 3 40 | 1 3 | 1 3 | 1 2 | 1 2 | 1 1 | 15 40 | 1 3 | 1 3 | 1 3 | 1 4 | 1 5 | 2 |
| 3 50 | 1 0 | 1 0 | 1 0 | 1 0 | 0 58 | 15 50 | 1 0 | 1 1 | 1 1 | 1 1 | 1 3 | 2 |
| 4 0 | 0 58 | 0 58 | 0 58 | 0 57 | 0 56 | 16 0 | 0 58 | 0 59 | 0 59 | 0 59 | 1 1 | 2 |
| 4 10 | 0 56 | 0 56 | 0 55 | 0 55 | 0 53 | 16 10 | 0 56 | 0 56 | 0 56 | 0 57 | 0 59 | 1 |
| 4 20 | 0 54 | 0 54 | 0 54 | 0 53 | 0 52 | 16 20 | 0 54 | 0 55 | 0 55 | 0 56 | 0 57 | 1 |
| 4 30 | 0 52 | 0 51 | 0 51 | 0 50 | 0 49 | 16 30 | 0 52 | 0 52 | 0 52 | 0 53 | 0 55 | 1 |
| 4 40 | 0 49 | 0 49 | 0 48 | 0 48 | 0 46 | 16 40 | 0 49 | 0 49 | 0 50 | 0 51 | 0 52 | 1 |
| 4 50 | 0 46 | 0 46 | 0 45 | 0 45 | 0 43 | 16 50 | 0 46 | 0 47 | 0 47 | 0 48 | 0 50 | 1 |
| 5 0 | 0 44 | 0 44 | 0 44 | 0 43 | 0 41 | 17 0 | 0 44 | 0 45 | 0 45 | 0 46 | 0 48 | 1 |
| 5 10 | 0 41 | 0 41 | 0 41 | 0 40 | 0 37 | 17 10 | 0 41 | 0 42 | 0 42 | 0 43 | 0 45 | 1 |
| 5 20 | 0 38 | 0 38 | 0 38 | 0 36 | 0 34 | 17 20 | 0 38 | 0 39 | 0 39 | 0 40 | 0 43 | 0 |
| 5 30 | 0 35 | 0 35 | 0 34 | 0 33 | 0 31 | 17 30 | 0 35 | 0 36 | 0 36 | 0 37 | 0 41 | 0 |
| 5 40 | 0 32 | 0 32 | 0 31 | 0 30 | 0 28 | 17 40 | 0 32 | 0 33 | 0 33 | 0 34 | 0 37 | 0 |
| 5 50 | 0 29 | 0 28 | 0 28 | 0 27 | 0 24 | 17 50 | 0 29 | 0 29 | 0 30 | 0 31 | 0 33 | 0 |
| 6 0 | 0 26 | 0 25 | 0 25 | 0 23 | 0 21 | 18 0 | 0 26 | 0 26 | 0 27 | 0 28 | 0 30 | 0 |
| 6 10 | 0 22 | 0 22 | 0 21 | 0 20 | 0 17 | 18 10 | 0 22 | 0 23 | 0 23 | 0 25 | 0 27 | 0 |
| 6 20 | 0 19 | 0 18 | 0 18 | 0 16 | 0 14 | 18 20 | 0 19 | 0 19 | 0 20 | 0 21 | 0 24 | 0 |
| 6 30 | 0 16 | 0 16 | 0 15 | 0 14 | 0 11 | 18 30 | 0 16 | 0 17 | 0 17 | 0 19 | 0 21 | 0 |
| 6 40 | 0 13 | 0 12 | 0 12 | 0 10 | 0 8 | 18 40 | 0 13 | 0 13 | 0 14 | 0 15 | 0 18 | 0 |
| 6 50 | 0 9 | 0 9 | 0 8 | 0 7 | 0 4 | 18 50 | 0 9 | 0 10 | 0 11 | 0 12 | 0 15 | 0 |
| 7 0 | 0 6 | 0 5 | 0 5 | 0 3 | 0 1 | 19 0 | 0 6 | 0 6 | 0 7 | 0 9 | 0 11 | 0 |
| | | | | add | add | | | | | | | |
| 7 10 | 0 3 | 0 3 | 0 2 | 0 1 | 0 3 | 19 10 | 0 3 | 0 4 | 0 5 | 0 6 | 0 9 | 0 |
| | add | add | add | | | | sub. | sub. | | | | |
| 7 20 | 0 1 | 0 2 | 0 2 | 0 4 | 0 6 | 19 20 | 0 1 | 0 1 | 0 0 | 0 1 | 0 4 | 1 |
| | | | | | | | | | sub. | sub. | | |
| 7 30 | 0 4 | 0 4 | 0 5 | 0 6 | 0 9 | 19 30 | 0 4 | 0 3 | 0 2 | 0 1 | 0 2 | 1 |
| | | | | | | | | | | | sub. | |
| 7 40 | 0 7 | 0 8 | 0 8 | 0 10 | 0 12 | 19 40 | 0 7 | 0 7 | 0 6 | 0 5 | 0 2 | 1 |
| 7 50 | 0 11 | 0 11 | 0 12 | 0 13 | 0 16 | 19 50 | 0 11 | 0 10 | 0 9 | 0 8 | 0 5 | 2 |
| 8 0 | 0 14 | 0 15 | 0 15 | 0 17 | 0 19 | 20 0 | 0 14 | 0 14 | 0 13 | 0 12 | 0 9 | 2 |
| 8 10 | 0 17 | 0 18 | 0 18 | 0 20 | 0 22 | 20 10 | 0 17 | 0 17 | 0 16 | 0 15 | 0 12 | 2 |
| 8 20 | 0 21 | 0 21 | 0 22 | 0 23 | 0 26 | 20 20 | 0 21 | 0 20 | 0 20 | 0 18 | 0 16 | 2 |
| 8 30 | 0 24 | 0 25 | 0 25 | 0 26 | 0 29 | 20 30 | 0 24 | 0 24 | 0 23 | 0 22 | 0 20 | 2 |
| 8 40 | 0 27 | 0 28 | 0 28 | 0 30 | 0 32 | 20 40 | 0 27 | 0 27 | 0 27 | 0 25 | 0 23 | 2 |
| 8 50 | 0 30 | 0 30 | 0 31 | 0 32 | 0 34 | 20 50 | 0 30 | 0 29 | 0 29 | 0 28 | 0 25 | 2 |
| 9 0 | 0 33 | 0 33 | 0 34 | 0 35 | 0 37 | 21 0 | 0 33 | 0 32 | 0 32 | 0 31 | 0 29 | 2 |
| 9 10 | 0 36 | 0 36 | 0 37 | 0 38 | 0 40 | 21 10 | 0 36 | 0 36 | 0 35 | 0 34 | 0 32 | 3 |
| 9 20 | 0 39 | 0 39 | 0 40 | 0 41 | 0 43 | 21 20 | 0 39 | 0 39 | 0 38 | 0 37 | 0 35 | 3 |
| 9 30 | 0 42 | 0 42 | 0 43 | 0 44 | 0 45 | 21 30 | 0 42 | 0 42 | 0 41 | 0 40 | 0 38 | 3 |
| 9 40 | 0 45 | 0 45 | 0 46 | 0 47 | 0 48 | 21 40 | 0 45 | 0 45 | 0 44 | 0 43 | 0 41 | 3 |
| 9 50 | 0 47 | 0 47 | 0 47 | 0 48 | 0 50 | 21 50 | 0 47 | 0 46 | 0 46 | 0 45 | 0 43 | 3 |
| 10 0 | 0 50 | 0 51 | 0 51 | 0 52 | 0 53 | 22 0 | 0 50 | 0 50 | 0 50 | 0 49 | 0 47 | 3 |
| 10 10 | 0 53 | 0 53 | 0 53 | 0 54 | 0 55 | 22 10 | 0 53 | 0 53 | 0 52 | 0 52 | 0 50 | 3 |
| 10 20 | 0 55 | 0 56 | 0 56 | 0 57 | 0 58 | 22 20 | 0 55 | 0 55 | 0 55 | 0 54 | 0 53 | 3 |
| 10 30 | 0 57 | 0 57 | 0 57 | 0 58 | 0 59 | 22 30 | 0 57 | 0 56 | 0 56 | 0 56 | 0 55 | 3 |
| 10 40 | 0 59 | 0 59 | 0 59 | 1 0 | 1 1 | 22 40 | 0 59 | 0 59 | 0 59 | 0 58 | 0 57 | 3 |
| 10 50 | 1 1 | 1 1 | 1 1 | 1 2 | 1 3 | 22 50 | 1 1 | 1 1 | 1 1 | 1 0 | 0 59 | 3 |
| 11 0 | 1 3 | 1 3 | 1 3 | 1 4 | 1 5 | 23 0 | 1 3 | 1 3 | 1 3 | 1 2 | 1 1 | 3 |
| 11 20 | 1 7 | 1 7 | 1 7 | 1 7 | 1 8 | 23 20 | 1 7 | 1 7 | 1 6 | 1 6 | 1 6 | 3 |
| 11 40 | 1 10 | 1 10 | 1 10 | 1 10 | 1 10 | 23 40 | 1 10 | 1 10 | 1 9 | 1 9 | 1 9 | 3 |
| 12 0 | 1 13 | 1 13 | 1 13 | 1 14 | 1 14 | 24 0 | 1 13 | 1 13 | 1 13 | 1 13 | 1 13 | 3 |

## TABLE 52

**REDUCTION OF LATITUDE**

Compression $\frac{1}{293}$,

(Clarke's figure of the earth)

| Lat. | Red. | Lat. | Red. | Lat. | Red. |
|---|---|---|---|---|---|
| 0° | 0′ 0″ | 30° | 10′ 9″ | 60° | 10′ 11″ |
| 1 | 0 24 | 31 | 10 21 | 61 | 9 58 |
| 2 | 0 49 | 32 | 10 32 | 62 | 9 45 |
| 3 | 1 13 | 33 | 10 42 | 63 | 9 31 |
| 4 | 1 38 | 34 | 10 52 | 64 | 9 16 |
| 5 | 2 2 | 35 | 11 1 | 65 | 9 1 |
| 6 | 2 26 | 36 | 11 9 | 66 | 8 44 |
| 7 | 2 50 | 37 | 11 16 | 67 | 8 27 |
| 8 | 3 13 | 38 | 11 23 | 68 | 8 10 |
| 9 | 3 37 | 39 | 11 28 | 69 | 7 52 |
| 10 | 4 0 | 40 | 11 33 | 70 | 7 34 |
| 11 | 4 23 | 41 | 11 37 | 71 | 7 15 |
| 12 | 4 45 | 42 | 11 40 | 72 | 6 55 |
| 13 | 5 8 | 43 | 11 42 | 73 | 6 35 |
| 14 | 5 30 | 44 | 11 44 | 74 | 6 14 |
| 15 | 5 51 | 45 | 11 44 | 75 | 5 53 |
| 16 | 6 12 | 46 | 11 44 | 76 | 5 32 |
| 17 | 6 33 | 47 | 11 43 | 77 | 5 10 |
| 18 | 6 53 | 48 | 11 40 | 78 | 4 47 |
| 19 | 7 12 | 49 | 11 38 | 79 | 4 25 |
| 20 | 7 31 | 50 | 11 34 | 80 | 4 2 |
| 21 | 7 50 | 51 | 11 29 | 81 | 3 38 |
| 22 | 8 8 | 52 | 11 24 | 82 | 3 15 |
| 23 | 8 25 | 53 | 11 17 | 83 | 2 51 |
| 24 | 8 42 | 54 | 11 10 | 84 | 2 27 |
| 25 | 8 58 | 55 | 11 2 | 85 | 2 3 |
| 26 | 9 14 | 56 | 10 54 | 86 | 1 38 |
| 27 | 9 28 | 57 | 10 44 | 87 | 1 14 |
| 28 | 9 43 | 58 | 10 34 | 88 | 0 49 |
| 29 | 9 56 | 59 | 10 23 | 89 | 0 25 |

## TABLE 53

**CORRECTION OF THE LUNAR DISTANCE**

**FOR THE CONTRACTION OF THE VERTICAL SEMIDIAMETER**

| Alt. | Angle between the Lun. Dist. and the Plumb Line | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0° | 10° | 20° | 30° | 40° | 50° | 60° | 70° | 80° | 90° |
| 3° | 51′ | 49′ | 45′ | 38′ | 30′ | 21′ | 13′ | 6′ | 1′ | 0 |
| 4 | 36 | 35 | 32 | 27 | 21 | 15 | 9 | 4 | 1 | 0 |
| 5 | 26 | 24 | 22 | 19 | 15 | 10 | 6 | 3 | 1 | 0 |
| 6 | 20 | 19 | 18 | 15 | 12 | 8 | 5 | 2 | 0 | 0 |
| 7 | 16 | 16 | 14 | 12 | 9 | 6 | 4 | 2 | 0 | 0 |
| 8 | 11 | 11 | 10 | 9 | 7 | 4 | 3 | 1 | 0 | 0 |
| 9 | 10 | 9 | 9 | 7 | 6 | 4 | 2 | 1 | 0 | 0 |
| 10 | 9 | 8 | 7 | 6 | 5 | 3 | 2 | 1 | 0 | 0 |
| 12 | 5 | 5 | 4 | 4 | 3 | 2 | 1 | 1 | 0 | 0 |
| 15 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 0 | 0 | 0 |
| 20 | 2 | 2 | 2 | 2 | 1 | 1 | 0 | 0 | 0 | 0 |
| 30 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

For the *nearest* Limb, *sub.*; for the *farthest* Limb, *add.*

## TABLE 54

**ERROR OF OBSERVATION ARISING FROM ERROR OF PARALLELISM**

| Obser. Angle. | Error of Parallelism of the Telescope | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 10′ | 20′ | 30′ | 40′ | 50′ | 1° 0′ | 1° 10′ | 1° 20′ |
| 10° | 0′ 0″ | 0′ 1″ | 0′ 1″ | 0′ 2″ | 0′ 4″ | 0′ 6″ | 0′ 7″ | 0′ 10″ |
| 20 | 0 0 | 0 1 | 0 3 | 0 5 | 0 8 | 0 11 | 0 15 | 0 20 |
| 30 | 0 1 | 0 2 | 0 4 | 0 7 | 0 12 | 0 17 | 0 23 | 0 30 |
| 40 | 0 1 | 0 3 | 0 6 | 0 10 | 0 16 | 0 23 | 0 31 | 0 40 |
| 50 | 0 1 | 0 3 | 0 8 | 0 13 | 0 20 | 0 29 | 0 40 | 0 52 |
| 60 | 0 1 | 0 4 | 0 9 | 0 16 | 0 25 | 0 36 | 0 49 | 1 4 |
| 70 | 0 1 | 0 5 | 0 11 | 0 20 | 0 31 | 0 44 | 1 0 | 1 18 |
| 80 | 0 2 | 0 6 | 0 13 | 0 23 | 0 37 | 0 53 | 1 12 | 1 33 |
| 90 | 0 2 | 0 7 | 0 16 | 0 28 | 0 44 | 1 3 | 1 26 | 1 52 |
| 100 | 0 2 | 0 8 | 0 19 | 0 33 | 0 52 | 1 15 | 1 42 | 2 13 |
| 110 | 0 3 | 0 10 | 0 22 | 0 40 | 1 2 | 1 30 | 2 2 | 2 39 |
| 120 | 0 3 | 0 12 | 0 27 | 0 48 | 1 16 | 1 49 | 2 28 | 3 14 |

## TABLE 55

**FOR CORRECTING THE LUNAR DISTANCE**

**FOR THE SPHEROIDAL FIGURE OF THE EARTH**

| Latitude | Moon's Altitude | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0° | 10° | 20° | 30° | 40° | 50° | 60° | 70° | 80° | 90° |
| 0° or 90° | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 .. 87 | 0 | 20 | 40 | 60 | 80 | 90 | 100 | 110 | 120 | 120 |
| 5 .. 85 | 0 | 30 | 70 | 100 | 130 | 150 | 170 | 190 | 200 | 200 |
| 8 .. 82 | 0 | 50 | 110 | 160 | 200 | 240 | 270 | 300 | 310 | 310 |
| 10 .. 80 | 0 | 70 | 140 | 200 | 260 | 300 | 340 | 360 | 380 | 390 |
| 13 .. 77 | 0 | 90 | 170 | 250 | 320 | 380 | 430 | 470 | 490 | 500 |
| 16 .. 74 | 0 | 110 | 200 | 300 | 391 | 460 | 530 | 570 | 600 | 610 |
| 19 .. 71 | 0 | 120 | 240 | 250 | 450 | 540 | 610 | 660 | 690 | 700 |
| 22 .. 68 | 0 | 140 | 270 | 400 | 500 | 610 | 690 | 740 | 780 | 790 |
| 26 .. 64 | 0 | 160 | 310 | 450 | 580 | 690 | 780 | 850 | 890 | 900 |
| 31 .. 59 | 0 | 180 | 340 | 500 | 550 | 770 | 870 | 950 | 990 | 1010 |
| 37 .. 53 | 0 | 190 | 370 | 550 | 700 | 840 | 950 | 1030 | 1080 | 1100 |
| 45 | 0 | 200 | 390 | 690 | 740 | 900 | 990 | 1070 | 1120 | 1140 |

## FOR COMPUTING THE MOON'S *SECOND* CORRECTION OF DISTANCE

| ☽'s Cor. of Alt. or Dist. | Apparent Distance | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 13° | 14° | 15° | 16° | 17° | 18° | 20° | 23° | 26° | 30° | 34° | 38° | 44° | 50° | 60° | 70° | 80° | 90° |
| | | | | | | | | | add | | | | | | | | | |
| 5' | 1" | 1" | 1" | 1" | 1" | 1" | 1" | 1" | 0" | 0" | 0" | 0" | 0" | 0" | 0" | 0" | 0" | 0 |
| 8 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 10 | 4 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| 11 | 5 | 4 | 4 | 4 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| 12 | 5 | 5 | 5 | 4 | 4 | 4 | 3 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 0 | 0 | 0 |
| 13 | 6 | 6 | 6 | 5 | 5 | 5 | 4 | 3 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 0 | 0 |
| 14 | 7 | 7 | 6 | 6 | 6 | 5 | 5 | 4 | 4 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 0 | 0 |
| 15 | 9 | 8 | 7 | 7 | 6 | 6 | 5 | 5 | 4 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 0 | 0 |
| 16 | 10 | 9 | 8 | 8 | 7 | 7 | 6 | 5 | 5 | 4 | 3 | 3 | 2 | 2 | 1 | 1 | 0 | 0 |
| 17 | 11 | 10 | 9 | 9 | 8 | 8 | 7 | 6 | 5 | 4 | 4 | 3 | 3 | 2 | 1 | 1 | 0 | 0 |
| 18 | 12 | 11 | 11 | 10 | 9 | 9 | 8 | 7 | 6 | 5 | 4 | 4 | 3 | 2 | 2 | 1 | 0 | 0 |
| 19 | 14 | 13 | 12 | 11 | 10 | 10 | 9 | 7 | 6 | 5 | 5 | 4 | 3 | 3 | 2 | 1 | 1 | 0 |
| 20 | 15 | 14 | 13 | 12 | 11 | 11 | 10 | 8 | 7 | 6 | 5 | 4 | 4 | 3 | 2 | 1 | 1 | 0 |
| 21 | 17 | 15 | 14 | 13 | 13 | 12 | 11 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 1 | 0 |
| 22 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 10 | 9 | 7 | 6 | 5 | 4 | 4 | 2 | 2 | 1 | 0 |
| 23 | 20 | 19 | 17 | 16 | 15 | 14 | 13 | 11 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 24 | 22 | 20 | 19 | 18 | 16 | 15 | 14 | 12 | 10 | 9 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 25 | 24 | 22 | 20 | 19 | 18 | 17 | 15 | 13 | 11 | 9 | 8 | 7 | 6 | 5 | 3 | 2 | 1 | 0 |
| 26 | 26 | 24 | 22 | 21 | 19 | 18 | 16 | 14 | 12 | 10 | 9 | 8 | 6 | 5 | 3 | 2 | 1 | 0 |
| 27 | 28 | 26 | 24 | 22 | 21 | 20 | 17 | 15 | 13 | 11 | 9 | 8 | 7 | 5 | 4 | 2 | 1 | 0 |
| 28 | 30 | 27 | 26 | 24 | 22 | 21 | 19 | 16 | 14 | 12 | 10 | 9 | 7 | 6 | 4 | 2 | 1 | 0 |
| 29 | 32 | 29 | 27 | 26 | 24 | 23 | 20 | 17 | 15 | 13 | 11 | 9 | 8 | 6 | 4 | 3 | 1 | 0 |
| 30 | 34 | 31 | 29 | 27 | 26 | 24 | 22 | 19 | 16 | 14 | 12 | 10 | 8 | 7 | 5 | 3 | 1 | 0 |
| 31 | 36 | 34 | 31 | 29 | 27 | 26 | 23 | 20 | 17 | 15 | 12 | 11 | 9 | 7 | 5 | 3 | 1 | 0 |
| 32 | 39 | 36 | 33 | 31 | 29 | 27 | 25 | 21 | 18 | 15 | 13 | 11 | 9 | 7 | 5 | 3 | 2 | 0 |
| 33 | 41 | 38 | 35 | 33 | 31 | 29 | 26 | 22 | 19 | 16 | 14 | 12 | 10 | 8 | 5 | 3 | 2 | 0 |
| 34 | 44 | 40 | 38 | 35 | 33 | 31 | 28 | 24 | 21 | 17 | 15 | 13 | 10 | 8 | 6 | 4 | 2 | 0 |
| 35 | 46 | 43 | 40 | 37 | 35 | 33 | 29 | 25 | 22 | 19 | 16 | 14 | 11 | 9 | 6 | 4 | 2 | 0 |
| 36 | 49 | 45 | 42 | 39 | 37 | 35 | 31 | 27 | 23 | 20 | 17 | 14 | 12 | 9 | 7 | 4 | 2 | 0 |
| 37 | 52 | 48 | 45 | 42 | 39 | 37 | 33 | 28 | 24 | 21 | 18 | 15 | 12 | 10 | 7 | 4 | 2 | 0 |
| 38 | 55 | 51 | 47 | 44 | 41 | 39 | 35 | 30 | 26 | 22 | 19 | 16 | 13 | 11 | 7 | 5 | 2 | 0 |
| 39 | 57 | 53 | 50 | 46 | 43 | 41 | 36 | 31 | 27 | 23 | 20 | 17 | 14 | 11 | 8 | 5 | 2 | 0 |
| 40 | 60 | 56 | 52 | 49 | 46 | 43 | 38 | 33 | 29 | 24 | 21 | 18 | 14 | 12 | 8 | 5 | 2 | 0 |
| 41 | 63 | 59 | 55 | 51 | 48 | 45 | 40 | 35 | 30 | 25 | 22 | 19 | 15 | 12 | 8 | 5 | 3 | 0 |
| 42 | 67 | 62 | 57 | 54 | 50 | 47 | 42 | 36 | 32 | 27 | 23 | 20 | 16 | 13 | 9 | 6 | 3 | 0 |
| 43 | 70 | 65 | 60 | 56 | 53 | 50 | 44 | 38 | 33 | 28 | 24 | 21 | 17 | 14 | 9 | 6 | 3 | 0 |
| 44 | 73 | 68 | 63 | 59 | 55 | 52 | 46 | 40 | 35 | 29 | 25 | 22 | 17 | 14 | 10 | 6 | 3 | 0 |
| 45 | 76 | 71 | 66 | 62 | 58 | 54 | 49 | 42 | 36 | 31 | 26 | 23 | 18 | 15 | 10 | 6 | 3 | 0 |
| 46 | 80 | 74 | 69 | 64 | 60 | 57 | 51 | 43 | 38 | 32 | 27 | 24 | 19 | 15 | 11 | 7 | 3 | 0 |
| 47 | 83 | 77 | 72 | 67 | 63 | 59 | 53 | 45 | 40 | 33 | 29 | 25 | 20 | 16 | 11 | 7 | 3 | 0 |
| 48 | 87 | 81 | 75 | 70 | 66 | 62 | 55 | 47 | 41 | 35 | 30 | 26 | 21 | 17 | 12 | 7 | 4 | 0 |
| 49 | 91 | 84 | 78 | 73 | 68 | 64 | 58 | 49 | 43 | 36 | 31 | 27 | 22 | 18 | 12 | 8 | 4 | 0 |
| 50 | 94 | 87 | 81 | 76 | 71 | 67 | 60 | 51 | 45 | 38 | 32 | 28 | 23 | 18 | 13 | 8 | 4 | 0 |
| 51 | 98 | 91 | 85 | 79 | 74 | 70 | 62 | 53 | 47 | 39 | 34 | 29 | 24 | 19 | 13 | 8 | 4 | 0 |
| 52 | 102 | 95 | 88 | 82 | 77 | 73 | 65 | 56 | 48 | 41 | 35 | 30 | 24 | 20 | 14 | 9 | 4 | 0 |
| 53 | 106 | 98 | 91 | 85 | 80 | 75 | 67 | 58 | 50 | 42 | 36 | 31 | 25 | 21 | 14 | 9 | 4 | 0 |
| 54 | 110 | 102 | 95 | 89 | 83 | 78 | 70 | 60 | 52 | 44 | 38 | 33 | 26 | 21 | 15 | 9 | 4 | 0 |
| 55 | 114 | 106 | 98 | 92 | 86 | 81 | 72 | 62 | 54 | 46 | 39 | 34 | 27 | 22 | 15 | 10 | 5 | 0 |
| 56 | 118 | 110 | 102 | 95 | 89 | 84 | 75 | 64 | 56 | 47 | 41 | 35 | 28 | 23 | 16 | 10 | 5 | 0 |
| 57 | 123 | 114 | 106 | 99 | 93 | 87 | 78 | 67 | 58 | 49 | 42 | 36 | 29 | 24 | 16 | 10 | 5 | 0 |
| 58 | 127 | 118 | 109 | 102 | 96 | 90 | 81 | 69 | 60 | 51 | 44 | 38 | 30 | 25 | 17 | 11 | 5 | 0 |
| 59 | 131 | 122 | 113 | 106 | 99 | 93 | 83 | 72 | 62 | 53 | 45 | 39 | 31 | 25 | 18 | 11 | 5 | 0 |
| 60 | 136 | 126 | 117 | 109 | 103 | 97 | 86 | 74 | 64 | 54 | 47 | 40 | 33 | 26 | 18 | 11 | 6 | 0 |
| | | | | | | | | | | | | | | *sub.* | *sub.* | *sub.* | *sub.* | *sub.* |
| | | | | | | | | | | | | | | 130° | 120° | 110° | 100° | 90° |

## CORRECTION OF THE GREENWICH MEAN TIME
### FOR THE 2D DIFFERENCE OF THE LUNAR DISTANCE

| Diff. of Prop. Logs. in the Naut. Alm. | Interval 0h 0m | 0h 10m | 0h 20m | 0h 30m | 0h 40m | 0h 50m | 1h 0m | 1h 10m | 1h 20m | 1h 30m |
|---|---|---|---|---|---|---|---|---|---|---|
| 6 | 0s | 0s | 1s | 1s | 1s | 1s | 2s | 2s | 2s | 2s |
| 12 | 0 | 1 | 1 | 2 | 3 | 3 | 3 | 4 | 4 | 4 |
| 18 | 0 | 1 | 2 | 3 | 4 | 4 | 5 | 5 | 6 | 6 |
| 24 | 0 | 2 | 3 | 4 | 5 | 6 | 6 | 7 | 7 | 7 |
| 30 | 0 | 2 | 3 | 5 | 6 | 7 | 8 | 9 | 9 | 9 |
| 36 | 0 | 2 | 4 | 6 | 8 | 9 | 10 | 11 | 11 | 11 |
| 42 | 0 | 3 | 5 | 7 | 9 | 10 | 11 | 12 | 13 | 14 |
| 48 | 0 | 3 | 6 | 8 | 10 | 12 | 13 | 14 | 15 | 15 |
| 54 | 0 | 4 | 7 | 9 | 12 | 13 | 15 | 16 | 17 | 17 |
| 60 | 0 | 4 | 7 | 10 | 13 | 15 | 16 | 18 | 18 | 19 |
| 66 | 0 | 4 | 8 | 11 | 14 | 16 | 18 | 19 | 20 | 20 |
| 72 | 0 | 5 | 9 | 12 | 15 | 18 | 19 | 21 | 22 | 22 |
| 78 | 0 | 5 | 10 | 13 | 17 | 19 | 21 | 23 | 24 | 24 |
| 84 | 0 | 6 | 10 | 14 | 18 | 21 | 23 | 25 | 26 | 26 |
| 90 | 0 | 6 | 11 | 15 | 19 | 22 | 24 | 27 | 28 | 28 |
| 96 | 0 | 7 | 12 | 17 | 21 | 25 | 26 | 28 | 29 | 30 |
| 102 | 0 | 7 | 12 | 18 | 22 | 25 | 27 | 30 | 31 | 32 |
| 108 | 0 | 7 | 13 | 19 | 23 | 27 | 29 | 32 | 33 | 33 |
| Interval | 3h 0m | 2h 50m | 2h 40m | 2h 30m | 2h 20m | 2h 10m | 2h 0m | 1h 50m | 1h 40m | 1h 30m |

| Diff. of Prop. Logs. in the Naut. Alm. | Interval 0h 0m | 0h 10m | 0h 20m | 0h 30m | 0h 40m | 0h 50m | 1h 0m | 1h 10m | 1h 20m | 1h 30m |
|---|---|---|---|---|---|---|---|---|---|---|
| 114 | 0s | 8s | 14s | 20s | 24s | 28s | 31s | 34s | 35s | 35s |
| 120 | 0 | 8 | 15 | 21 | 26 | 30 | 32 | 36 | 37 | 37 |
| 126 | 0 | 9 | 16 | 22 | 27 | 31 | 34 | 37 | 39 | 39 |
| 132 | 0 | 9 | 17 | 23 | 28 | 33 | 36 | 39 | 40 | 41 |
| 138 | 0 | 9 | 18 | 24 | 30 | 34 | 37 | 41 | 42 | 43 |
| 144 | 0 | 10 | 18 | 25 | 31 | 36 | 39 | 43 | 44 | 45 |
| 150 | 0 | 10 | 19 | 26 | 32 | 37 | 40 | 44 | 47 | 47 |
| 156 | 0 | 11 | 20 | 27 | 33 | 39 | 42 | 46 | 48 | 48 |
| 162 | 0 | 11 | 21 | 28 | 35 | 40 | 44 | 48 | 50 | 50 |
| 168 | 0 | 11 | 21 | 29 | 36 | 42 | 45 | 50 | 52 | 52 |
| 174 | 0 | 12 | 22 | 30 | 37 | 43 | 47 | 51 | 53 | 54 |
| 180 | 0 | 12 | 23 | 31 | 39 | 45 | 49 | 53 | 55 | 56 |
| 186 | 0 | 12 | 24 | 32 | 40 | 46 | 50 | 55 | 57 | 58 |
| 192 | 0 | 13 | 24 | 33 | 41 | 48 | 52 | 57 | 59 | 60 |
| 198 | 0 | 13 | 25 | 34 | 43 | 49 | 53 | 58 | 61 | 62 |
| 204 | 0 | 14 | 26 | 35 | 44 | 51 | 55 | 60 | 63 | 63 |
| 210 | 0 | 14 | 26 | 36 | 45 | 52 | 57 | 62 | 64 | 65 |
| 216 | 0 | 14 | 27 | 37 | 46 | 54 | 58 | 64 | 66 | 67 |
| Interval | 3h 0m | 2h 50m | 2h 40m | 2h 30m | 2h 20m | 2h 10m | 2h 0m | 1h 50m | 1h 40m | 1h 30m |

# TABLE 58

## ERROR OF THE SHIP'S PLACE IN NAUTICAL MILES, AND OF THE LONG. IN TIME,
### Corresponding to an Error of 1′ in the Lunar Distance.

| Prop. Log. in the Naut. Alm. | Change in 3 hours | Latitude 0° | 10° | 20° | 30° | 40° | 50° | 60° | 70° | 80° | Error of Long. in Time. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | mil. | mil. | mil. | mil. | mil. | mil. | mil. | mil. | mil. | m s |
| 2218 | 1° 48′ | 25 | 25 | 23 | 22 | 19 | 16 | 12 | 9 | 4 | 1 40 |
| 2341 | 1 45 | 26 | 26 | 24 | 22 | 20 | 17 | 13 | 9 | 4 | 1 44 |
| 2467 | 1 42 | 27 | 27 | 25 | 23 | 21 | 17 | 13 | 9 | 5 | 1 48 |
| 2596 | 1 39 | 28 | 27 | 26 | 24 | 21 | 18 | 14 | 10 | 5 | 1 52 |
| 2685 | 1 37 | 29 | 28 | 27 | 25 | 22 | 19 | 14 | 10 | 5 | 1 56 |
| 2821 | 1 34 | 30 | 29 | 28 | 26 | 23 | 19 | 15 | 10 | 5 | 2 0 |
| 2962 | 1 31 | 31 | 30 | 29 | 27 | 24 | 20 | 15 | 11 | 5 | 2 4 |
| 3108 | 1 28 | 32 | 31 | 30 | 28 | 24 | 21 | 16 | 11 | 5 | 2 8 |
| 3259 | 1 25 | 33 | 32 | 31 | 28 | 25 | 21 | 16 | 11 | 6 | 2 12 |
| 3415 | 1 22 | 34 | 33 | 32 | 29 | 26 | 22 | 17 | 12 | 6 | 2 16 |
| 3522 | 1 20 | 35 | 34 | 33 | 30 | 27 | 22 | 17 | 12 | 6 | 2 20 |
| 3688 | 1 17 | 36 | 35 | 34 | 31 | 28 | 23 | 18 | 12 | 6 | 2 24 |
| 3860 | 1 14 | 37 | 36 | 35 | 32 | 28 | 24 | 18 | 13 | 6 | 2 28 |
| 4040 | 1 11 | 38 | 37 | 36 | 33 | 29 | 24 | 19 | 13 | 7 | 2 32 |

## FOR COMPUTING THE MOON'S *SECOND* CORRECTION OF DISTANCE

| ☽'s Cor. of Alt. or Dist. | Apparent Distance | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 13° | 14° | 15° | 16° | 17° | 18° | 20° | 23° | 26° | 30° | 34° | 38° | 44° | 50° | 60° | 70° | 80° | 90° |
| | | | | | | | | | add | | | | | | | | | |
| 8' | 1″ | 1″ | 1″ | 1″ | 1″ | 1″ | 1″ | 1″ | 0″ | 0″ | 0″ | 0″ | 0″ | 0″ | 0″ | 0″ | 0″ | 0 |
| 9 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 10 | 4 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| 11 | 5 | 4 | 4 | 4 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| 12 | 5 | 5 | 5 | 4 | 4 | 4 | 3 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 0 | 0 | 0 |
| 13 | 6 | 6 | 6 | 5 | 5 | 5 | 4 | 3 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 0 | 0 |
| 14 | 7 | 7 | 6 | 6 | 6 | 5 | 5 | 4 | 4 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 0 | 0 |
| 15 | 9 | 8 | 7 | 7 | 6 | 6 | 5 | 5 | 4 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 0 | 0 |
| 16 | 10 | 9 | 8 | 8 | 7 | 7 | 6 | 5 | 5 | 4 | 3 | 3 | 2 | 2 | 1 | 1 | 0 | 0 |
| 17 | 11 | 10 | 9 | 9 | 8 | 8 | 7 | 6 | 5 | 4 | 4 | 3 | 3 | 2 | 1 | 1 | 0 | 0 |
| 18 | 12 | 11 | 11 | 10 | 9 | 9 | 8 | 7 | 6 | 5 | 4 | 4 | 3 | 2 | 2 | 1 | 0 | 0 |
| 19 | 14 | 13 | 12 | 11 | 10 | 10 | 9 | 7 | 6 | 5 | 5 | 4 | 3 | 3 | 2 | 1 | 1 | 0 |
| 20 | 15 | 14 | 13 | 12 | 11 | 11 | 10 | 8 | 7 | 6 | 5 | 4 | 4 | 3 | 2 | 1 | 1 | 0 |
| 21 | 17 | 15 | 14 | 13 | 13 | 12 | 11 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 1 | 0 |
| 22 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 10 | 9 | 7 | 6 | 5 | 4 | 4 | 2 | 2 | 1 | 0 |
| 23 | 20 | 19 | 17 | 16 | 15 | 14 | 13 | 11 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 24 | 22 | 20 | 19 | 18 | 16 | 15 | 14 | 12 | 10 | 9 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 25 | 24 | 22 | 20 | 19 | 18 | 17 | 15 | 13 | 11 | 9 | 8 | 7 | 6 | 5 | 3 | 2 | 1 | 0 |
| 26 | 26 | 24 | 22 | 21 | 19 | 18 | 16 | 14 | 12 | 10 | 9 | 8 | 6 | 5 | 3 | 2 | 1 | 0 |
| 27 | 28 | 26 | 24 | 22 | 21 | 20 | 17 | 15 | 13 | 11 | 9 | 8 | 7 | 5 | 4 | 2 | 1 | 0 |
| 28 | 30 | 27 | 26 | 24 | 22 | 21 | 19 | 16 | 14 | 12 | 10 | 9 | 7 | 6 | 4 | 2 | 1 | 0 |
| 29 | 32 | 29 | 27 | 26 | 24 | 23 | 20 | 17 | 15 | 13 | 11 | 9 | 8 | 6 | 4 | 3 | 1 | 0 |
| 30 | 34 | 31 | 29 | 27 | 26 | 24 | 22 | 19 | 16 | 14 | 12 | 10 | 8 | 7 | 5 | 3 | 1 | 0 |
| 31 | 36 | 34 | 31 | 29 | 27 | 26 | 23 | 20 | 17 | 15 | 12 | 11 | 9 | 7 | 5 | 3 | 1 | 0 |
| 32 | 39 | 36 | 33 | 31 | 29 | 27 | 25 | 21 | 18 | 15 | 13 | 11 | 9 | 7 | 5 | 3 | 2 | 0 |
| 33 | 41 | 38 | 35 | 33 | 31 | 29 | 26 | 22 | 19 | 16 | 14 | 12 | 10 | 8 | 5 | 3 | 2 | 0 |
| 34 | 44 | 40 | 38 | 35 | 33 | 31 | 28 | 24 | 21 | 17 | 15 | 13 | 10 | 8 | 6 | 4 | 2 | 0 |
| 35 | 46 | 43 | 40 | 37 | 35 | 33 | 29 | 25 | 22 | 19 | 16 | 14 | 11 | 9 | 6 | 4 | 2 | 0 |
| 36 | 49 | 45 | 42 | 39 | 37 | 35 | 31 | 27 | 23 | 20 | 17 | 14 | 12 | 9 | 7 | 4 | 2 | 0 |
| 37 | 52 | 48 | 45 | 42 | 39 | 37 | 33 | 28 | 24 | 21 | 18 | 15 | 12 | 10 | 7 | 4 | 2 | 0 |
| 38 | 55 | 51 | 47 | 44 | 41 | 39 | 35 | 30 | 26 | 22 | 19 | 16 | 13 | 11 | 7 | 5 | 2 | 0 |
| 39 | 57 | 53 | 50 | 46 | 43 | 41 | 36 | 31 | 27 | 23 | 20 | 17 | 14 | 11 | 8 | 5 | 2 | 0 |
| 40 | 60 | 56 | 52 | 49 | 46 | 43 | 38 | 33 | 29 | 24 | 21 | 18 | 14 | 12 | 8 | 5 | 2 | 0 |
| 41 | 63 | 59 | 55 | 51 | 48 | 45 | 40 | 35 | 30 | 25 | 22 | 19 | 15 | 12 | 8 | 5 | 3 | 0 |
| 42 | 67 | 62 | 57 | 54 | 50 | 47 | 42 | 36 | 32 | 27 | 23 | 20 | 16 | 13 | 9 | 6 | 3 | 0 |
| 43 | 70 | 65 | 60 | 56 | 53 | 50 | 44 | 38 | 33 | 28 | 24 | 21 | 17 | 14 | 9 | 6 | 3 | 0 |
| 44 | 73 | 68 | 63 | 59 | 55 | 52 | 46 | 40 | 35 | 29 | 25 | 22 | 17 | 14 | 10 | 6 | 3 | 0 |
| 45 | 76 | 71 | 66 | 62 | 58 | 54 | 49 | 42 | 36 | 31 | 26 | 23 | 18 | 15 | 10 | 6 | 3 | 0 |
| 46 | 80 | 74 | 69 | 64 | 60 | 57 | 51 | 43 | 38 | 32 | 27 | 24 | 19 | 15 | 11 | 7 | 3 | 0 |
| 47 | 83 | 77 | 72 | 67 | 63 | 59 | 53 | 45 | 40 | 33 | 29 | 25 | 20 | 16 | 11 | 7 | 3 | 0 |
| 48 | 87 | 81 | 75 | 70 | 66 | 62 | 55 | 47 | 41 | 35 | 30 | 26 | 21 | 17 | 12 | 7 | 4 | 0 |
| 49 | 91 | 84 | 78 | 73 | 68 | 64 | 58 | 49 | 43 | 36 | 31 | 27 | 22 | 18 | 12 | 8 | 4 | 0 |
| 50 | 94 | 87 | 81 | 76 | 71 | 67 | 60 | 51 | 45 | 38 | 32 | 28 | 23 | 18 | 13 | 8 | 4 | 0 |
| 51 | 98 | 91 | 85 | 79 | 74 | 70 | 62 | 53 | 47 | 39 | 34 | 29 | 24 | 19 | 13 | 8 | 4 | 0 |
| 52 | 102 | 95 | 88 | 82 | 77 | 73 | 65 | 56 | 48 | 41 | 35 | 30 | 24 | 20 | 14 | 9 | 4 | 0 |
| 53 | 106 | 98 | 91 | 85 | 80 | 75 | 67 | 58 | 50 | 42 | 36 | 31 | 25 | 21 | 14 | 9 | 4 | 0 |
| 54 | 110 | 102 | 95 | 89 | 83 | 78 | 70 | 60 | 52 | 44 | 38 | 33 | 26 | 21 | 15 | 9 | 4 | 0 |
| 55 | 114 | 106 | 98 | 92 | 86 | 81 | 72 | 62 | 54 | 46 | 39 | 34 | 27 | 22 | 15 | 10 | 5 | 0 |
| 56 | 118 | 110 | 102 | 95 | 89 | 84 | 75 | 64 | 56 | 47 | 41 | 35 | 28 | 23 | 16 | 10 | 5 | 0 |
| 57 | 123 | 114 | 106 | 99 | 93 | 87 | 78 | 67 | 58 | 49 | 42 | 36 | 29 | 24 | 16 | 10 | 5 | 0 |
| 58 | 127 | 118 | 109 | 102 | 96 | 90 | 81 | 69 | 60 | 51 | 44 | 38 | 30 | 25 | 17 | 11 | 5 | 0 |
| 59 | 131 | 122 | 113 | 106 | 99 | 93 | 83 | 72 | 62 | 53 | 45 | 39 | 31 | 25 | 18 | 11 | 5 | 0 |
| 60 | 136 | 126 | 117 | 109 | 103 | 97 | 86 | 74 | 64 | 54 | 47 | 40 | 33 | 26 | 18 | 11 | 6 | 0 |
| | | | | | | | | | | | | | | sub. | sub. | sub. | sub. | sub. |
| | | | | | | | | | | | | | | 130° | 120° | 110° | 100° | 90° |

## CORRECTION OF THE GREENWICH MEAN TIME
### FOR THE 2D DIFFERENCE OF THE LUNAR DISTANCE

| Diff. of Prop. Logs. in the Naut. Alm. | Interval 0h | | | | | | 1h | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0m | 10m | 20m | 30m | 40m | 50m | 0m | 10m | 20m | 30m |
| 6 | 0s | 0s | 1s | 1s | 1s | 1s | 2s | 2s | 2s | 2s |
| 12 | 0 | 1 | 1 | 2 | 3 | 3 | 3 | 4 | 4 | 4 |
| 18 | 0 | 1 | 2 | 3 | 4 | 4 | 5 | 5 | 6 | 6 |
| 24 | 0 | 2 | 3 | 4 | 5 | 6 | 6 | 7 | 7 | 7 |
| 30 | 0 | 2 | 3 | 5 | 6 | 7 | 8 | 9 | 9 | 9 |
| 36 | 0 | 2 | 4 | 6 | 8 | 9 | 10 | 11 | 11 | 11 |
| 42 | 0 | 3 | 5 | 7 | 9 | 10 | 11 | 12 | 13 | 14 |
| 48 | 0 | 3 | 6 | 8 | 10 | 12 | 13 | 14 | 15 | 15 |
| 54 | 0 | 4 | 7 | 9 | 12 | 13 | 15 | 16 | 17 | 17 |
| 60 | 0 | 4 | 7 | 10 | 13 | 15 | 16 | 18 | 18 | 19 |
| 66 | 0 | 4 | 8 | 11 | 14 | 16 | 18 | 19 | 20 | 20 |
| 72 | 0 | 5 | 9 | 12 | 15 | 18 | 19 | 21 | 22 | 22 |
| 78 | 0 | 5 | 10 | 13 | 17 | 19 | 21 | 23 | 24 | 24 |
| 84 | 0 | 6 | 10 | 14 | 18 | 21 | 23 | 25 | 26 | 26 |
| 90 | 0 | 6 | 11 | 15 | 19 | 22 | 24 | 27 | 28 | 28 |
| 96 | 0 | 7 | 12 | 17 | 21 | 25 | 26 | 28 | 29 | 30 |
| 102 | 0 | 7 | 12 | 18 | 22 | 25 | 27 | 30 | 31 | 32 |
| 108 | 0 | 7 | 13 | 19 | 23 | 27 | 29 | 32 | 33 | 33 |
| | 0m | 50m | 40m | 30m | 20m | 10m | 0m | 50m | 40m | 30m |
| | 3h | 2h | | | | | | 1h | | |
| | Interval | | | | | | | | | |

| Diff. of Prop. Logs. in the Naut. Alm. | Interval 0h | | | | | | 1h | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0m | 10m | 20m | 30m | 40m | 50m | 0m | 10m | 20m | 30m |
| 114 | 0s | 8s | 14s | 20s | 24s | 28s | 31s | 34s | 35s | 35s |
| 120 | 0 | 8 | 15 | 21 | 26 | 30 | 32 | 36 | 37 | 37 |
| 126 | 0 | 9 | 16 | 22 | 27 | 31 | 34 | 37 | 39 | 39 |
| 132 | 0 | 9 | 17 | 23 | 28 | 33 | 36 | 39 | 40 | 41 |
| 138 | 0 | 9 | 18 | 24 | 30 | 34 | 37 | 41 | 42 | 43 |
| 144 | 0 | 10 | 18 | 25 | 31 | 36 | 39 | 43 | 44 | 45 |
| 150 | 0 | 10 | 19 | 26 | 32 | 37 | 40 | 44 | 47 | 47 |
| 156 | 0 | 11 | 20 | 27 | 33 | 39 | 42 | 46 | 48 | 48 |
| 162 | 0 | 11 | 21 | 28 | 35 | 40 | 44 | 48 | 50 | 50 |
| 168 | 0 | 11 | 21 | 29 | 36 | 42 | 45 | 50 | 52 | 52 |
| 174 | 0 | 12 | 22 | 30 | 37 | 43 | 47 | 51 | 53 | 54 |
| 180 | 0 | 12 | 23 | 31 | 39 | 45 | 49 | 53 | 55 | 56 |
| 186 | 0 | 12 | 24 | 32 | 40 | 46 | 50 | 55 | 57 | 58 |
| 192 | 0 | 13 | 24 | 33 | 41 | 48 | 52 | 57 | 59 | 60 |
| 198 | 0 | 13 | 25 | 34 | 43 | 49 | 53 | 58 | 61 | 62 |
| 204 | 0 | 14 | 26 | 35 | 44 | 51 | 55 | 60 | 63 | 63 |
| 210 | 0 | 14 | 26 | 36 | 45 | 52 | 57 | 62 | 64 | 65 |
| 216 | 0 | 14 | 27 | 37 | 46 | 54 | 58 | 64 | 66 | 67 |
| | 0m | 50m | 40m | 30m | 20m | 10m | 0m | 50m | 40m | 30m |
| | 3h | 2h | | | | | | 1h | | |
| | Interval | | | | | | | | | |

# TABLE 58

## ERROR OF THE SHIP'S PLACE IN NAUTICAL MILES, AND OF THE LONG. IN TIME,

**Corresponding to an Error of 1′ in the Lunar Distance.**

| Prop. Log. in the Naut. Alm. | Change in 3 hours | Latitude 0° | 10° | 20° | 30° | 40° | 50° | 60° | 70° | 80° | Error of Long. in Time. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | mil. | mil. | mil. | mil. | mil. | mil. | mil. | mil. | mil. | m s |
| 2218 | 1° 48′ | 25 | 25 | 23 | 22 | 19 | 16 | 12 | 9 | 4 | 1 40 |
| 2341 | 1 45 | 26 | 26 | 24 | 22 | 20 | 17 | 13 | 9 | 4 | 1 44 |
| 2467 | 1 42 | 27 | 27 | 25 | 23 | 21 | 17 | 13 | 9 | 5 | 1 48 |
| 2596 | 1 39 | 28 | 27 | 26 | 24 | 21 | 18 | 14 | 10 | 5 | 1 52 |
| 2685 | 1 37 | 29 | 28 | 27 | 25 | 22 | 19 | 14 | 10 | 5 | 1 56 |
| 2821 | 1 34 | 30 | 29 | 28 | 26 | 23 | 19 | 15 | 10 | 5 | 2 0 |
| 2962 | 1 31 | 31 | 30 | 29 | 27 | 24 | 20 | 15 | 11 | 5 | 2 4 |
| 3108 | 1 28 | 32 | 31 | 30 | 28 | 24 | 21 | 16 | 11 | 5 | 2 8 |
| 3259 | 1 25 | 33 | 32 | 31 | 28 | 25 | 21 | 16 | 11 | 6 | 2 12 |
| 3415 | 1 22 | 34 | 33 | 32 | 29 | 26 | 22 | 17 | 12 | 6 | 2 16 |
| 3522 | 1 20 | 35 | 34 | 33 | 30 | 27 | 22 | 17 | 12 | 6 | 2 20 |
| 3688 | 1 17 | 36 | 35 | 34 | 31 | 28 | 23 | 18 | 12 | 6 | 2 24 |
| 3860 | 1 14 | 37 | 36 | 35 | 32 | 28 | 24 | 18 | 13 | 6 | 2 28 |
| 4040 | 1 11 | 38 | 37 | 36 | 33 | 29 | 24 | 19 | 13 | 7 | 2 32 |

## AMPLITUDES

| Lat. | Declination | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0° | 1° | 2° | 3° | 4° | 5° | 6° | 7° | 8° | 9° | 10° | 11° | 12° | 13° | 14° | 15° |
| ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° |
| 0 | 0 | 1·0 | 2·0 | 3·0 | 4·0 | 5·0 | 6·0 | 7·0 | 8·0 | 9·0 | 10·0 | 11·0 | 12·0 | 13·0 | 14·0 | 15·0 |
| 10 | 0 | 1·0 | 2·0 | 3·0 | 4·1 | 5·1 | 6·1 | 7·0 | 8·1 | 9·1 | 10·1 | 11·2 | 12·2 | 13·2 | 14·2 | 15·2 |
| 15 | 0 | 1·0 | 2·1 | 3·1 | 4·2 | 5·2 | 6·2 | 7·2 | 8·3 | 9·3 | 10·4 | 11·4 | 12·5 | 13·5 | 14·5 | 15·6 |
| 20 | 0 | 1·1 | 2·1 | 3·2 | 4·3 | 5·3 | 6·4 | 7·5 | 8·5 | 9·6 | 10·6 | 11·7 | 12·8 | 13·8 | 14·9 | 16·0 |
| 25 | 0 | 1·1 | 2·2 | 3·3 | 4·4 | 5·5 | 6·6 | 7·7 | 8·8 | 9·9 | 11·1 | 12·4 | 13·3 | 14·4 | 15·5 | 16·6 |
| 30 | 0 | 1·2 | 2·3 | 3·4 | 4·6 | 5·8 | 6 9 | 8·1 | 9·3 | 10·3 | 11·6 | 12·7 | 13·9 | 15·0 | 16·2 | 17·4 |
| 32 | 0 | 1·2 | 2·4 | 3·5 | 4·7 | 5·9 | 7·1 | 8·3 | 9·5 | 10·6 | 11·8 | 13·0 | 14·2 | 15·4 | 16·6 | 17·8 |
| 34 | 0 | 1·2 | 2·4 | 3·6 | 4·8 | 6·0 | 7·2 | 8·4 | 9·7 | 10·8 | 12·1 | 13·3 | 14·5 | 15·7 | 17·0 | 18·2 |
| 35 | 0 | 1·2 | 2·4 | 3·7 | 4·9 | 6·1 | 7·3 | 8·5 | 9·8 | 11·0 | 12·2 | 13·5 | 14·7 | 15·9 | 17·2 | 18·4 |
| 36 | 0 | 1·2 | 2·5 | 3·7 | 4·9 | 6·2 | 7·4 | 8·7 | 9·9 | 11·1 | 12·4 | 13·6 | 14·9 | 16·1 | 17·4 | 18·7 |
| 37 | 0 | 1·2 | 2·5 | 3·7 | 5·0 | 6·3 | 7·5 | 8·8 | 10·0 | 11·3 | 12·6 | 13·8 | 15·1 | 16·4 | 17·6 | 18·9 |
| 38 | 0 | 1·3 | 2·5 | 3·8 | 5·1 | 6·3 | 7·6 | 8·9 | 10·2 | 11·4 | 12·7 | 14·0 | 15·3 | 16·6 | 17·9 | 19·2 |
| 39 | 0 | 1·3 | 2·6 | 3·8 | 5·1 | 6·4 | 7·7 | 9·0 | 10·3 | 11·6 | 12·9 | 14·2 | 15·5 | 16·8 | 18·1 | 19·4 |
| 40 | 0 | 1·3 | 2·6 | 3·9 | 5·2 | 6·5 | 7·8 | 9·1 | 10·5 | 11·8 | 13·1 | 14·4 | 15·7 | 17·1 | 18·4 | 19·7 |
| 41 | 0 | 1·3 | 2·6 | 4·0 | 5·3 | 6·6 | 8·0 | 9·3 | 10·6 | 12·0 | 13·3 | 14·6 | 16·0 | 17·3 | 18·7 | 20·0 |
| 42 | 0 | 1·3 | 2·7 | 4·0 | 5·4 | 6·7 | 8·1 | 9·4 | 10·8 | 12·1 | 13·5 | 14·8 | 16·2 | 17·6 | 19·0 | 20·4 |
| 43 | 0 | 1·4 | 2·7 | 4·1 | 5·5 | 6·8 | 8·2 | 9·6 | 11·0 | 12·3 | 13·7 | 15·1 | 16·5 | 17·9 | 19·3 | 20·7 |
| 44 | 0 | 1·4 | 2·8 | 4·2 | 5·6 | 7·0 | 8·3 | 9·7 | 11·1 | 12·6 | 14·0 | 15·4 | 16·8 | 18·2 | 19·6 | 21·1 |
| 45 | 0 | 1·4 | 2·8 | 4·2 | 5·7 | 7·1 | 8·5 | 9·9 | 11·3 | 12·8 | 14·2 | 15·6 | 17·1 | 18·5 | 20·0 | 21·5 |
| 46 | 0 | 1·4 | 2·9 | 4·3 | 5·8 | 7·2 | 8·6 | 10·1 | 11·5 | 13·0 | 14·5 | 15·9 | 17·4 | 18·9 | 20·4 | 21·9 |
| 47 | 0 | 1·4 | 2·9 | 4·4 | 5·8 | 7·3 | 8·8 | 10·3 | 11·8 | 13·3 | 14·7 | 16·2 | 17·7 | 19·3 | 20·8 | 22·3 |
| 48 | 0 | 1·5 | 3·0 | 4·5 | 6·0 | 7·5 | 9·0 | 10·5 | 12·0 | 13·5 | 15·0 | 16·6 | 18·1 | 19·5 | 21·2 | 22·7 |
| 49 | 0 | 1·5 | 3·0 | 4·6 | 6·1 | 7·6 | 9·2 | 10·7 | 12·2 | 13·8 | 15·3 | 16·9 | 18·5 | 20·0 | 21·6 | 23·2 |
| 50 | 0 | 1·5 | 3·1 | 4·7 | 6·2 | 7·8 | 9·3 | 10·9 | 12·5 | 14·1 | 15·7 | 17·3 | 18·9 | 20·5 | 22·1 | 23·7 |
| 51 | 0 | 1·6 | 3·2 | 4·8 | 6·4 | 8·0 | 9·6 | 11·2 | 12·8 | 14·4 | 16·0 | 17·6 | 19·3 | 20·9 | 22·6 | 24·3 |
| 52 | 0 | 1·6 | 3·3 | 4·9 | 6·5 | 8·1 | 9·7 | 11·4 | 13·1 | 14·7 | 16·4 | 18·0 | 19·7 | 21·4 | 23·1 | 24·9 |
| 53 | 0 | 1·6 | 3·3 | 5·0 | 6·7 | 8·3 | 10·0 | 11·7 | 13·4 | 15·1 | 16·8 | 18·5 | 20·2 | 21·9 | 23·7 | 25·5 |
| 54 | 0 | 1·7 | 3·4 | 5·1 | 6·8 | 8·5 | 10·2 | 12·0 | 13·7 | 15·4 | 17·2 | 18·9 | 20·7 | 22·5 | 24·3 | 26·1 |
| 55 | 0 | 1·7 | 3·5 | 5·2 | 7·0 | 8·7 | 10·5 | 12·3 | 14·0 | 15·8 | 17·6 | 19·4 | 21·2 | 23·1 | 24·9 | 26·8 |
| 56 | 0 | 1·8 | 3·6 | 5·4 | 7·2 | 9·0 | 10·7 | 12·6 | 14·4 | 16·2 | 18·1 | 19·9 | 21·8 | 23·7 | 25·6 | 27·6 |
| 57 | 0 | 1·8 | 3·7 | 5·5 | 7·4 | 9·2 | 11·1 | 12·9 | 14·8 | 16·7 | 18·3 | 20·5 | 22·4 | 24·4 | 26·4 | 28·4 |
| 58 | 0 | 1·9 | 3·8 | 5·7 | 7·6 | 9·5 | 11·4 | 13·3 | 15·2 | 17·2 | 19·1 | 21·1 | 23·1 | 25·1 | 27·2 | 29·2 |
| 59 | 0 | 1·9 | 3·8 | 5·8 | 7·8 | 9·7 | 11·7 | 13·7 | 15·7 | 17·7 | 19·7 | 21·7 | 23·8 | 25·9 | 28·0 | 30·2 |
| 60 | 0 | 2·0 | 4·0 | 6·0 | 8·0 | 10·0 | 12·1 | 14·1 | 16·2 | 18·2 | 20·3 | 22·4 | 24·6 | 26·7 | 28·9 | 31·2 |
| 61 | 0 | 2·1 | 4·1 | 6·2 | 8·3 | 10·3 | 12·5 | 14·6 | 16·7 | 18·8 | 21·0 | 23·1 | 25·4 | 27·6 | 29·9 | 32·2 |
| 62 | 0 | 2·1 | 4·3 | 6·4 | 8·5 | 10·7 | 12·9 | 15·1 | 17·3 | 19·4 | 21·9 | 23·9 | 26·3 | 28·5 | 31·0 | 33·4 |
| 63 | 0 | 2·2 | 4·5 | 6·7 | 8·8 | 11·1 | 13·4 | 15·6 | 17·9 | 20·1 | 22·5 | 24·8 | 27·3 | 29·6 | 32·2 | 34·7 |
| 64 | 0 | 2·3 | 4·6 | 6·9 | 9·1 | 11·5 | 13·9 | 16·2 | 18·5 | 20·9 | 23·3 | 25·7 | 28·3 | 30·9 | 33·5 | 36·2 |
| 65 | 0 | 2·4 | 4·8 | 7·1 | 9·5 | 11·9 | 14·4 | 16·8 | 19·3 | 21·7 | 24·2 | 26·8 | 29·5 | 32·5 | 34·9 | 37·8 |

## TABLE 59 A

### CORRECTION OF THE AMPLITUDE OBSERVED ON THE HORIZON,

FOR THE EFFECT OF REFRACTION.

(Height of the Eye, 16 feet.)

| Lat. | Declination | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 0° | 10° | 15° | 18° | 20° | 22° | 23° | 24° |
| 0 | 0° | 0° | 0° | 0° | 0° | 0° | 0° | 0° |
| 10 | 0 | 0·1 | 0·1 | 0·1 | 0·1 | 0·1 | 0·1 | 0·1 |
| 20 | 0·2 | 0·2 | 0·2 | 0·3 | 0·3 | 0·3 | 0·3 | 0·3 |
| 30 | 0·3 | 0·3 | 0·3 | 0·3 | 0·4 | 0·4 | 0·5 | 0·5 |
| 40 | 0·5 | 0·5 | 0·7 | 0·7 | 0·7 | 0·8 | 0·8 | 0·8 |
| 50 | 0·7 | 0·8 | 0·9 | 0·9 | 0·9 | 0·9 | 1·0 | 1·0 |
| 55 | 0·9 | 0·9 | 1·1 | 1·2 | 1·3 | 1·3 | 1·4 | 1·4 |
| 60 | 1·1 | 1·1 | 1·3 | 1·4 | 1·5 | 1·7 | 1·8 | 1·9 |
| 65 | 1·3 | 1·4 | 1·9 | 2·3 | 2·5 | | | |

## AMPLITUDES

| Lat. | Declination 16° | 16½° | 17° | 17½° | 18° | 18½° | 19° | 19½° | 20° | 20½° | 21° | 21½° | 22° | 22½° | 23° | 23½° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° |
| 0 | 16·0 | 16·5 | 17·0 | 17·5 | 18·0 | 18·5 | 19·0 | 19·5 | 20·0 | 20·5 | 21·0 | 21·5 | 22·0 | 22·5 | 23·0 | 23·5 |
| 10 | 16·2 | 16·7 | 17·3 | 17·8 | 18·3 | 18·8 | 19·3 | 19·9 | 20·3 | 20·8 | 21·3 | 21·8 | 22·3 | 22·9 | 23·4 | 23·9 |
| 15 | 16·6 | 17·1 | 17·7 | 18·1 | 18·7 | 19·2 | 19·7 | 20·2 | 20·8 | 21·3 | 21·8 | 22·3 | 22·8 | 23·3 | 23·9 | 24·3 |
| 20 | 17·1 | 17·6 | 18·1 | 18·7 | 19·2 | 19·7 | 20·3 | 20·8 | 21·3 | 21·9 | 22·4 | 22·9 | 23·5 | 24·0 | 24·6 | 25·1 |
| 25 | 17·7 | 18·3 | 18·8 | 19·4 | 19·9 | 20·5 | 21·0 | 21·6 | 22·5 | 22·7 | 23·3 | 23·8 | 24·4 | 24·6 | 25·5 | 26·1 |
| 30 | 18·6 | 19·1 | 19·7 | 20·3 | 20·9 | 21·5 | 22·1 | 22·7 | 23·3 | 23·8 | 24·4 | 25·0 | 25·6 | 26·2 | 26·8 | 27·4 |
| 32 | 19·0 | 19·6 | 20·2 | 20·8 | 21·4 | 22·0 | 22·6 | 23·2 | 23·8 | 24·4 | 25·0 | 25·6 | 26·2 | 26·8 | 27·4 | 28·0 |
| 34 | 19·4 | 20·0 | 20·6 | 21·3 | 21·9 | 22·5 | 23·1 | 23·7 | 24·4 | 25·0 | 25·6 | 26·2 | 26·8 | 27·5 | 28·1 | 28·7 |
| 35 | 19·6 | 20·3 | 20·9 | 21·5 | 22·2 | 22·8 | 23·4 | 24·0 | 24·7 | 25·3 | 25·9 | 26·6 | 27·2 | 27·8 | 28·5 | 29·1 |
| 36 | 19·9 | 20·5 | 21·2 | 21·8 | 22·4 | 23·1 | 23·7 | 24·4 | 25·0 | 25·6 | 26·3 | 26·9 | 27·6 | 28·2 | 28·9 | 29·5 |
| 37 | 20·2 | 20·8 | 21·5 | 22·1 | 22·8 | 23·4 | 24·0 | 24·7 | 25·3 | 26·0 | 26·7 | 27·3 | 28·0 | 28·6 | 29·3 | 29·9 |
| 38 | 20·5 | 21·1 | 21·8 | 22·4 | 23·1 | 23·7 | 24·4 | 25·1 | 25·7 | 26·4 | 27·0 | 27·7 | 28·4 | 29·0 | 29·7 | 30·3 |
| 39 | 20·8 | 21·4 | 22·[illegible] | 22·8 | 23·4 | 24·1 | 24·8 | 25·4 | 26·1 | 26·8 | 27·5 | 28·1 | 28·8 | 29·5 | 30·2 | 30·8 |
| 40 | 21·1 | 21·8 | 22·4 | 23·1 | 23·8 | 24·5 | 25·1 | 25·8 | 26·5 | 27·2 | 27·9 | 28·6 | 29·3 | 30·0 | 30·7 | 31·3 |
| 41 | 21·4 | 22·1 | 22·8 | 23·5 | 24·2 | 24·8 | 25·5 | 26·2 | 26·9 | 27·6 | 28·3 | 29·0 | 29·8 | 30·5 | 31·2 | 31·8 |
| 42 | 21·8 | 22·5 | 23·2 | 23·8 | 24·6 | 25·3 | 26·0 | 26·7 | 27·4 | 28·1 | 28·8 | 29·5 | 30·3 | 31·0 | 31·7 | 32·4 |
| 43 | 22·1 | 22·8 | 23·6 | 24·3 | 25·0 | 25·7 | 26·4 | 27·1 | 27·8 | 28·6 | 29·3 | 30·1 | 30·8 | 31·5 | 32·3 | 33·0 |
| 44 | 22·5 | 23·2 | 24·0 | 24·7 | 25·6 | 26·2 | 26·9 | 27·6 | 28·4 | 29·1 | 29·8 | 30·6 | 31·4 | 32·1 | 32·9 | 33·6 |
| 45 | 22·9 | 23·7 | 24·4 | 25·2 | 25·9 | 26·7 | 27·4 | 28·2 | 28·9 | 29·7 | 30·4 | 31·2 | 32·0 | 32·8 | 33·5 | 34·3 |
| 46 | 23·4 | 24·1 | 24·8 | 25·6 | 26·4 | 27·2 | 27·9 | 28·7 | 29·5 | 30·3 | 31·0 | 31·8 | 32·6 | 33·4 | 34·2 | 35·0 |
| 47 | 23·8 | 24·6 | 25·4 | 26·2 | 26·9 | 27·7 | 28·5 | 29·3 | 30·1 | 30·9 | 31·7 | 32·5 | 33·3 | 34·1 | 34·9 | 35·7 |
| 48 | 24·3 | 25·1 | 25·9 | 26·7 | 27·5 | 28·3 | 29·1 | 29·9 | 30·7 | 31·6 | 32·4 | 33·2 | 34·0 | 34·8 | 35·7 | 36·5 |
| 49 | 24·8 | 25·6 | 26·5 | 27·3 | 28·1 | 28·9 | 29·7 | 30·6 | 31·4 | 32·3 | 33·1 | 33·9 | 34·8 | 35·7 | 36·5 | 37·4 |
| 50 | 25·4 | 26·2 | 27·0 | 27·8 | 28·7 | 29·6 | 30·4 | 31·3 | 32·1 | 33·0 | 33·9 | 34·8 | 35·6 | 36·5 | 37·4 | 38·3 |
| 51 | 26·0 | 26·8 | 27·7 | 28·5 | 29·4 | 30·3 | 31·1 | 32·0 | 32·9 | 33·8 | 34·7 | 35·6 | 36·5 | 37·5 | 38·4 | 39·3 |
| 52 | 26·6 | 27·5 | 28·3 | 29·2 | 30·1 | 31·0 | 31·9 | 32·8 | 33·7 | 34·7 | 35·6 | 36·5 | 37·5 | 38·4 | 39·4 | 40·3 |
| 53 | 27·3 | 28·2 | 29·1 | 30·0 | 30·9 | 31·8 | 32·7 | 33·7 | 34·6 | 35·6 | 36·5 | 37·5 | 38·5 | 39·5 | 40·5 | 41·4 |
| 54 | 28·0 | 28·9 | 29·8 | 30·8 | 31·7 | 32·7 | 33·6 | 34·6 | 35·6 | 36·6 | 37·6 | 38·6 | 39·6 | 40·6 | 41·7 | 42·6 |
| 55 | 28·7 | 29·7 | 30·6 | 31·6 | 32·6 | 33·6 | 34·6 | 35·6 | 36·6 | 37·6 | 38·7 | 39·7 | 40·8 | 41·8 | 42·9 | 44·0 |
| 56 | 29·5 | 30·5 | 31·5 | 32·5 | 33·5 | 34·6 | 35·6 | 36·6 | 37·7 | 38·8 | 39·8 | 40·9 | 42·1 | 43·2 | 44·3 | 45·4 |
| 57 | 30·4 | 31·4 | 32·5 | 33·5 | 34·5 | 35·6 | 36·7 | 37·8 | 38·9 | 40·0 | 41·1 | 42·3 | 43·4 | 44·6 | 45·8 | 47·0 |
| 58 | 31·3 | 32·4 | 33·5 | 34·6 | 35·7 | 36·8 | 37·9 | 39·0 | 40·2 | 41·7 | 42·5 | 43·8 | 45·0 | 46·2 | 47·5 | 48·7 |
| 59 | 32·3 | 33·5 | 34·6 | 35·7 | 36·8 | 38·0 | 39·2 | 40·4 | 41·6 | 42·8 | 44·1 | 45·4 | 46·7 | 48·0 | 49·3 | 50·6 |
| 60 | 33·4 | 34·6 | 35·8 | 37·0 | 38·2 | 39·4 | 40·6 | 41·9 | 43·2 | 44·5 | 45·8 | 47·1 | 48·5 | 49·9 | 51·4 | 52·8 |
| 61 | 34·6 | 35·8 | 37·1 | 38·3 | 39·6 | 40·8 | 42·2 | 43·5 | 44·8 | 46·2 | 47·7 | 49·1 | 50·6 | 52·1 | 53·7 | 55·2 |
| 62 | 35·9 | 37·2 | 38·5 | 39·8 | 41·2 | 42·5 | 43·9 | 45·3 | 46·8 | 48·2 | 49·8 | 51·3 | 52·9 | 54·6 | 56·3 | 58·0 |
| 63 | 37·4 | 38·7 | 40·1 | 41·5 | 42·9 | 44·3 | 45·8 | 47·3 | 48·8 | 50·5 | 52·1 | 53·8 | 55·6 | 57·4 | 59·4 | 61·3 |
| 64 | 39·0 | 40·4 | 41·8 | 43·3 | 44·8 | 46·4 | 48·0 | 49·6 | 51·3 | 53·0 | 54·8 | 56·7 | 58·7 | 60·8 | 63·0 | 65·3 |
| 65 | 40·7 | 42·2 | 43·8 | 45·4 | 47·0 | 48·7 | 50·4 | 52·2 | 54·0 | 56·0 | 58·0 | 60·1 | 62·4 | 64·9 | 67·6 | 70·4 |

## TABLE 59 A

### CORRECTION OF THE AMPLITUDE OBSERVED ON THE HORIZON, FOR THE EFFECT OF REFRACTION.

(Height of the Eye, 16 feet.)

| Lat. | Declination 0° | 10° | 15° | 18° | 20° | 22° | 23° | 24° |
|---|---|---|---|---|---|---|---|---|
| 0 | 0° | 0° | 0° | 0° | 0° | 0° | 0° | 0° |
| 10 | 0·1 | 0·1 | 0·1 | 0·1 | 0·1 | 0·1 | 0·1 | 0·1 |
| 20 | 0·2 | 0·2 | 0·2 | 0·3 | 0·3 | 0·3 | 0·3 | 0·3 |
| 30 | 0·3 | 0·3 | 0·3 | 0·3 | 0·4 | 0·4 | 0·5 | 0·5 |
| 40 | 0·5 | 0·5 | 0·7 | 0·7 | 0·7 | 0·8 | 0·8 | 0·8 |
| 50 | 0·7 | 0·8 | 0·9 | 0·9 | 0·9 | 0·9 | 1·0 | 1 0 |
| 55 | 0·9 | 0·9 | 1·1 | 1·2 | 1·3 | 1·3 | 1·4 | 1·4 |
| 60 | 1·1 | 1·1 | 1·3 | 1·4 | 1·5 | 1·7 | 1·9 | 1·9 |
| 65 | 1·3 | 1·4 | 1·9 | 2·3 | 2·5 | | | |

## DECLINATION OF THE SUN, FOR THE YEAR 1901, At Apparent Noon at Greenwich.

| Day | Jan. | Feb. | Mar. | April | May | June | July | Aug | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ |
| 1 | 23 2S | 17 12S | 7 44S | 4 23N | 14 57N | 22 0N | 23 9N | 18 9N | 8 27N | 3 1S | 14 18S | 21 45S |
| 2 | 22 57 | 16 55 | 7 21 | 4 46 | 15 15 | 22 8 | 23 5 | 17 54 | 8 5 | 3 24 | 14 37 | 21 54 |
| 3 | 22 52 | 16 38 | 6 58 | 5 9 | 15 33 | 22 16 | 23 1 | 17 38 | 7 43 | 3 47 | 14 56 | 22 3 |
| 4 | 22 46 | 16 20 | 6 35 | 5 32 | 15 51 | 22 23 | 22 56 | 17 22 | 7 21 | 4 11 | 15 15 | 22 12 |
| 5 | 22 40 | 16 2 | 6 12 | 5 55 | 16 8 | 22 30 | 22 50 | 17 6 | 6 59 | 4 34 | 15 33 | 22 20 |
| 6 | 22 33 | 15 44 | 5 49 | 6 18 | 16 25 | 22 37 | 22 45 | 16 50 | 6 37 | 4 57 | 15 52 | 22 27 |
| 7 | 22 26 | 15 25 | 5 26 | 6 40 | 16 42 | 22 43 | 22 39 | 16 34 | 6 15 | 5 20 | 16 10 | 22 34 |
| 8 | 22 18 | 15 7 | 5 2 | 7 3 | 16 58 | 22 49 | 22 32 | 16 17 | 5 52 | 5 43 | 16 27 | 22 41 |
| 9 | 22 10 | 14 48 | 4 39 | 7 25 | 17 15 | 22 54 | 22 26 | 16 0 | 5 29 | 6 6 | 16 45 | 22 47 |
| 10 | 22 1 | 14 28 | 4 15 | 7 48 | 17 31 | 22 59 | 22 18 | 15 42 | 5 7 | 6 29 | 17 2 | 22 53 |
| 11 | 21 52 | 14 9 | 3 52 | 8 10 | 17 46 | 23 4 | 22 11 | 15 25 | 4 44 | 6 51 | 17 19 | 22 59 |
| 12 | 21 43 | 13 49 | 3 29 | 8 32 | 18 2 | 23 8 | 22 3 | 15 7 | 4 21 | 7 14 | 17 35 | 23 3 |
| 13 | 21 33 | 13 29 | 3 5 | 8 54 | 18 17 | 23 12 | 21 54 | 14 49 | 3 58 | 7 37 | 17 52 | 23 8 |
| 14 | 21 23 | 13 9 | 2 41 | 9 15 | 18 31 | 23 15 | 21 46 | 14 31 | 3 35 | 7 59 | 18 8 | 23 12 |
| 15 | 21 12 | 12 48 | 2 18 | 9 37 | 18 46 | 23 18 | 21 37 | 14 12 | 3 12 | 8 21 | 18 23 | 23 15 |
| 16 | 21 1 | 12 28 | 1 54 | 9 58 | 19 0 | 23 20 | 21 27 | 13 53 | 2 49 | 8 44 | 18 38 | 23 18 |
| 17 | 20 49 | 12 7 | 1 30 | 10 20 | 19 14 | 23 23 | 21 17 | 13 34 | 2 26 | 9 6 | 18 53 | 23 21 |
| 18 | 20 37 | 11 46 | 1 6 | 10 41 | 19 27 | 23 24 | 21 7 | 13 15 | 2 3 | 9 28 | 19 8 | 23 23 |
| 19 | 20 25 | 11 25 | 0 43 | 11 2 | 19 41 | 23 26 | 20 56 | 12 56 | 1 39 | 9 50 | 19 23 | 23 25 |
| 20 | 20 12 | 11 3 | 0 19S | 11 22 | 19 53 | 23 26 | 20 46 | 12 36 | 1 16 | 10 11 | 19 36 | 23 26 |
| 21 | 19 59 | 10 42 | 0 5N | 11 43 | 20 6 | 23 27 | 20 34 | 12 16 | 0 53 | 10 33 | 19 50 | 23 27 |
| 22 | 19 46 | 10 20 | 0 28 | 12 3 | 20 18 | 23 27 | 20 23 | 11 57 | 0 29 | 10 54 | 20 3 | 23 27 |
| 23 | 19 32 | 9 58 | 0 52 | 12 23 | 20 30 | 23 27 | 20 11 | 11 36 | 0 6N | 11 15 | 20 16 | 23 27 |
| 24 | 19 18 | 9 36 | 1 16 | 12 43 | 20 41 | 23 26 | 19 58 | 11 16 | 0 17S | 11 36 | 20 28 | 23 26 |
| 25 | 19 3 | 9 14 | 1 39 | 13 3 | 20 52 | 23 25 | 19 46 | 10 55 | 0 41 | 11 57 | 20 41 | 23 25 |
| 26 | 18 49 | 8 52 | 2 3 | 13 23 | 21 3 | 23 23 | 19 33 | 10 35 | 1 4 | 12 18 | 20 52 | 23 23 |
| 27 | 18 33 | 8 29 | 2 26 | 13 42 | 21 14 | 23 21 | 19 20 | 10 14 | 1 27 | 12 39 | 21 4 | 23 21 |
| 28 | 18 18 | 8 7 | 2 50 | 14 1 | 21 24 | 23 19 | 19 6 | 9 53 | 1 51 | 12 59 | 21 15 | 23 19 |
| 29 | 18 2 | | 3 13 | 14 20 | 21 33 | 23 16 | 18 52 | 9 32 | 2 14 | 13 19 | 21 25 | 23 16 |
| 30 | 17 46 | | 3 37 | 14 39 | 21 43 | 23 13 | 18 38 | 9 10 | 2 38 | 13 39 | 21 35 | 23 12 |
| 31 | 17 29 | | 4 0 | | 21 51 | | 18 23 | 8 49 | | 13 59 | | 23 8 |

## DECLINATION OF THE SUN, FOR 1902.

| Day | Jan. | Feb. | Mar. | April | May | June | July | Aug | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ |
| 1 | 23 4S | 17 17S | 7 50S | 4 17N | 14 52N | 21 58N | 23 10N | 18 12N | 8 32N | 2 55S | 14 13S | 21 43S |
| 2 | 22 59 | 17 0 | 7 27 | 4 40 | 15 11 | 22 6 | 23 6 | 17 57 | 8 10 | 3 19 | 14 33 | 21 52 |
| 3 | 22 53 | 16 42 | 7 4 | 5 4 | 15 29 | 22 14 | 23 2 | 17 42 | 7 49 | 3 42 | 14 52 | 22 1 |
| 4 | 22 48 | 16 25 | 6 41 | 5 27 | 15 46 | 22 21 | 22 57 | 17 26 | 7 27 | 4 5 | 15 10 | 22 10 |
| 5 | 22 41 | 16 7 | 6 18 | 5 49 | 16 4 | 22 28 | 22 52 | 17 10 | 7 4 | 4 28 | 15 29 | 22 18 |
| 6 | 22 35 | 15 48 | 5 55 | 6 12 | 16 21 | 22 35 | 22 46 | 16 54 | 6 42 | 4 52 | 15 47 | 22 25 |
| 7 | 22 27 | 15 30 | 5 31 | 6 35 | 16 38 | 22 41 | 22 40 | 16 38 | 6 20 | 5 15 | 16 5 | 22 33 |
| 8 | 22 20 | 15 11 | 5 8 | 6 57 | 16 54 | 22 47 | 22 34 | 16 21 | 5 57 | 5 38 | 16 23 | 22 39 |
| 9 | 22 12 | 14 52 | 4 45 | 7 20 | 17 11 | 22 53 | 22 27 | 16 4 | 5 35 | 6 0 | 16 41 | 22 46 |
| 10 | 22 3 | 14 33 | 4 21 | 7 42 | 17 27 | 22 58 | 22 20 | 15 47 | 5 12 | 6 23 | 16 58 | 22 52 |
| 11 | 21 54 | 14 14 | 3 58 | 8 4 | 17 42 | 23 3 | 22 12 | 15 29 | 4 49 | 6 46 | 17 15 | 22 57 |
| 12 | 21 45 | 13 54 | 3 34 | 8 26 | 17 58 | 23 7 | 22 5 | 15 11 | 4 27 | 7 9 | 17 31 | 23 2 |
| 13 | 21 35 | 13 34 | 3 11 | 8 48 | 18 13 | 23 11 | 21 56 | 14 53 | 4 4 | 7 31 | 17 48 | 23 7 |
| 14 | 21 25 | 13 14 | 2 47 | 9 10 | 18 28 | 23 14 | 21 48 | 14 35 | 3 41 | 7 54 | 18 4 | 23 11 |
| 15 | 21 14 | 12 53 | 2 23 | 9 32 | 18 42 | 23 17 | 21 39 | 14 17 | 3 18 | 8 16 | 18 19 | 23 15 |
| 16 | 21 3 | 12 33 | 2 0 | 9 53 | 18 57 | 23 20 | 21 29 | 13 58 | 2 55 | 8 38 | 18 35 | 23 18 |
| 17 | 20 52 | 12 12 | 1 36 | 10 15 | 19 11 | 23 22 | 21 20 | 13 39 | 2 31 | 9 0 | 18 50 | 23 20 |
| 18 | 20 40 | 11 51 | 1 12 | 10 36 | 19 24 | 23 24 | 21 9 | 13 20 | 2 8 | 9 22 | 19 5 | 23 23 |
| 19 | 20 28 | 11 30 | 0 49 | 10 57 | 19 37 | 23 25 | 20 59 | 13 1 | 1 45 | 9 44 | 19 19 | 23 24 |
| 20 | 20 15 | 11 9 | 0 25 | 11 17 | 19 50 | 23 26 | 20 48 | 12 41 | 1 22 | 10 6 | 19 33 | 23 26 |
| 21 | 20 3 | 10 47 | 0 1S | 11 38 | 20 3 | 23 27 | 20 37 | 12 21 | 0 58 | 10 28 | 19 47 | 23 27 |
| 22 | 19 49 | 10 25 | 0 23N | 11 58 | 20 15 | 23 27 | 20 25 | 12 1 | 0 35 | 10 49 | 20 0 | 23 27 |
| 23 | 19 35 | 10 4 | 0 46 | 12 19 | 20 27 | 23 27 | 20 14 | 11 41 | 0 12N | 11 10 | 20 13 | 23 27 |
| 24 | 19 21 | 9 42 | 1 10 | 12 39 | 20 39 | 23 26 | 20 1 | 11 21 | 0 12S | 11 31 | 20 25 | 23 26 |
| 25 | 19 7 | 9 19 | 1 33 | 12 58 | 20 50 | 23 25 | 19 49 | 11 0 | 0 35 | 11 52 | 20 38 | 23 25 |
| 26 | 18 52 | 8 57 | 1 57 | 13 18 | 21 1 | 23 23 | 19 36 | 10 40 | 0 58 | 12 13 | 20 49 | 23 24 |
| 27 | 18 37 | 8 35 | 2 21 | 13 37 | 21 11 | 23 22 | 19 23 | 10 19 | 1 22 | 12 34 | 21 1 | 23 22 |
| 28 | 18 22 | 8 12 | 2 44 | 13 56 | 21 21 | 23 19 | 19 9 | 9 58 | 1 45 | 12 54 | 21 12 | 23 19 |
| 29 | 18 6 | | 3 7 | 14 15 | 21 31 | 23 17 | 18 55 | 9 37 | 2 9 | 13 14 | 21 23 | 23 16 |
| 30 | 17 50 | | 3 31 | 14 34 | 21 40 | 23 13 | 18 41 | 9 15 | 2 32 | 13 34 | 21 33 | 23 13 |
| 31 | 17 33 | | 3 54 | | 21 49 | | 18 27 | 8 54 | | 13 54 | | 23 9 |

## DECLINATION OF THE SUN. FOR THE YEAR 1903.

### At Apparent Noon at Greenwich.

| Day | Jan. | Feb. | Mar. | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ |
| 1 | 23 5S. | 17 21S. | 7 55S. | 4 12N. | 14 48N. | 21 56N. | 23 11N. | 18 16N. | 8 37N. | 2 50S. | 14 9S. | 21 40S. |
| 2 | 23 0 | 17 4 | 7 33 | 4 35 | 15 6 | 22 4 | 23 7 | 18 1 | 8 16 | 3 13 | 14 28 | 21 50 |
| 3 | 22 55 | 16 47 | 7 10 | 4 58 | 15 24 | 22 12 | 23 3 | 17 46 | 7 54 | 3 36 | 14 47 | 21 59 |
| 4 | 22 49 | 16 29 | 6 47 | 5 21 | 15 42 | 22 20 | 22 58 | 17 30 | 7 32 | 4 0 | 15 6 | 22 8 |
| 5 | 22 43 | 16 11 | 6 24 | 5 44 | 16 0 | 22 27 | 22 53 | 17 14 | 7 10 | 4 23 | 15 25 | 22 16 |
| 6 | 22 36 | 15 53 | 6 0 | 6 7 | 16 17 | 22 34 | 22 48 | 16 58 | 6 48 | 4 46 | 15 43 | 22 24 |
| 7 | 22 29 | 15 35 | 5 37 | 6 29 | 16 34 | 22 40 | 22 42 | 16 42 | 6 25 | 5 9 | 16 1 | 22 31 |
| 8 | 22 22 | 15 16 | 5 14 | 6 52 | 16 50 | 22 46 | 22 35 | 16 25 | 6 3 | 5 32 | 16 19 | 22 38 |
| 9 | 22 14 | 14 57 | 4 51 | 7 14 | 17 7 | 22 52 | 22 29 | 16 8 | 5 40 | 5 55 | 16 37 | 22 44 |
| 10 | 22 6 | 14 38 | 4 27 | 7 37 | 17 23 | 22 57 | 22 22 | 15 51 | 5 18 | 6 18 | 16 54 | 22 50 |
| 11 | 21 57 | 14 19 | 4 4 | 7 59 | 17 39 | 23 2 | 22 14 | 15 33 | 4 55 | 6 41 | 17 11 | 22 56 |
| 12 | 21 47 | 13 59 | 3 40 | 8 21 | 17 54 | 23 6 | 22 6 | 15 16 | 4 32 | 7 3 | 17 27 | 23 1 |
| 13 | 21 38 | 13 39 | 3 17 | 8 43 | 18 9 | 23 10 | 21 58 | 14 58 | 4 9 | 7 26 | 17 44 | 23 6 |
| 14 | 21 28 | 13 19 | 2 53 | 9 5 | 18 24 | 23 13 | 21 50 | 14 40 | 3 46 | 7 48 | 18 0 | 23 10 |
| 15 | 21 17 | 12 59 | 2 29 | 9 26 | 18 39 | 23 16 | 21 41 | 14 21 | 3 23 | 8 11 | 18 16 | 23 14 |
| 16 | 21 6 | 12 38 | 2 6 | 9 48 | 18 53 | 23 19 | 21 32 | 14 3 | 3 0 | 8 33 | 18 31 | 23 17 |
| 17 | 20 55 | 12 17 | 1 42 | 10 9 | 19 7 | 23 21 | 21 22 | 13 44 | 2 37 | 8 55 | 18 46 | 23 20 |
| 18 | 20 43 | 11 56 | 1 18 | 10 30 | 19 21 | 23 23 | 21 12 | 13 25 | 2 14 | 9 17 | 19 1 | 23 22 |
| 19 | 20 31 | 11 35 | 0 55 | 10 51 | 19 34 | 23 25 | 21 2 | 13 5 | 1 51 | 9 39 | 19 16 | 23 24 |
| 20 | 20 19 | 11 14 | 0 31 | 11 12 | 19 47 | 23 26 | 20 51 | 12 46 | 1 27 | 10 1 | 19 30 | 23 26 |
| 21 | 20 6 | 10 53 | 0 7S. | 11 33 | 20 0 | 23 27 | 20 40 | 12 26 | 1 4 | 10 23 | 19 43 | 23 26 |
| 22 | 19 53 | 10 31 | 0 17N. | 11 53 | 20 12 | 23 27 | 20 28 | 12 6 | 0 41 | 10 44 | 19 57 | 23 27 |
| 23 | 19 39 | 10 9 | 0 40 | 12 14 | 20 24 | 23 27 | 20 16 | 11 46 | 0 17N. | 11 5 | 20 10 | 23 27 |
| 24 | 19 25 | 9 47 | 1 4 | 12 34 | 20 36 | 23 26 | 20 4 | 11 26 | 0 6S. | 11 26 | 20 23 | 23 26 |
| 25 | 19 11 | 9 25 | 1 28 | 12 54 | 20 47 | 23 25 | 19 52 | 11 5 | 0 30 | 11 47 | 20 35 | 23 25 |
| 26 | 18 56 | 9 3 | 1 51 | 13 13 | 20 58 | 23 24 | 19 39 | 10 45 | 0 53 | 12 8 | 20 47 | 23 24 |
| 27 | 18 41 | 8 40 | 2 15 | 13 33 | 21 9 | 23 22 | 19 26 | 10 24 | 1 16 | 12 29 | 20 58 | 23 22 |
| 28 | 18 26 | 8 18S. | 2 38 | 13 52 | 21 19 | 23 20 | 19 13 | 10 3 | 1 40 | 12 49 | 21 9 | 23 20 |
| 29 | 18 10 | | 3 2 | 14 11 | 21 29 | 23 17 | 18 59 | 9 42 | 2 3 | 13 9 | 21 20 | 23 17 |
| 30 | 17 54 | | 3 25 | 14 30 | 21 38 | 23 14N. | 18 45 | 9 20 | 2 26S. | 13 29 | 21 30S. | 23 14 |
| 31 | 17 38S. | | 3 48N. | N. | 21 47N. | | 18 30N. | 8 59N. | | 13 49S. | | 23 10S. |

## DECLINATION OF THE SUN, FOR 1904.

| Day | Jan. | Feb. | Mar. | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ |
| 1 | 23 6S. | 17 25S. | 7 38S. | 4 29N. | 15 2N. | 22 2N | 23 8N. | 18 5N. | 8 21N. | 3 7S. | 14 23S. | 21 48S. |
| 2 | 23 1 | 17 8 | 7 15 | 4 52 | 15 20 | 22 10 | 23 4 | 17 49 | 7 59 | 3 31 | 14 42 | 21 57 |
| 3 | 22 56 | 16 51 | 6 52 | 5 15 | 15 38 | 22 18 | 22 59 | 17 34 | 7 37 | 3 54 | 15 1 | 22 5 |
| 4 | 22 50 | 16 33 | 6 29 | 5 38 | 15 55 | 22 25 | 22 54 | 17 18 | 7 15 | 4 17 | 15 20 | 22 14 |
| 5 | 22 44 | 16 16 | 6 6 | 6 1 | 16 13 | 22 32 | 22 49 | 17 2 | 6 53 | 4 40 | 15 39 | 22 22 |
| 6 | 22 38 | 15 58 | 5 43 | 6 24 | 16 30 | 22 38 | 22 43 | 16 46 | 6 31 | 5 3 | 15 57 | 22 29 |
| 7 | 22 31 | 15 39 | 5 20 | 6 46 | 16 46 | 22 44 | 22 37 | 16 29 | 6 8 | 5 26 | 16 15 | 22 36 |
| 8 | 22 24 | 15 21 | 4 56 | 7 9 | 17 3 | 22 50 | 22 30 | 16 12 | 5 46 | 5 49 | 16 32 | 22 43 |
| 9 | 22 16 | 15 2 | 4 33 | 7 31 | 17 19 | 22 55 | 22 23 | 15 55 | 5 23 | 6 12 | 16 50 | 22 49 |
| 10 | 22 8 | 14 43 | 4 9 | 7 54 | 17 35 | 23 0 | 22 16 | 15 38 | 5 1 | 6 35 | 17 7 | 22 55 |
| 11 | 21 59 | 14 23 | 3 46 | 8 16 | 17 50 | 23 5 | 22 8 | 15 20 | 4 38 | 6 58 | 17 23 | 23 0 |
| 12 | 21 50 | 14 4 | 3 22 | 8 38 | 18 6 | 23 9 | 22 0 | 15 2 | 4 15 | 7 20 | 17 40 | 23 5 |
| 13 | 21 40 | 13 44 | 2 59 | 9 0 | 18 21 | 23 12 | 21 51 | 14 44 | 3 52 | 7 43 | 17 56 | 23 9 |
| 14 | 21 30 | 13 24 | 2 35 | 9 21 | 18 35 | 23 16 | 21 43 | 14 26 | 3 29 | 8 5 | 18 12 | 23 13 |
| 15 | 21 20 | 13 4 | 2 11 | 9 43 | 18 50 | 23 19 | 21 34 | 14 7 | 3 6 | 8 28 | 18 27 | 23 16 |
| 16 | 21 9 | 12 43 | 1 48 | 10 4 | 19 4 | 23 21 | 21 24 | 13 48 | 2 43 | 8 50 | 18 43 | 23 19 |
| 17 | 20 58 | 12 22 | 1 24 | 10 25 | 19 18 | 23 23 | 21 14 | 13 29 | 2 20 | 9 12 | 18 58 | 23 22 |
| 18 | 20 46 | 12 1 | 1 0 | 10 46 | 19 31 | 23 25 | 21 4 | 13 10 | 1 56 | 9 34 | 19 12 | 23 24 |
| 19 | 20 34 | 11 40 | 0 37 | 11 7 | 19 44 | 23 26 | 20 53 | 12 51 | 1 33 | 9 56 | 19 26 | 23 25 |
| 20 | 20 22 | 11 19 | 0 13S. | 11 28 | 19 57 | 23 27 | 20 42 | 12 31 | 1 10 | 10 17 | 19 40 | 23 26 |
| 21 | 20 9 | 10 58 | 0 11N. | 11 48 | 20 9 | 23 27 | 20 31 | 12 11 | 0 46 | 10 39 | 19 54 | 23 27 |
| 22 | 19 56 | 10 36 | 0 35 | 12 9 | 20 21 | 23 27 | 20 19 | 11 51 | 0 23N. | 11 0 | 20 7 | 23 27 |
| 23 | 19 42 | 10 14 | 0 58 | 12 29 | 20 33 | 23 26 | 20 7 | 11 31 | 0 0 | 11 21 | 20 19 | 23 27 |
| 24 | 19 28 | 9 52 | 1 22 | 12 49 | 20 44 | 23 25 | 19 55 | 11 10 | 0 24S. | 11 42 | 20 32 | 23 26 |
| 25 | 19 14 | 9 30 | 1 45 | 13 8 | 20 55 | 23 24 | 19 42 | 10 50 | 0 47 | 12 3 | 20 44 | 23 25 |
| 26 | 19 0 | 9 8 | 2 9 | 13 28 | 21 6 | 23 22 | 19 29 | 10 29 | 1 10 | 12 24 | 20 55 | 23 23 |
| 27 | 18 45 | 8 46 | 2 33 | 13 47 | 21 16 | 23 20 | 19 16 | 10 8 | 1 34 | 12 44 | 21 6 | 23 20 |
| 28 | 18 29 | 8 23 | 2 56 | 14 6 | 21 26 | 23 18 | 19 2 | 9 47 | 1 57 | 13 4 | 21 17 | 23 18 |
| 29 | 18 14 | 8 0S. | 3 19 | 14 25 | 21 36 | 23 15 | 18 48 | 9 26 | 2 21 | 13 24 | 21 28 | 23 15 |
| 30 | 17 58 | | 3 43 | 14 44N. | 21 45 | 23 12N. | 18 34 | 9 4 | 2 44S. | 13 44 | 21 38S. | 23 11 |
| 31 | 17 42S. | | 4 6N. | | 21 54N. | | 18 19N. | 8 43N. | | 14 4S. | | 23 7S. |

## CORRECTION OF THE SUN'S DECLINATION, IN TABLE 60, FOR THE YEARS FOLLOWING 1901, 1902, 1903, 1904.

| Given Years. | Following Years. | | | | | | Given Years. | Following Years. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1901<br>1902<br>1903<br>1904 | 1905<br>1906<br>1907<br>1908 | 1909<br>1910<br>1911<br>1912 | 1913<br>1914<br>1915<br>1916 | 1917<br>1918<br>1919<br>1920 | 1921<br>1922<br>1923<br>1924 | 1925<br>1926<br>1927<br>1928 | 1901<br>1902<br>1903<br>1904 | 1905<br>1906<br>1907<br>1908 | 1909<br>1910<br>1911<br>1912 | 1913<br>1914<br>1915<br>1916 | 1917<br>1918<br>1919<br>1920 | 1921<br>1922<br>1923<br>1924 | 1925<br>1926<br>1927<br>1928 |
| | *sub.* | *sub.* | *sub.* | *sub.* | *sub.* | *sub.* | | *sub.* | *sub.* | *sub.* | *sub.* | *sub.* | *sub.* |
| Jan. 1 | 0'·1 | 0'·3 | 0'·4 | 0'·6 | 0'·7 | 0'·9 | June 30 | 0'·1 | 0'·3 | 0'·4 | 0'·6 | 0'·7 | 0'·8 |
| 10 | 0·2 | 0·5 | 0·8 | 1·0 | 1·3 | 1·6 | July 10 | 0·2 | 0·5 | 0·8 | 1·0 | 1·3 | 1·6 |
| 20 | 0·4 | 0·7 | 1·1 | 1·4 | 1·8 | 2·2 | 20 | 0·4 | 0·7 | 1·1 | 1·4 | 1·8 | 2·2 |
| 30 | 0·5 | 1·0 | 1·5 | 2·0 | 2·5 | 3·0 | 30 | 0·5 | 1·0 | 1·5 | 2·0 | 2·5 | 3·0 |
| Feb. 10 | 0·6 | 1·1 | 1·6 | 2·2 | 2·8 | 3·4 | Aug. 10 | 0·5 | 1·1 | 1·7 | 2·3 | 2·8 | 3·4 |
| 20 | 0·6 | 1·2 | 1·9 | 2·5 | 3·1 | 3·7 | 20 | 0·6 | 1·3 | 1·9 | 2·5 | 3·2 | 3·9 |
| 28 | 0·7 | 1·3 | 2·0 | 2·6 | 3·3 | 4·0 | 30 | 0·7 | 1·4 | 2·0 | 2·7 | 3·4 | 4·1 |
| Mar. 10 | 0·7 | 1·4 | 2·1 | 2·8 | 3·5 | 4·2 | Sept. 10 | 0·7 | 1·4 | 2·1 | 2·8 | 3·5 | 4·2 |
| 20 | 0·7 | 1·4 | 2·1 | 2·8 | 3·6 | 4·3 | 20 | 0·7 | 1·4 | 2·1 | 2·9 | 3·6 | 4·3 |
| | *add* | *add* | *add* | *add* | *add* | *add* | | *add* | *add* | *add* | *add* | *add* | *add* |
| 30 | 0·7 | 1·4 | 2·1 | 2·8 | 3·5 | 4·2 | 30 | 0·7 | 1·4 | 2·1 | 2·8 | 3·5 | 4·2 |
| Apr. 10 | 0·7 | 1·4 | 2·1 | 2·7 | 3·4 | 4·1 | Oct. 10 | 0·7 | 1·4 | 2·0 | 2·7 | 3·4 | 4·1 |
| 20 | 0·6 | 1·3 | 1·9 | 2·5 | 3·2 | 3·9 | 20 | 0·6 | 1·3 | 1·9 | 2·5 | 3·2 | 3·9 |
| 30 | 0·6 | 1·1 | 1·7 | 2·3 | 2·8 | 3·4 | 30 | 0·5 | 1·1 | 1·6 | 2·2 | 2·8 | 3·4 |
| May 10 | 0·5 | 0·9 | 1·5 | 2·0 | 2·5 | 3·0 | Nov. 10 | 0·5 | 1·0 | 1·4 | 1·9 | 2·4 | 2·8 |
| 20 | 0·4 | 0·8 | 1·2 | 1·6 | 1·9 | 2·3 | 20 | 0·4 | 0·8 | 1·2 | 1·5 | 2·0 | 2·5 |
| 30 | 0·3 | 0·5 | 0·8 | 1·0 | 1·4 | 1·7 | 30 | 0·2 | 0·5 | 0·7 | 1·0 | 1·3 | 1·6 |
| June 10 | 0·2 | 0·3 | 0·4 | 0·5 | 0·7 | 0·9 | Dec. 10 | 0·2 | 0·3 | 0·4 | 0·6 | 0·7 | 0·8 |
| 20 | 0·0 | 0·0 | 0·1 | 0·1 | 0·1 | 0·1 | 20 | 0·0 | 0·0 | 0·1 | 0·1 | 0·2 | 0·3 |
| | *sub.* | *sub.* | *sub.* | *sub.* | *sub.* | *sub.* | | *sub.* | *sub.* | *sub.* | *sub.* | *sub.* | *sub.* |
| 30 | 0·1 | 0·3 | 0·4 | 0·6 | 0·7 | 0·8 | 30 | 0·1 | 0·3 | 0·4 | 0·6 | 0·7 | 0·9 |

## SIDEREAL TIME, FOR THE YEAR 1901,
### At Mean Noon at Greenwich.

| Day | Jan. | Feb. | Mar. | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | h m | h m | h m | h m | h m | h m | h m | h m | h m | h m | h m | h m |
| 1 | 18 41·8 | 20 44 | 22 34·4 | 0 36·6 | 2 34·9 | 4 37·1 | 6 35·4 | 8 37·6 | 10 39·8 | 12 38·1 | 14 40·3 | 16 38·6 |
| 2 | 18 45·7 | 20 47·9 | 22 38·3 | 0 40·5 | 2 38·8 | 4 41 | 6 39·3 | 8 41·5 | 10 43·8 | 12 42 | 14 44·3 | 16 42·5 |
| 3 | 18 49·7 | 20 51·9 | 22 42·3 | 0 44·5 | 2 42·8 | 4 45 | 6 43·3 | 8 45·5 | 10 47·7 | 12 46 | 14 48·2 | 16 46·5 |
| 4 | 18 53·6 | 20 55·8 | 22 46·2 | 0 48·4 | 2 46·7 | 4 48·9 | 6 47·2 | 8 49·4 | 10 51·6 | 12 49·9 | 14 52·1 | 16 50·4 |
| 5 | 18 57·5 | 20 59·8 | 22 50·2 | 0 52·4 | 2 50·6 | 4 52·9 | 6 51·1 | 8 53·4 | 10 55·6 | 12 53·9 | 14 56·1 | 16 54·4 |
| 6 | 19 1·5 | 21 3·7 | 22 54·1 | 0 56·3 | 2 54·6 | 4 56·8 | 6 55·1 | 8 57·3 | 10 59·5 | 12 57·8 | 15 0 | 16 58·3 |
| 7 | 19 5·4 | 21 7·6 | 22 58 | 1 0·3 | 2 58·5 | 5 0·8 | 6 59 | 9 1·3 | 11 3·5 | 13 1·7 | 15 4 | 17 2·2 |
| 8 | 19 9·4 | 21 11·6 | 23 2 | 1 4·2 | 3 2·5 | 5 4·7 | 7 3 | 9 5·2 | 11 7·4 | 13 5·7 | 15 7·9 | 17 6·2 |
| 9 | 19 13·3 | 21 15·5 | 23 5·9 | 1 8·1 | 3 6·4 | 5 8·6 | 7 6·9 | 9 9·1 | 11 11·4 | 13 9·6 | 15 11·9 | 17 10·1 |
| 10 | 19 17·3 | 21 19·5 | 23 9·9 | 1 12·1 | 3 10·4 | 5 12·6 | 7 10·9 | 9 13·1 | 11 15·3 | 13 13·6 | 15 15·8 | 17 14·1 |
| 11 | 19 21·2 | 21 23·4 | 23 13·8 | 1 16 | 3 14·3 | 5 16·5 | 7 14·8 | 9 17 | 11 19·2 | 13 17·5 | 15 19·7 | 17 18 |
| 12 | 19 25·1 | 21 27·4 | 23 17·7 | 1 20 | 3 18·2 | 5 20·5 | 7 18·7 | 9 21 | 11 23·2 | 13 21·5 | 15 23·7 | 17 22 |
| 13 | 19 29·1 | 21 31·3 | 23 21·7 | 1 23·9 | 3 22·2 | 5 24·4 | 7 22·7 | 9 24·9 | 11 27·1 | 13 25·4 | 15 27·6 | 17 25·9 |
| 14 | 19 33 | 21 35·2 | 23 25·6 | 1 27·9 | 3 26·1 | 5 28·3 | 7 26·6 | 9 28·8 | 11 31·1 | 13 29·3 | 15 31·6 | 17 29·8 |
| 15 | 19 37 | 21 39·2 | 23 29·6 | 1 31·8 | 3 30·1 | 5 32·3 | 7 30·6 | 9 32·8 | 11 35 | 13 33·3 | 15 35·5 | 17 33·8 |
| 16 | 19 40·9 | 21 43·1 | 23 33·5 | 1 35·7 | 3 34 | 5 36·2 | 7 34·5 | 9 36·7 | 11 39 | 13 37·2 | 15 39·4 | 17 37·7 |
| 17 | 19 44·8 | 21 47·1 | 23 37·5 | 1 39·7 | 3 38 | 5 40·2 | 7 38·5 | 9 40·7 | 11 42·9 | 13 41·2 | 15 43·4 | 17 41·7 |
| 18 | 19 48·8 | 21 51 | 23 41·4 | 1 43·6 | 3 41·9 | 5 44·1 | 7 42·4 | 9 44·6 | 11 46·8 | 13 45·1 | 15 47·3 | 17 45·6 |
| 19 | 19 52·7 | 21 54 | 23 45·3 | 1 47·6 | 3 45·8 | 5 48·1 | 7 46·3 | 9 48·6 | 11 50·8 | 13 49·1 | 15 51·3 | 17 49·6 |
| 20 | 19 56·7 | 21 58·9 | 23 49·3 | 1 51·5 | 3 49·8 | 5 52 | 7 50·3 | 9 52·5 | 11 54·7 | 13 53 | 15 55·2 | 17 53·5 |
| 21 | 20 0·6 | 22 2·8 | 23 53·2 | 1 55·4 | 3 53·7 | 5 55·9 | 7 54·2 | 9 56·4 | 11 58·7 | 13 56·9 | 15 59·2 | 17 57·4 |
| 22 | 20 4·6 | 22 6·8 | 23 57·2 | 1 59·4 | 3 57·7 | 5 59·9 | 7 58·2 | 10 0·4 | 12 2·6 | 14 0·9 | 16 3·1 | 18 1·4 |
| 23 | 20 8·5 | 22 10·7 | 0 1·1 | 2 3·3 | 4 1·6 | 6 3·8 | 8 2·1 | 10 4·3 | 12 6·6 | 14 4·8 | 16 7 | 18 5·3 |
| 24 | 20 12·4 | 22 14·7 | 0 5·1 | 2 7·3 | 4 5·6 | 6 7·8 | 8 6·1 | 10 8·3 | 12 10·5 | 14 8·8 | 16 11 | 18 9·3 |
| 25 | 20 16·4 | 22 18·6 | 0 9 | 2 11·2 | 4 9·5 | 6 11·7 | 8 10 | 10 12·2 | 12 14·4 | 14 12·7 | 16 14·9 | 18 13·2 |
| 26 | 20 20·3 | 22 22·6 | 0 12·9 | 2 15·2 | 4 13·4 | 6 15·7 | 8 13·9 | 10 16·2 | 12 18·4 | 14 16·7 | 16 18·9 | 18 17·2 |
| 27 | 20 24·3 | 22 26·5 | 0 16·9 | 2 19·1 | 4 17·4 | 6 19·6 | 8 17·9 | 10 20·1 | 12 22·3 | 14 20·6 | 16 22·8 | 18 21·1 |
| 28 | 20 28·2 | 22 30·4 | 0 20·8 | 2 23 | 4 21·3 | 6 23·5 | 8 21·8 | 10 24 | 12 26·3 | 14 24·5 | 16 26·8 | 18 25 |
| 29 | 20 32·2 | | 0 24·8 | 2 27 | 4 25·3 | 6 27·5 | 8 25·8 | 10 28 | 12 30·2 | 14 28·5 | 16 30·7 | 18 29 |
| 30 | 20 36·1 | | 0 28·7 | 2 30·9 | 4 29·2 | 6 31·4 | 8 29·7 | 10 31·9 | 12 34·1 | 14 32·4 | 16 34·6 | 18 32·9 |
| 31 | 20 40 | | 0 32·7 | | 4 33·2 | | 8 33·7 | 10 35·9 | | 14 36·4 | | 18 36·9 |

### SIDEREAL TIME, FOR 1902.

| Day | Jan. | Feb. | Mar. | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 18 40·8 | 20 43 | 22 33·4 | 0 35·6 | 2 33·9 | 4 36·1 | 6 34·4 | 8 36·6 | 10 38·9 | 12 37·1 | 14 39·3 | 16 37·6 |
| 2 | 18 44·8 | 20 47 | 22 37·4 | 0 39·6 | 2 37·9 | 4 40·1 | 6 38·4 | 8 40·6 | 10 42·8 | 12 41·1 | 14 43·3 | 16 41·6 |
| 3 | 18 48·7 | 20 50·9 | 22 41·3 | 0 43·5 | 2 41·8 | 4 44 | 6 42·3 | 8 44·5 | 10 46·7 | 12 45 | 14 47·2 | 16 45·5 |
| 4 | 18 52·6 | 20 54·9 | 22 45·2 | 0 47·5 | 2 45·7 | 4 48 | 6 46·2 | 8 48·5 | 10 50·7 | 12 49 | 14 51·2 | 16 49·5 |
| 5 | 18 56·6 | 20 58·8 | 22 49·2 | 0 51·4 | 2 49·7 | 4 51·9 | 6 50·2 | 8 52·4 | 10 54·6 | 12 52·9 | 14 55·1 | 16 53·4 |
| 6 | 19 0·5 | 21 2·7 | 22 53·1 | 0 55·4 | 2 53·6 | 4 55·8 | 6 54·1 | 8 56·3 | 10 58·6 | 12 56·8 | 14 59·1 | 16 57·3 |
| 7 | 19 4·5 | 21 6·7 | 22 57·1 | 0 59·3 | 2 57·6 | 4 59·8 | 6 58·1 | 9 0·3 | 11 2·5 | 13 0·8 | 15 3 | 17 1·3 |
| 8 | 19 8·4 | 21 10·6 | 23 1 | 1 3·2 | 3 1·5 | 5 3·7 | 7 2 | 9 4·2 | 11 6·5 | 13 4·7 | 15 6·9 | 17 5·2 |
| 9 | 19 12·3 | 21 14·6 | 23 5 | 1 7·2 | 3 5·5 | 5 7·7 | 7 6 | 9 8·2 | 11 10·4 | 13 8·7 | 15 10·9 | 17 9·2 |
| 10 | 19 16·3 | 21 18·5 | 23 8·9 | 1 11·1 | 3 9·4 | 5 11·6 | 7 9·9 | 9 12·1 | 11 14·3 | 13 12·6 | 15 14·8 | 17 13·1 |
| 11 | 19 20·2 | 21 22·5 | 23 12·8 | 1 15·1 | 3 13·3 | 5 15·6 | 7 13·8 | 9 16·1 | 11 18·3 | 13 16·6 | 15 18·8 | 17 17·1 |
| 12 | 19 24·2 | 21 26·4 | 23 16·8 | 1 19 | 3 17·3 | 5 19·5 | 7 17·8 | 9 20 | 11 22·2 | 13 20·5 | 15 22·7 | 17 21 |
| 13 | 19 28·1 | 21 30·3 | 23 20·7 | 1 23 | 3 21·2 | 5 23·4 | 7 21·7 | 9 23·9 | 11 26·2 | 13 24·4 | 15 26·7 | 17 24·9 |
| 14 | 19 32·1 | 21 34·3 | 23 24·7 | 1 26·9 | 3 25·2 | 5 27·4 | 7 25·7 | 9 27·9 | 11 30·1 | 13 28·4 | 15 30·6 | 17 28·9 |
| 15 | 19 36 | 21 38·2 | 23 28·6 | 1 30·8 | 3 29·1 | 5 31·3 | 7 29·6 | 9 31·8 | 11 34·1 | 13 32·3 | 15 34·5 | 17 32·8 |
| 16 | 19 39·9 | 21 42·2 | 23 32·6 | 1 34·8 | 3 33·1 | 5 35·3 | 7 33·6 | 9 35·8 | 11 38 | 13 36·3 | 15 38·5 | 17 36·8 |
| 17 | 19 43·9 | 21 46·1 | 23 36·5 | 1 38·7 | 3 37 | 5 39·2 | 7 37·5 | 9 39·7 | 11 41·9 | 13 40·2 | 15 42·4 | 17 40·7 |
| 18 | 19 47·8 | 21 50·1 | 3 40·4 | 1 42·7 | 3 40·9 | 5 43·2 | 7 41·4 | 9 43·7 | 11 45·9 | 13 44·2 | 15 46·4 | 17 44·7 |
| 19 | 19 51·8 | 21 54 | 23 44·4 | 1 46·6 | 3 44·9 | 5 47·1 | 7 45·4 | 9 47·6 | 11 49·8 | 13 48·1 | 15 50·3 | 17 48·6 |
| 20 | 19 55·7 | 21 57·9 | 23 48·3 | 1 50·5 | 3 48·8 | 5 51 | 7 49·3 | 9 51·5 | 11 53·8 | 13 52 | 15 54·3 | 17 52·5 |
| 21 | 19 59·7 | 22 1·9 | 23 52·3 | 1 54·5 | 3 52·8 | 5 55 | 7 53·3 | 9 55·5 | 11 57·7 | 13 56 | 15 58·2 | 17 56·5 |
| 22 | 20 3·6 | 22 5·8 | 23 56·2 | 1 58·4 | 3 56·7 | 5 58·9 | 7 57·2 | 9 59·4 | 12 1·6 | 13 59·9 | 16 2·1 | 18 0·4 |
| 23 | 20 7·5 | 22 9·8 | 0 0·2 | 2 2·4 | 4 0·7 | 6 2·9 | 8 1·2 | 10 3·4 | 12 5·6 | 14 3·9 | 16 6·1 | 18 4·4 |
| 24 | 20 11·5 | 22 13·7 | 0 4·1 | 2 6·3 | 4 4·6 | 6 6·8 | 8 5·1 | 10 7·3 | 12 9·5 | 14 7·8 | 16 10 | 18 8·3 |
| 25 | 20 15·4 | 22 17·7 | 0 8 | 2 10·3 | 4 8·5 | 6 10·8 | 8 9 | 10 11·3 | 12 13·5 | 14 11·8 | 16 14 | 18 12·3 |
| 26 | 20 19·4 | 22 21·6 | 0 12 | 2 14·2 | 4 12·5 | 6 14·7 | 8 13 | 10 15·2 | 12 17·4 | 14 15·7 | 16 17·9 | 18 16·2 |
| 27 | 20 23·3 | 22 25·5 | 0 15·9 | 2 18·1 | 4 16·4 | 6 18·6 | 8 16·9 | 10 19·1 | 12 21·4 | 14 19·6 | 16 21·9 | 18 20·1 |
| 28 | 20 27·3 | 22 29·5 | 0 19·9 | 2 22·1 | 4 20·4 | 6 22·6 | 8 20·9 | 10 23·1 | 12 25·3 | 14 23·6 | 16 25·8 | 18 24·1 |
| 29 | 20 31·2 | | 0 23·8 | 2 26 | 4 24·3 | 6 26·5 | 8 24·8 | 10 27 | 12 29·2 | 14 27·5 | 16 29·7 | 18 28 |
| 30 | 20 35·1 | | 0 27·7 | 2 30 | 4 28·3 | 6 30·5 | 8 28·8 | 10 31 | 12 33·2 | 14 31·5 | 16 33·7 | 18 32 |
| 31 | 20 39·1 | | 0 31·7 | | 4 32·2 | | 8 32·7 | 10 34·9 | | 14 35·4 | | 18 35·9 |

## SIDEREAL TIME, for the Year 1903,

### At Mean Noon at Greenwich.

| Day | Jan. | Feb. | Mar. | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | h m | h m | h m | h m | h m | h m | h m | h m | h m | h m | h m | h m |
| 1 | 18 39·8 | 20 42·1 | 22 32·5 | 0 34·7 | 2 33·0 | 4 35·2 | 6 33·5 | 8 35·7 | 10 37·9 | 12 36·2 | 14 38·4 | 16 36·7 |
| 2 | 18 43·8 | 20 46·0 | 22 36·4 | 0 38·6 | 2 36·9 | 4 39·1 | 6 37·4 | 8 39·6 | 10 41·8 | 12 40·1 | 14 42·3 | 16 40·6 |
| 3 | 18 47·7 | 20 50·0 | 22 40·3 | 0 42·6 | 2 40·8 | 4 43·1 | 6 41·3 | 8 43·6 | 10 45·8 | 12 44·1 | 14 46·3 | 16 44·6 |
| 4 | 18 51·7 | 20 53·9 | 22 44·3 | 0 46·5 | 2 44·8 | 4 47·0 | 6 45·3 | 8 47·5 | 10 49·7 | 12 48·0 | 14 50·2 | 16 48·5 |
| 5 | 18 55·6 | 20 57·8 | 22 48·2 | 0 50·4 | 2 48·7 | 4 50·9 | 6 49·2 | 8 51·4 | 10 53·7 | 12 51·9 | 14 54·2 | 16 52·4 |
| 6 | 18 59·6 | 21 1·8 | 22 52·2 | 0 54·4 | 2 52·7 | 4 54·9 | 6 53·2 | 8 55·4 | 10 57·6 | 12 55·9 | 14 58·1 | 16 56·4 |
| 7 | 19 3·5 | 21 5·7 | 22 56·1 | 0 58·3 | 2 56·6 | 4 58·8 | 6 57·1 | 8 59·3 | 11 1·5 | 12 59·8 | 15 2·1 | 17 0·3 |
| 8 | 19 7·4 | 21 9·7 | 23 0·1 | 1 2·3 | 3 0·6 | 5 2·8 | 7 1·1 | 9 3·3 | 11 5·5 | 13 3·8 | 15 6·0 | 17 4·3 |
| 9 | 19 11·4 | 21 13·6 | 23 4·0 | 1 6·2 | 3 4·5 | 5 6·7 | 7 5·0 | 9 7·2 | 11 9·4 | 13 7·7 | 15 9·9 | 17 8·2 |
| 10 | 19 15·3 | 21 17·6 | 23 7·9 | 1 10·2 | 3 8·4 | 5 10·7 | 7 8·9 | 9 11·2 | 11 13·4 | 13 11·7 | 15 13·9 | 17 12·2 |
| 11 | 19 19·3 | 21 21·5 | 23 11·9 | 1 14·1 | 3 12·4 | 5 14·6 | 7 12·9 | 9 15·1 | 11 17·3 | 13 15·6 | 15 17·8 | 17 16·1 |
| 12 | 19 23·2 | 21 25·4 | 23 15·8 | 1 18·0 | 3 16·3 | 5 18·5 | 7 16·8 | 9 19·0 | 11 21·3 | 13 19·5 | 15 21·8 | 17 20·0 |
| 13 | 19 27·2 | 21 29·4 | 23 19·8 | 1 22·0 | 3 20·3 | 5 22·5 | 7 20·8 | 9 23·0 | 11 25·2 | 13 23·5 | 15 25·7 | 17 24·0 |
| 14 | 19 31·1 | 21 33·3 | 23 23·7 | 1 25·9 | 3 24·2 | 5 26·4 | 7 24·7 | 9 26·9 | 11 29·1 | 13 27·4 | 15 29·6 | 17 27·9 |
| 15 | 19 35·0 | 21 37·3 | 23 27·7 | 1 29·9 | 3 28·2 | 5 30·4 | 7 28·7 | 9 30·9 | 11 33·1 | 13 31·4 | 15 33·6 | 17 31·9 |
| 16 | 19 39·0 | 21 41·2 | 23 31·6 | 1 33·8 | 3 32·1 | 5 34·3 | 7 32·6 | 9 34·8 | 11 37·0 | 13 35·3 | 15 37·5 | 17 35·8 |
| 17 | 19 42·9 | 21 45·2 | 23 35·5 | 1 37·8 | 3 36·0 | 5 38·3 | 7 36·5 | 9 38·8 | 11 41·0 | 13 39·3 | 15 41·5 | 17 39·7 |
| 18 | 19 46·9 | 21 49·1 | 23 39·5 | 1 41·7 | 3 40·0 | 5 42·2 | 7 40·5 | 9 42·7 | 11 44·9 | 13 43·2 | 15 45·4 | 17 43·7 |
| 19 | 19 50·8 | 21 53·0 | 23 43·4 | 1 45·6 | 3 43·9 | 5 46·1 | 7 44·4 | 9 46·6 | 11 48·9 | 13 47·1 | 15 49·4 | 17 47·6 |
| 20 | 19 54·8 | 21 57·0 | 23 47·4 | 1 49·6 | 3 47·9 | 5 50·1 | 7 48·4 | 9 50·6 | 11 52·8 | 13 51·1 | 15 53·3 | 17 51·6 |
| 21 | 19 58·7 | 22 0·9 | 23 51·3 | 1 53·5 | 3 51·8 | 5 54·0 | 7 52·3 | 9 54·5 | 11 56·7 | 13 55·0 | 15 57·2 | 17 55·5 |
| 22 | 20 2·6 | 22 4·9 | 23 55·3 | 1 57·5 | 3 55·8 | 5 58·0 | 7 56·2 | 9 58·5 | 12 0·7 | 13 59·0 | 16 1·2 | 17 59·5 |
| 23 | 20 6·6 | 22 8·8 | 23 59·2 | 2 1·4 | 3 59·7 | 6 1·9 | 8 0·2 | 10 2·4 | 12 4·6 | 14 2·9 | 16 5·1 | 18 3·4 |
| 24 | 20 10·5 | 22 12·7 | 0 3·1 | 2 5·4 | 4 3·6 | 6 5·9 | 8 4·2 | 10 6·4 | 12 8·6 | 14 6·8 | 16 9·1 | 18 7·3 |
| 25 | 20 14·5 | 22 16·7 | 0 7·1 | 2 9·3 | 4 7·6 | 6 9·8 | 8 8·1 | 10 10·3 | 12 12·5 | 14 10·8 | 16 13·0 | 18 11·3 |
| 26 | 20 18·4 | 22 20·6 | 0 11·0 | 2 13·2 | 4 11·5 | 6 13·7 | 8 12·0 | 10 14·2 | 12 16·5 | 14 14·7 | 16 17·0 | 18 15·2 |
| 27 | 20 22·4 | 22 24·6 | 0 15·0 | 2 17·2 | 4 15·5 | 6 17·7 | 8 16·0 | 10 18·2 | 12 20·4 | 14 18·7 | 16 20·9 | 18 19·2 |
| 28 | 20 26·3 | 22 28·5 | 0 18·9 | 2 21·1 | 4 19·4 | 6 21·6 | 8 19·9 | 10 22·1 | 12 24·3 | 14 22·6 | 16 24·8 | 18 23·1 |
| 29 | 20 30·2 | | 0 22·9 | 2 25·1 | 4 23·3 | 6 25·6 | 8 23·8 | 10 26·1 | 12 28·3 | 14 26·6 | 16 28·8 | 18 27·1 |
| 30 | 20 34·2 | | 0 26·8 | 2 29·0 | 4 27·3 | 6 29·5 | 8 27·8 | 10 30·0 | 12 32·2 | 14 30·5 | 16 32·7 | 18 31·0 |
| 31 | 20 38·1 | | 0 30·7 | | 4 31·2 | | 8 31·7 | 10 34·0 | | 14 34·4 | | 18 34·9 |

### Sidereal Time, for 1904.

| Day | Jan. | Feb. | Mar. | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 18 38·9 | 20 41·1 | 22 35·4 | 0 37·7 | 2 35·9 | 4 38·2 | 6 36·4 | 8 38·7 | 10 40·9 | 12 39·2 | 14 41·4 | 16 39·6 |
| 2 | 18 42·8 | 20 45·1 | 22 39·4 | 0 41·6 | 3 39·9 | 4 42·1 | 6 40·4 | 8 42·6 | 10 44·8 | 12 43·1 | 14 45·3 | 16 43·6 |
| 3 | 18 46·8 | 20 49·0 | 22 43·3 | 0 45·5 | 2 43·8 | 4 46·0 | 6 44·3 | 8 46·5 | 10 48·8 | 12 47·0 | 14 49·3 | 16 47·5 |
| 4 | 18 50·7 | 20 52·9 | 22 47·3 | 0 49·5 | 2 47·8 | 4 49·0 | 6 48·3 | 8 50·5 | 10 52·7 | 12 51·0 | 14 53·2 | 16 51·5 |
| 5 | 18 54·7 | 20 56·9 | 22 51·2 | 0 53·4 | 2 51·7 | 4 53·9 | 6 52·2 | 8 54·4 | 10 56·6 | 12 54·9 | 14 57·2 | 16 55·4 |
| 6 | 18 58·6 | 21 0·8 | 22 55·2 | 0 57·4 | 2 55·7 | 4 57·9 | 6 56·1 | 8 58·4 | 11 0·6 | 12 58·9 | 15 1·1 | 16 59·4 |
| 7 | 19 2·5 | 21 4·8 | 22 59·1 | 1 1·3 | 2 59·6 | 5 1·8 | 7 0·1 | 9 2·3 | 11 4·5 | 13 2·8 | 15 5·0 | 17 3·3 |
| 8 | 19 6·5 | 21 8·7 | 23 3·0 | 1 5·3 | 3 3·5 | 5 5·8 | 7 4·0 | 9 6·3 | 11 8·5 | 13 6·8 | 15 9·0 | 17 7·2 |
| 9 | 19 10·4 | 21 12·6 | 23 7·0 | 1 9·2 | 3 7·5 | 5 9·7 | 7 8·0 | 9 10·2 | 11 12·4 | 13 10·7 | 15 12·9 | 17 11·2 |
| 10 | 19 14·4 | 21 16·6 | 23 10·9 | 1 13·1 | 3 11·4 | 5 13·6 | 7 11·9 | 9 14·1 | 11 16·3 | 13 14·6 | 15 16·9 | 17 15·1 |
| 11 | 19 18·3 | 21 20·5 | 23 14·9 | 1 17·1 | 3 15·4 | 5 17·6 | 7 15·9 | 9 18·1 | 11 20·3 | 13 18·6 | 15 20·8 | 17 19·1 |
| 12 | 19 22·3 | 21 24·5 | 23 18·8 | 1 21·0 | 3 19·3 | 5 21·5 | 7 19·8 | 9 22·0 | 11 24·2 | 13 22·5 | 15 24·7 | 17 23·0 |
| 13 | 19 26·2 | 21 28·4 | 23 22·8 | 1 24·0 | 3 23·2 | 5 25·5 | 7 23·7 | 9 26·0 | 11 28·2 | 13 26·5 | 15 28·7 | 17 27·0 |
| 14 | 19 30·2 | 21 32·4 | 23 26·7 | 1 28·9 | 3 27·2 | 5 29·4 | 7 27·7 | 9 29·9 | 11 32·1 | 13 30·4 | 15 32·6 | 17 30·9 |
| 15 | 19 34·1 | 21 36·3 | 23 30·6 | 1 32·9 | 3 31·1 | 5 33·4 | 7 31·6 | 9 33·9 | 11 36·1 | 13 34·3 | 15 36·6 | 17 34·8 |
| 16 | 19 38·0 | 21 40·2 | 23 34·6 | 1 36·8 | 3 35·1 | 5 37·3 | 7 35·6 | 9 37·8 | 11 40·0 | 13 38·3 | 15 40·5 | 17 38·8 |
| 17 | 19 42·0 | 21 44·2 | 23 38·5 | 1 40·7 | 3 39·0 | 5 41·2 | 7 39·5 | 9 41·7 | 11 44·0 | 13 42·2 | 15 44·5 | 17 42·7 |
| 18 | 19 45·9 | 21 48·1 | 23 42·5 | 1 44·7 | 3 43·0 | 5 45·2 | 7 43·5 | 9 45·7 | 11 47·9 | 13 46·2 | 15 48·4 | 17 46·7 |
| 19 | 19 49·8 | 21 52·1 | 23 46·4 | 1 48·6 | 3 46·9 | 5 49·1 | 7 47·4 | 9 49·6 | 11 51·8 | 13 50·1 | 15 52·3 | 17 50·6 |
| 20 | 19 53·8 | 21 56·0 | 23 50·4 | 1 52·6 | 3 50·8 | 5 53·1 | 7 51·3 | 9 53·6 | 11 55·8 | 12 54·1 | 15 56·3 | 17 54·6 |
| 21 | 19 57·7 | 22 0·0 | 23 54·3 | 1 56·5 | 3 54·8 | 5 57·0 | 7 55·3 | 9 57·5 | 11 59·7 | 13 58·0 | 16 0·2 | 17 58·5 |
| 22 | 20 1·7 | 22 3·9 | 23 58·2 | 2 0·5 | 3 58·7 | 6 1·0 | 7 59·2 | 10 1·5 | 12 3·7 | 14 1·9 | 16 4·2 | 18 2·4 |
| 23 | 20 5·6 | 22 7·8 | 0 2·2 | 2 4·4 | 4 2·7 | 6 4·9 | 8 3·2 | 10 5·4 | 12 7·6 | 14 5·9 | 16 8·1 | 18 6·4 |
| 24 | 20 9·6 | 22 11·8 | 0 6·1 | 2 8·3 | 4 6·6 | 6 8·8 | 8 7·1 | 10 9·3 | 12 11·6 | 14 9·8 | 16 12·1 | 18 10·3 |
| 25 | 20 13·5 | 22 15·7 | 0 10 1 | 2 12·3 | 4 10·6 | 6 12·8 | 8 11·1 | 10 13·3 | 12 15·5 | 14 13·8 | 16 16·0 | 18 14·3 |
| 26 | 20 17·5 | 22 19·7 | 0 14·0 | 2 16·2 | 4 14·5 | 6 16·7 | 8 15·0 | 10 17·2 | 12 19·4 | 14 17·7 | 16 19·9 | 18 18·2 |
| 27 | 20 21·4 | 22 23·6 | 0 17·9 | 2 20·2 | 4 18·4 | 6 20·7 | 8 18·9 | 10 21·2 | 12 23·4 | 14 21·7 | 16 23·9 | 18 22·2 |
| 28 | 20 25·3 | 22 27·6 | 0 21·9 | 2 24·1 | 4 22·4 | 6 24·6 | 8 22·9 | 10 25·1 | 12 27·3 | 14 25·6 | 16 27·8 | 18 26·1 |
| 29 | 20 29·3 | 22 31 5 | 0 25·8 | 2 28·1 | 4 26·3 | 6 28·6 | 8 26·8 | 10 29·0 | 12 31·3 | 14 29·5 | 16 31·8 | 18 30·0 |
| 30 | 20 33·2 | | 0 29·8 | 2 32·0 | 4 30·3 | 6 32·5 | 8 30·8 | 10 33·0 | 12 35·2 | 14 33·5 | 16 35·7 | 18 34·0 |
| 31 | 20 37·2 | | 0 33·7 | | 4 34·2 | | 8 34·7 | 10 36·9 | | 14 37·4 | | 18 37·9 |

## EQUATION OF TIME, FOR THE YEAR 1901,

### For Apparent Noon at Greenwich.

| Day | Jan. | Feb. | Mar. | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *add* | *add* | *add* | | *sub* | | *add* | *add* | | *sub* | *sub.* | |
| 1 | 3m 34s | 13m 46s | 12m 38s | *add* 4m 7s | 2m 55s | *sub.* 2m 30s | 3m 27s | 6m 8s | *add* 0m 4s | 10m 10s | 16m 20s | *sub.* 11m 2 |
| 2 | 4 2 | 13 53 | 12 26 | 3 49 | 3 3 | 2 21 | 3 39 | 6 4 | *sub.* 0 15 | 10 30 | 16 21 | 10 40 |
| 3 | 4 30 | 14 0 | 12 14 | 3 30 | 3 10 | 2 12 | 3 50 | 6 0 | 0 35 | 10 49 | 16 22 | 10 16 |
| 4 | 4 58 | 14 6 | 12 1 | 3 13 | 3 17 | 2 2 | 4 1 | 5 55 | 0 54 | 11 7 | 16 21 | 9 53 |
| 5 | 5 25 | 14 12 | 11 48 | 2 55 | 3 22 | 1 52 | 4 12 | 5 50 | 1 14 | 11 25 | 16 20 | 9 28 |
| 6 | 5 52 | 14 16 | 11 34 | 2 37 | 3 28 | 1 42 | 4 22 | 5 44 | 1 33 | 11 43 | 16 18 | 9 3 |
| 7 | 6 18 | 14 20 | 11 20 | 2 20 | 3 33 | 1 31 | 4 32 | 5 37 | 1 54 | 12 1 | 16 16 | 8 38 |
| 8 | 6 44 | 14 23 | 11 5 | 2 3 | 3 37 | 1 20 | 4 42 | 5 30 | 2 14 | 12 18 | 16 12 | 8 11 |
| 9 | 7 9 | 14 25 | 10 50 | 1 46 | 3 41 | 1 9 | 4 51 | 5 23 | 2 34 | 12 34 | 16 8 | 7 45 |
| 10 | 7 34 | 14 26 | 10 34 | 1 29 | 3 44 | 0 57 | 5 0 | 5 14 | 2 55 | 12 50 | 16 2 | 7 18 |
| 11 | 7 58 | 14 27 | 10 19 | 1 13 | 3 46 | 0 45 | 5 9 | 5 6 | 3 15 | 13 6 | 15 56 | 6 50 |
| 12 | 8 22 | 14 27 | 10 3 | 0 56 | 3 48 | 0 33 | 5 17 | 4 56 | 3 36 | 13 21 | 15 49 | 6 22 |
| 13 | 8 45 | 14 26 | 9 46 | 0 41 | 3 49 | 0 21 | 5 24 | 4 46 | 3 57 | 13 36 | 15 41 | 5 54 |
| 14 | 9 7 | 14 24 | 9 30 | 0 25 | 3 50 | *sub.* 0 8 | 5 32 | 4 36 | 4 18 | 13 50 | 15 33 | 5 20 |
| 15 | 9 29 | 14 22 | 9 13 | *add* 0 10 | 3 50 | *add* 0 4 | 5 38 | 4 25 | 4 39 | 14 4 | 15 23 | 4 57 |
| 16 | 9 50 | 14 19 | 8 56 | *sub.* 0 5 | 3 49 | 0 17 | 5 45 | 4 13 | 5 0 | 14 17 | 15 13 | 4 28 |
| 17 | 10 10 | 14 15 | 8 39 | 0 19 | 3 48 | 0 30 | 5 50 | 4 1 | 5 21 | 14 29 | 15 1 | 3 58 |
| 18 | 10 30 | 14 11 | 8 21 | 0 33 | 3 47 | 0 43 | 5 56 | 3 49 | 5 43 | 14 41 | 14 49 | 3 29 |
| 19 | 10 49 | 14 6 | 8 4 | 0 46 | 3 45 | 0 56 | 6 0 | 3 35 | 6 4 | 14 53 | 14 37 | 2 59 |
| 20 | 11 8 | 14 0 | 7 46 | 1 0 | 3 42 | 1 9 | 6 5 | 3 22 | 6 25 | 15 3 | 14 23 | 2 29 |
| 21 | 11 25 | 13 53 | 7 28 | 1 12 | 3 38 | 1 22 | 6 8 | 3 8 | 6 46 | 15 14 | 14 8 | 2 0 |
| 22 | 11 42 | 13 46 | 7 10 | 1 25 | 3 35 | 1 35 | 6 11 | 2 53 | 7 7 | 15 23 | 13 53 | 1 30 |
| 23 | 11 58 | 13 38 | 6 52 | 1 37 | 3 30 | 1 48 | 6 14 | 2 38 | 7 28 | 15 32 | 13 37 | 1 0 |
| 24 | 12 13 | 13 30 | 6 34 | 1 48 | 3 26 | 2 1 | 6 15 | 2 22 | 7 49 | 15 40 | 13 21 | 0 30 |
| 25 | 12 28 | 13 21 | 6 15 | 1 59 | 3 20 | 2 14 | 6 17 | 2 6 | 8 10 | 15 48 | 13 3 | *sub.* 0 0 |
| 26 | 12 41 | 13 11 | 5 57 | 2 10 | 3 14 | 2 27 | 6 17 | 1 50 | 8 30 | 15 54 | 12 45 | *add* 0 30 |
| 27 | 12 54 | 13 1 | 5 39 | 2 20 | 3 8 | 2 39 | 6 17 | 1 33 | 8 51 | 16 1 | 12 26 | 0 59 |
| 28 | 13 6 | 12 50 | 5 20 | 2 30 | 3 1 | 2 52 | 6 17 | 1 16 | 9 11 | 16 6 | 12 6 | 1 29 |
| 29 | 13 17 | | 5 2 | 2 39 | 2 54 | 3 4 | 6 15 | 0 58 | 9 31 | 16 11 | 11 45 | 1 58 |
| 30 | 13 28 | | 4 43 | 2 47 | 2 47 | 3 16 | 6 14 | 0 40 | 9 51 | 16 14 | 11 24 | 2 27 |
| 31 | 13 37 | | 4 25 | | 2 38 | | 6 11 | 0 22 | | 16 17 | | 2 56 |

### EQUATION OF TIME, FOR 1902.

| Day | Jan. | Feb. | Mar. | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *add* | *add* | *add* | | *sub.* | | *add* | *add* | | *sub.* | *sub.* | |
| 1 | 3m 25s | 13m 42s | 12m 40s | *add* 4m 10s | 2m 54s | *sub.* 2m 32s | 3m 25s | 6m 10s | *add* 0m 10s | 10m 4s | 16m 18s | *sub.* 11m 7s |
| 2 | 3 53 | 13 50 | 12 28 | 3 52 | 3 2 | 2 23 | 3 37 | 6 7 | *sub.* 0 9 | 10 23 | 16 19 | 10 45 |
| 3 | 4 22 | 13 57 | 12 16 | 3 34 | 3 9 | 2 14 | 3 49 | 6 3 | 0 28 | 10 42 | 16 20 | 10 22 |
| 4 | 4 49 | 14 4 | 12 3 | 3 16 | 3 15 | 2 4 | 4 0 | 5 58 | 0 47 | 11 1 | 16 20 | 9 58 |
| 5 | 5 17 | 14 9 | 11 50 | 2 59 | 3 21 | 1 54 | 4 11 | 5 53 | 1 7 | 11 19 | 16 19 | 9 34 |
| 6 | 5 44 | 14 14 | 11 36 | 2 41 | 3 26 | 1 43 | 4 21 | 5 48 | 1 26 | 11 37 | 16 18 | 9 9 |
| 7 | 6 10 | 14 18 | 11 22 | 2 24 | 3 31 | 1 32 | 4 32 | 5 41 | 1 46 | 11 54 | 16 15 | 8 43 |
| 8 | 6 36 | 14 22 | 11 8 | 2 7 | 3 35 | 1 21 | 4 42 | 5 34 | 2 7 | 12 12 | 16 12 | 8 17 |
| 9 | 7 2 | 14 24 | 10 53 | 1 50 | 3 39 | 1 10 | 4 51 | 5 27 | 2 27 | 12 28 | 16 8 | 7 51 |
| 10 | 7 27 | 14 26 | 10 38 | 1 33 | 3 42 | 0 58 | 5 0 | 5 19 | 2 48 | 12 45 | 16 3 | 7 24 |
| 11 | 7 51 | 14 27 | 10 22 | 1 17 | 3 44 | 0 46 | 5 9 | 5 10 | 3 8 | 13 1 | 15 57 | 6 57 |
| 12 | 8 15 | 14 27 | 10 7 | 1 1 | 3 46 | 0 34 | 5 17 | 5 1 | 3 29 | 13 16 | 15 50 | 6 30 |
| 13 | 8 38 | 14 26 | 9 50 | 0 45 | 3 48 | 0 22 | 5 25 | 4 51 | 3 50 | 13 31 | 15 43 | 6 2 |
| 14 | 9 1 | 14 25 | 9 34 | 0 30 | 3 49 | *sub* 0 10 | 5 32 | 4 40 | 4 11 | 13 45 | 15 34 | 5 33 |
| 15 | 9 23 | 14 22 | 9 17 | *add* 0 14 | 3 49 | *add* 0 3 | 5 39 | 4 29 | 4 33 | 13 59 | 15 25 | 5 5 |
| 16 | 9 44 | 14 19 | 9 0 | *sub.* 0 0 | 3 49 | 0 15 | 5 45 | 4 18 | 4 54 | 14 13 | 15 15 | 4 36 |
| 17 | 10 5 | 14 16 | 8 43 | 0 15 | 3 48 | 0 28 | 5 51 | 4 6 | 5 15 | 14 26 | 15 5 | 4 7 |
| 18 | 10 25 | 14 11 | 8 26 | 0 29 | 3 46 | 0 41 | 5 56 | 3 53 | 5 37 | 14 38 | 14 53 | 3 38 |
| 19 | 10 44 | 14 6 | 8 8 | 0 43 | 3 44 | 0 54 | 6 0 | 3 40 | 5 58 | 14 50 | 14 40 | 3 8 |
| 20 | 11 2 | 14 0 | 7 50 | 0 56 | 3 42 | 1 7 | 6 5 | 3 26 | 6 19 | 15 1 | 14 27 | 2 38 |
| 21 | 11 20 | 13 54 | 7 32 | 1 9 | 3 39 | 1 20 | 6 8 | 3 12 | 6 40 | 15 11 | 14 13 | 2 8 |
| 22 | 11 37 | 13 47 | 7 14 | 1 22 | 3 35 | 1 33 | 6 11 | 2 57 | 7 1 | 15 21 | 13 58 | 1 39 |
| 23 | 11 53 | 13 39 | 6 56 | 1 34 | 3 31 | 1 46 | 6 14 | 2 42 | 7 22 | 15 30 | 13 42 | 1 9 |
| 24 | 12 8 | 13 30 | 6 37 | 1 46 | 3 27 | 1 58 | 6 16 | 2 27 | 7 43 | 15 38 | 13 25 | 0 39 |
| 25 | 12 23 | 13 41 | 6 19 | 1 57 | 3 22 | 2 11 | 6 17 | 2 11 | 8 4 | 15 46 | 13 8 | *sub.* 0 9 |
| 26 | 12 36 | 13 12 | 6 0 | 2 8 | 3 16 | 2 24 | 6 18 | 1 55 | 8 25 | 15 53 | 12 49 | *add* 0 21 |
| 27 | 12 49 | 13 2 | 5 42 | 2 18 | 3 10 | 2 37 | 6 18 | 1 38 | 8 45 | 15 59 | 12 30 | 0 51 |
| 28 | 13 1 | 12 51 | 5 23 | 2 28 | 3 3 | 2 49 | 6 18 | 1 21 | 9 5 | 16 4 | 12 11 | 1 21 |
| 29 | 13 13 | | 5 5 | 2 37 | 2 56 | 3 1 | 6 17 | 1 4 | 9 25 | 16 9 | 11 50 | 1 50 |
| 30 | 13 23 | | 4 47 | 2 46 | 2 48 | 3 13 | 6 15 | 0 46 | 9 45 | 16 13 | 11 29 | 2 20 |
| 31 | 13 33 | | 4 28 | | 2 40 | | 6 13 | 0 28 | | 16 16 | | 2 49 |

## EQUATION OF TIME, FOR THE YEAR 1903,
### For Apparent Noon at Greenwich.

| Day | Jan. | Feb. | Mar. | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | add | add | | sub. | | add | | | sub. | sub. | |
| 1 | add 3m 18s | 13m 39s | 12m 42s | add 4m 15s | 2m 51s | sub. 2m 33s | 3m 24s | add 6m 12s | add 0m 14s | 9m 59s | 16m 17s | sub. 11m [illegible] |
| 2 | 3 46 | 13 47 | 12 31 | 3 57 | 2 59 | 2 24 | 3 35 | 6 8 | sub. 0 4 | 10 19 | 16 19 | 10 [illegible] |
| 3 | 4 15 | 13 55 | 12 19 | 3 39 | 3 6 | 2 15 | 3 47 | 6 4 | 0 23 | 10 38 | 16 20 | 10 [illegible] |
| 4 | 4 42 | 14 2 | 12 6 | 3 21 | 3 13 | 2 5 | 3 58 | 6 0 | 0 43 | 10 57 | 16 21 | 10 [illegible] |
| 5 | 5 10 | 14 8 | 11 53 | 3 3 | 3 19 | 1 55 | 4 9 | 5 55 | 1 2 | 11 15 | 16 20 | 9 [illegible] |
| 6 | 5 37 | 14 13 | 11 40 | 2 46 | 3 24 | 1 45 | 4 19 | 5 49 | 1 22 | 11 33 | 16 19 | 9 [illegible] |
| 7 | 6 3 | 14 17 | 11 26 | 2 28 | 3 29 | 1 35 | 4 29 | 5 43 | 1 42 | 11 51 | 16 16 | 8 [illegible] |
| 8 | 6 29 | 14 20 | 11 11 | 2 11 | 3 34 | 1 24 | 4 39 | 5 36 | 2 2 | 12 8 | 16 13 | 8 [illegible] |
| 9 | 6 55 | 14 23 | 10 56 | 1 54 | 3 38 | 1 13 | 4 49 | 5 28 | 2 23 | 12 25 | 16 9 | 7 [illegible] |
| 10 | 7 20 | 14 24 | 10 41 | 1 37 | 3 41 | 1 1 | 4 58 | 5 20 | 2 44 | 12 42 | 16 5 | 7 [illegible] |
| 11 | 7 44 | 14 25 | 10 26 | 1 21 | 3 44 | 0 49 | 5 6 | 5 11 | 3 4 | 12 58 | 15 59 | 7 [illegible] |
| 12 | 8 8 | 14 25 | 10 10 | 1 4 | 3 46 | 0 37 | 5 14 | 5 2 | 3 25 | 13 13 | 15 53 | 6 [illegible] |
| 13 | 8 31 | 14 25 | 9 54 | 0 48 | 3 48 | 0 25 | 5 22 | 4 52 | 3 46 | 13 28 | 15 45 | 6 [illegible] |
| 14 | 8 54 | 14 23 | 9 37 | 0 33 | 3 49 | 0 13 | 5 29 | 4 42 | 4 7 | 13 43 | 15 37 | 5 [illegible] |
| 15 | 9 16 | 14 21 | 9 20 | 0 17 | 3 49 | sub. 0 1 | 5 36 | 4 31 | 4 28 | 13 57 | 15 28 | 5 [illegible] |
| 16 | 9 37 | 14 18 | 9 3 | add 0 2 | 3 49 | add 0 12 | 5 43 | 4 20 | 4 50 | 14 10 | 15 18 | 4 [illegible] |
| 17 | 9 58 | 14 15 | 8 46 | sub. 0 12 | 3 48 | 0 25 | 5 49 | 4 8 | 5 11 | 14 23 | 15 7 | 4 [illegible] |
| 18 | 10 18 | 14 11 | 8 29 | 0 27 | 3 47 | 0 38 | 5 54 | 3 56 | 5 32 | 14 35 | 14 55 | 3 [illegible] |
| 19 | 10 37 | 14 6 | 8 11 | 0 41 | 3 45 | 0 51 | 5 59 | 3 43 | 5 53 | 14 47 | 14 43 | 3 [illegible] |
| 20 | 10 56 | 14 0 | 7 53 | 0 54 | 3 43 | 1 4 | 6 3 | 3 29 | 6 14 | 14 58 | 14 30 | 2 [illegible] |
| 21 | 11 14 | 13 54 | 7 35 | 1 7 | 3 40 | 1 17 | 6 7 | 3 15 | 6 35 | 15 8 | 14 15 | 2 [illegible] |
| 22 | 11 31 | 13 47 | 7 17 | 1 20 | 3 36 | 1 30 | 6 10 | 3 1 | 6 56 | 15 18 | 14 0 | 1 [illegible] |
| 23 | 11 47 | 13 40 | 6 59 | 1 32 | 3 32 | 1 43 | 6 13 | 2 46 | 7 17 | 15 27 | 13 45 | 1 [illegible] |
| 24 | 12 3 | 13 32 | 6 41 | 1 43 | 3 28 | 1 56 | 6 16 | 2 31 | 7 38 | 15 35 | 13 28 | 0 [illegible] |
| 25 | 12 18 | 13 23 | 6 23 | 1 54 | 3 23 | 2 9 | 6 17 | 2 15 | 7 59 | 15 43 | 13 11 | sub. 0 [illegible] |
| 26 | 12 32 | 13 14 | 6 4 | 2 5 | 3 17 | 2 22 | 6 18 | 1 59 | 8 19 | 15 50 | 12 53 | add 0 [illegible] |
| 27 | 12 45 | 13 4 | 5 46 | 2 15 | 3 11 | 2 34 | 6 19 | 1 43 | 8 40 | 15 57 | 12 34 | 0 [illegible] |
| 28 | 12 57 | 12 53 | 5 28 | 2 25 | 3 4 | 2 47 | 6 19 | 1 26 | 9 0 | 16 2 | 12 15 | 1 [illegible] |
| 29 | 13 9 | | 5 10 | 2 34 | 2 57 | 2 59 | 6 18 | 1 9 | 9 20 | 16 7 | 11 55 | 1 [illegible] |
| 30 | 13 20 | | 4 51 | sub 2 43 | 2 49 | add 3 12 | 6 16 | 0 51 | sub. 9 40 | 16 11 | 11 34 | 2 [illegible] |
| 31 | add 13 30 | | 4 33 | | 2 41 | | 6 14 | add 0 33 | | 16 15 | | add 2 [illegible] |

## EQUATION OF TIME, FOR 1904.

| Day | Jan. | Feb. | Mar. | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | add | add | | sub. | | add | | | sub. | sub. | |
| 1 | add 3m 11s | 13m 37s | 12m 34s | add 4m 1s | 2m 57s | sub. 2m 27s | 3m 32s | add 6m 8s | sub. 0m 1s | 10m 16s | 16m 20s | sub. 10m [illegible] |
| 2 | 3 40 | 13 45 | 12 22 | 3 43 | 3 4 | 2 18 | 3 43 | 6 4 | 0 20 | 10 35 | 16 21 | 10 [illegible] |
| 3 | 4 8 | 13 53 | 12 9 | 3 25 | 3 11 | 2 8 | 3 54 | 6 0 | 0 39 | 10 53 | 16 21 | 10 [illegible] |
| 4 | 4 35 | 14 0 | 11 56 | 3 7 | 3 18 | 1 58 | 4 5 | 5 55 | 0 59 | 11 12 | 16 21 | 9 [illegible] |
| 5 | 5 3 | 14 6 | 11 43 | 2 50 | 3 24 | 1 48 | 4 16 | 5 49 | 1 18 | 11 30 | 16 20 | 9 [illegible] |
| 6 | 5 30 | 14 11 | 11 29 | 2 32 | 3 29 | 1 38 | 4 26 | 5 43 | 1 38 | 11 48 | 16 17 | 8 [illegible] |
| 7 | 5 57 | 14 15 | 11 14 | 2 15 | 3 33 | 1 27 | 4 36 | 5 37 | 1 58 | 12 5 | 16 14 | 8 [illegible] |
| 8 | 6 23 | 14 19 | 11 0 | 1 58 | 3 37 | 1 16 | 4 46 | 5 29 | 2 19 | 12 22 | 16 10 | 8 [illegible] |
| 9 | 6 48 | 14 22 | 10 45 | 1 41 | 3 40 | 1 4 | 4 55 | 5 21 | 2 39 | 12 38 | 16 6 | 7 [illegible] |
| 10 | 7 13 | 14 24 | 10 29 | 1 25 | 3 43 | 0 52 | 5 4 | 5 13 | 3 0 | 12 54 | 16 0 | 7 [illegible] |
| 11 | 7 38 | 14 25 | 10 14 | 1 8 | 3 45 | 0 40 | 5 12 | 5 4 | 3 20 | 13 10 | 15 54 | 6 [illegible] |
| 12 | 8 2 | 14 25 | 9 58 | 0 52 | 3 47 | 0 28 | 5 20 | 4 55 | 3 41 | 13 25 | 15 47 | 6 [illegible] |
| 13 | 8 26 | 14 25 | 9 41 | 0 37 | 3 48 | 0 16 | 5 28 | 4 45 | 4 2 | 13 39 | 15 39 | 5 [illegible] |
| 14 | 8 49 | 14 24 | 9 25 | 0 22 | 3 49 | sub. 0 3 | 5 35 | 4 34 | 4 23 | 13 53 | 15 30 | 5 [illegible] |
| 15 | 9 11 | 14 22 | 9 8 | add 0 7 | 3 49 | add 0 10 | 5 42 | 4 23 | 4 44 | 14 7 | 15 20 | 4 [illegible] |
| 16 | 9 33 | 14 20 | 8 51 | sub. 0 8 | 3 48 | 0 22 | 5 48 | 4 11 | 5 6 | 14 20 | 15 10 | 4 [illegible] |
| 17 | 9 54 | 14 17 | 8 34 | 0 22 | 3 47 | 0 35 | 5 53 | 3 59 | 5 27 | 14 32 | 14 58 | 3 [illegible] |
| 18 | 10 14 | 14 13 | 8 16 | 0 36 | 3 45 | 0 48 | 5 58 | 3 46 | 5 48 | 14 44 | 14 46 | 3 [illegible] |
| 19 | 10 34 | 14 8 | 7 59 | 0 50 | 3 42 | 1 1 | 6 3 | 3 33 | 6 9 | 14 55 | 14 33 | 2 [illegible] |
| 20 | 10 53 | 14 3 | 7 41 | 1 3 | 3 39 | 1 14 | 6 7 | 3 19 | 6 30 | 15 6 | 14 19 | 2 [illegible] |
| 21 | 11 11 | 13 57 | 7 23 | 1 15 | 3 36 | 1 27 | 6 10 | 3 4 | 6 52 | 15 16 | 14 5 | 1 [illegible] |
| 22 | 11 28 | 13 50 | 7 5 | 1 27 | 3 32 | 1 40 | 6 13 | 2 50 | 7 13 | 15 26 | 13 49 | 1 [illegible] |
| 23 | 11 44 | 13 43 | 6 47 | 1 39 | 3 28 | 1 53 | 6 15 | 2 34 | 7 34 | 15 34 | 13 33 | 0 [illegible] |
| 24 | 12 0 | 13 35 | 6 28 | 1 51 | 3 23 | 2 6 | 6 17 | 2 18 | 7 55 | 15 42 | 13 16 | sub. 0 [illegible] |
| 25 | 12 15 | 13 26 | 6 10 | 2 2 | 3 18 | 2 19 | 6 18 | 2 2 | 8 15 | 15 50 | 12 58 | add 0 [illegible] |
| 26 | 12 29 | 13 17 | 5 52 | 2 12 | 3 12 | 2 31 | 6 18 | 1 46 | 8 36 | 15 56 | 12 40 | 0 [illegible] |
| 27 | 12 43 | 13 7 | 5 33 | 2 22 | 3 5 | 2 44 | 6 18 | 1 29 | 8 56 | 16 2 | 12 21 | 1 [illegible] |
| 28 | 12 55 | 12 56 | 5 15 | 2 32 | 2 58 | 2 56 | 6 17 | 1 12 | 9 16 | 16 7 | 12 1 | 1 [illegible] |
| 29 | 13 7 | 12 45 | 4 56 | 2 41 | 2 51 | 3 8 | 6 16 | 0 54 | 9 36 | 16 12 | 11 40 | 2 [illegible] |
| 30 | 13 18 | | 4 38 | sub. 2 49 | 2 43 | add 3 20 | 6 14 | 0 36 | sub 9 56 | 16 15 | 11 18 | 2 [illegible] |
| 31 | add 13 28 | | 4 20 | | 2 35 | | 6 11 | add 0 18 | | 16 18 | | add 3 [illegible] |

## MEAN PLACES OF THE PRINCIPAL FIXED STARS FOR JAN 1ST. 1900.

| Name | Mag. | Right Asc. | Ann. Var. | Declination | Ann. Var. |
|---|---|---|---|---|---|
| | | h m s | s | ° ′ ″ | ″ |
| α Andromedæ *Alpheratz* | 2 | 0 3 13 | +3·09 | 28 32 18 N. | +19·9 |
| γ Pegasi *Algenib* | 3 | 0 8 5 | 3·08 | 14 37 39 N. | +20·0 |
| α Phœnicis ..................... | 2 | 0 21 20 | 2·97 | 42 50 57 S. | −19·5 |
| α Cassiopeæ *Schedar* | var. | 0 34 50 | 3·37 | 55 59 19 N. | +19·8 |
| β Ceti *Deneb Kaitos* | 2 | 0 38 34 | 3·01 | 18 32 8 S. | −19·8 |
| α Ursæ Minoris *Polaris* | 2 | 1 22 33 | 25·31 | 88 46 27 N. | +18·8 |
| α Eridani *Achernar* | 1 | 1 33 59 | 2·24 | 57 44 41 S. | −18·3 |
| γ Andromedæ *Almach* | 2 | 1 57 45 | 3·66 | 41 51 0 N. | +17·4 |
| α Arietis *Hamel* | 2 | 2 1 32 | 3·37 | 22 59 23 N. | +17·2 |
| α Ceti *Menkar* | 2, 3 | 2 57 3 | 3·13 | 3 41 51 N. | +14·3 |
| α Persei *Mirfak* | 2 | 3 17 11 | +4·26 | 49 30 19 N. | +13·1 |
| α Tauri *Aldebaran* | 1 | 4 30 11 | 3·44 | 16 18 30 N. | + 7·5 |
| α Aurigæ *Capella* | 1 | 5 9 18 | 4·43 | 45 53 47 N. | + 4·0 |
| β Orionis *Rigel* | 1 | 5 9 44 | 2·88 | 8 19 1 S. | − 4·4 |
| β Tauri *Nath* | 2 | 5 19 58 | 3·79 | 28 31 23 N. | + 3·3 |
| δ Orionis ......................... | 2 | 5 26 54 | 3·06 | 0 22 23 S. | − 2·9 |
| ε Orionis *Alnilam* | 2 | 5 31 8 | 3·04 | 1 15 57 S. | − 2·5 |
| α Columbæ *Phact* | 2 | 5 36 2 | 2·18 | 34 7 38 S. | − 2·1 |
| α Orionis *Betelguese* | var. | 5 49 45 | 3·25 | 7 23 19 N. | + 1·0 |
| β Aurigæ *Menkalinan* | 2 | 5 52 12 | 4·40 | 44 56 14 N. | + 6·7 |
| α Argûs *Canopus* | 1 | 6 21 44 | +1·33 | 52 38 27 S. | + 1·9 |
| γ Geminorum *Alhena* | 2 | 6 31 56 | 3·47 | 16 29 5 N. | − 2·8 |
| α Canis Majoris *Sirius* | 1 | 6 40 44 | 2·64 | 16 34 43 S. | + 4·7 |
| ε Canis Majoris *Adara* | 1, 2 | 6 54 42 | 2·36 | 28 50 9 S. | + 4·7 |
| α² Geminorum *Castor* | 2 | 7 28 13 | 3·84 | 32 6 29 N. | − 7·6 |
| α Canis Minoris *Procyon* | 1 | 7 34 4 | 3·14 | 5 28 52 N. | − 9·0 |
| β Geminorum *Pollux* | 1 | 7 39 12 | 3·68 | 28 16 4 N. | − 8·4 |
| ζ Argûs ......................... | 2 | 8 0 4 | 2·11 | 39 43 16 S. | +10·0 |
| δ Argûs ......................... | 2 | 8 41 57 | 1·65 | 54 20 32 S. | +15·0 |
| α Hydræ *Alphard* | 2 | 9 22 40 | 2·95 | 8 13 30 S. | +15·4 |
| α Leonis *Regulus* | 1, 2 | 10 3 3 | +3·20 | 12 27 22 N. | −17·5 |
| γ¹ Leonis *Algeiba* | 2 | 10 14 28 | 3·31 | 20 20 50 N. | −18·1 |
| η Argûs ......................... | var. | 10 41 11 | 2·32 | 59 9 30 S. | +18·9 |
| α Ursæ Majoris *Dubhe* | 2 | 10 57 34 | 3·74 | 62 17 27 N. | −19·4 |
| δ Leonis *Zosma* | 2, 3 | 11 8 47 | 3·20 | 21 4 18 N. | −19·7 |
| β Leonis *Denebola* | 2 | 11 43 58 | 3·06 | 15 7 52 N. | −20·1 |
| γ Ursæ Majoris *Phecda* | 2, 3 | 11 48 34 | 3·18 | 54 15 3 N. | −20·0 |
| α¹ Crucis ......................... | 1 | 12 21 2 | 3·30 | 62 32 41 S. | +20·0 |
| β Corvi ......................... | 2, 3 | 12 29 8 | 3·14 | 22 50 38 S. | +20·0 |
| α Canum Venaticorum ...... | 3 | 12 51 21 | 2·81 | 38 51 30 N. | −19·5 |
| α Virginis *Spica* | 1 | 13 19 55 | +3·15 | 10 38 22 S. | +18·9 |
| η Ursæ Majoris *Benetnasch* | 2 | 13 43 36 | 2·37 | 49 48 44 N. | −18·1 |
| β Centauri ..................... | 1 | 13 56 46 | 4·19 | 59 53 26 S. | +17·6 |
| α Draconis *Thuban* | 3, 4 | 14 1 41 | 1·62 | 64 51 13 N. | −17·3 |
| α Boötis *Arcturus* | 1 | 14 11 6 | 2·73 | 19 42 11 N. | −18·8 |
| α² Centauri ..................... | 1 | 14 32 49 | 4·05 | 60 25 10 S. | +15·0 |
| α Libræ *Zuben el Genubi* | 3 | 14 45 21 | +3·31 | 15 37 35 S. | +15·1 |
| β Ursæ Minoris *Kochab* | 2 | 14 51 0 | −0·22 | 74 33 51 N. | −14·7 |
| β Libræ *Zuben el Chamali* | 2 | 15 11 37 | +3·22 | 9 0 51 S. | +13·5 |
| α Coronæ Borealis *Alphacca* | 2 | 15 30 27 | 2·54 | 27 3 4 N. | −12·3 |
| α Serpentis *Unukalhai* | 2, 3 | 15 39 20 | +2·95 | 6 44 24 N. | −11·5 |
| β¹ Scorpii ......................... | 3 | 15 59 37 | 3·48 | 19 31 55 S. | +10·1 |
| α Scorpii *Antares* | 1, 2 | 16 23 16 | 3·67 | 26 12 36 S. | + 8·3 |
| α Trianguli Australis ...... | 2 | 16 38 4 | 6·31 | 68 50 39 S. | + 7·1 |
| β Draconis *Alwaid* | 3 | 17 28 10 | 1·35 | 52 22 31 N. | − 2·8 |
| α Ophiuchi *Ras Alhague* | 2 | 17 30 17 | 2·78 | 12 37 58 N. | − 2·8 |
| γ Draconis *Rastaban* | 2, 3 | 17 54 17 | 1·39 | 51 30 2 N. | − 0·5 |
| α Lyræ *Vega* | 1 | 18 33 33 | 2·03 | 38 41 26 N. | + 3·2 |
| α Aquilæ *Altair* | 1 | 19 45 54 | 2·93 | 8 36 14 N. | + 9·3 |
| α Pavonis ......................... | 2 | 20 17 44 | 4·78 | 57 3 20 S. | −11·2 |
| α Cygni *Deneb* | 1, 2 | 20 38 1 | +2·04 | 44 55 22 N. | +12·7 |
| α Cephei *Alderamin* | 2, 3 | 21 16 11 | 1·44 | 62 9 42 N. | +15·2 |
| ε Pegasi ......................... | 2, 3 | 21 39 16 | 2·95 | 9 24 59 N. | +16·4 |
| α Gruis ......................... | 2 | 22 1 56 | 3·80 | 47 26 43 S. | −17·3 |
| β Gruis ......................... | 2 | 22 36 42 | 3·60 | 47 24 28 S. | −18·7 |
| α Piscis Aust. *Fomalhaut* | 1 | 22 52 7 | 3·32 | 30 9 8 S. | −19·0 |
| α Pegasi *Markab* | 2 | 22 59 47 | 2·98 | 14 40 2 N. | +19·3 |

## LOGARITHMS OF NUMBERS

**No. 1 to 100** — **Log. 0·000000 to 2·000000**

| No. | Log. | No. | Log. | No. | Log. | No. | Log. | No. | Log. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0·000000 | 21 | 1·322219 | 41 | 1·612784 | 61 | 1·785330 | 81 | 1·908485 |
| 2 | 0·301030 | 22 | 1·342423 | 42 | 1·623249 | 62 | 1·792392 | 82 | 1·913814 |
| 3 | 0·477121 | 23 | 1·361728 | 43 | 1·633468 | 63 | 1·799341 | 83 | 1·919078 |
| 4 | 0·602060 | 24 | 1·380211 | 44 | 1·643453 | 64 | 1·806180 | 84 | 1·924279 |
| 5 | 0·698970 | 25 | 1·397940 | 45 | 1·653213 | 65 | 1·812913 | 85 | 1·929419 |
| 6 | 0·778151 | 26 | 1·414973 | 46 | 1·662758 | 66 | 1·819544 | 86 | 1·934498 |
| 7 | 0·845098 | 27 | 1·431364 | 47 | 1·672098 | 67 | 1·826075 | 87 | 1·939519 |
| 8 | 0·903090 | 28 | 1·447158 | 48 | 1·681241 | 68 | 1·832509 | 88 | 1·944483 |
| 9 | 0·954243 | 29 | 1·462398 | 49 | 1·690196 | 69 | 1·838849 | 89 | 1·949390 |
| 10 | 1·000000 | 30 | 1·477121 | 50 | 1·698970 | 70 | 1·845098 | 90 | 1·954243 |
| 11 | 1·041393 | 31 | 1·491362 | 51 | 1·707570 | 71 | 1·851258 | 91 | 1·959041 |
| 12 | 1·079181 | 32 | 1·505150 | 52 | 1·716003 | 72 | 1·857332 | 92 | 1·963788 |
| 13 | 1·113943 | 33 | 1·518514 | 53 | 1·724276 | 73 | 1·863323 | 93 | 1·968483 |
| 14 | 1·146128 | 34 | 1·531479 | 54 | 1·732394 | 74 | 1·869232 | 94 | 1·973128 |
| 15 | 1·176091 | 35 | 1·544068 | 55 | 1·740363 | 75 | 1·875061 | 95 | 1·977724 |
| 16 | 1·204120 | 36 | 1·556303 | 56 | 1·748188 | 76 | 1·880814 | 96 | 1·982271 |
| 17 | 1·230449 | 37 | 1·568202 | 57 | 1·755875 | 77 | 1·886491 | 97 | 1·986772 |
| 18 | 1·255273 | 38 | 1·579784 | 58 | 1·763428 | 78 | 1·892095 | 98 | 1·991226 |
| 19 | 1·278754 | 39 | 1·591065 | 59 | 1·770852 | 79 | 1·897627 | 99 | 1·995635 |
| 20 | 1·301030 | 40 | 1·602060 | 60 | 1·778151 | 80 | 1·903090 | 100 | 2·000000 |

**No. 1000 to 1149** — **Log. 0 to 060320**

| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 100 | 000000 | 000434 | 000868 | 001301 | 001734 | 002166 | 002598 | 003029 | 003461 | 003891 | 432 |
| 101 | 004321 | 004751 | 005181 | 005609 | 006038 | 006466 | 006894 | 007321 | 007748 | 008174 | 428 |
| 102 | 008600 | 009026 | 009451 | 009876 | 010300 | 010724 | 011147 | 011570 | 011993 | 012415 | 424 |
| 103 | 012837 | 013259 | 013680 | 014100 | 014521 | 014940 | 015360 | 015779 | 016197 | 016616 | 420 |
| 104 | 017033 | 017451 | 017868 | 018284 | 018700 | 019116 | 019532 | 019947 | 020361 | 020775 | 416 |
| 105 | 021189 | 021603 | 022016 | 022428 | 022841 | 023252 | 023664 | 024075 | 024486 | 024896 | 412 |
| 106 | 025306 | 025715 | 026125 | 026533 | 026942 | 027350 | 027757 | 028164 | 028571 | 028978 | 408 |
| 107 | 029384 | 029789 | 030195 | 030600 | 031004 | 031408 | 031812 | 032216 | 032619 | 033021 | 404 |
| 108 | 033424 | 033826 | 034227 | 034628 | 035029 | 035430 | 035830 | 036230 | 036629 | 037028 | 400 |
| 109 | 037426 | 037825 | 038223 | 038620 | 039017 | 039414 | 039811 | 040207 | 040602 | 040998 | 397 |
| 110 | 041393 | 041787 | 042182 | 042576 | 042969 | 043362 | 043755 | 044148 | 044540 | 044932 | 393 |
| 111 | 045323 | 045714 | 046105 | 046495 | 046885 | 047275 | 047664 | 048053 | 048442 | 048830 | 389 |
| 112 | 049218 | 049606 | 049993 | 050380 | 050766 | 051153 | 051538 | 051924 | 052309 | 052694 | 386 |
| 113 | 053078 | 053463 | 053846 | 054230 | 054613 | 054996 | 055378 | 055760 | 056142 | 056524 | 383 |
| 114 | 056905 | 057286 | 057666 | 058046 | 058426 | 058805 | 059185 | 059563 | 059942 | 060320 | 379 |
| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. |

| D. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 378 | 38 | 76 | 113 | 151 | 189 | 227 | 265 | 302 | 340 |
| 380 | 38 | 76 | 114 | 152 | 190 | 228 | 266 | 304 | 342 |
| 382 | 38 | 76 | 115 | 153 | 191 | 229 | 267 | 306 | 344 |
| 384 | 38 | 77 | 115 | 154 | 192 | 230 | 269 | 307 | 346 |
| 386 | 39 | 77 | 116 | 154 | 193 | 232 | 270 | 309 | 347 |
| 388 | 39 | 78 | 116 | 155 | 194 | 233 | 272 | 310 | 349 |
| 390 | 39 | 78 | 117 | 156 | 195 | 234 | 273 | 312 | 351 |
| 392 | 39 | 78 | 118 | 157 | 196 | 235 | 274 | 314 | 353 |
| 394 | 39 | 79 | 118 | 158 | 197 | 236 | 276 | 315 | 355 |
| 396 | 40 | 79 | 119 | 158 | 198 | 238 | 277 | 317 | 356 |
| 398 | 40 | 80 | 119 | 159 | 199 | 239 | 279 | 318 | 358 |
| 400 | 40 | 80 | 120 | 160 | 200 | 240 | 280 | 320 | 360 |
| 402 | 40 | 80 | 121 | 161 | 201 | 241 | 281 | 322 | 362 |
| 404 | 40 | 81 | 121 | 162 | 202 | 242 | 283 | 323 | 364 |
| 406 | 41 | 81 | 122 | 162 | 203 | 244 | 284 | 325 | 365 |

| D. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 408 | 41 | 82 | 122 | 163 | 204 | 245 | 286 | 326 | 367 |
| 410 | 41 | 82 | 123 | 164 | 205 | 246 | 287 | 328 | 369 |
| 412 | 41 | 82 | 124 | 165 | 206 | 247 | 288 | 330 | 371 |
| 414 | 41 | 83 | 124 | 166 | 207 | 248 | 290 | 331 | 373 |
| 416 | 42 | 83 | 125 | 166 | 208 | 250 | 291 | 333 | 374 |
| 418 | 42 | 84 | 125 | 167 | 209 | 251 | 293 | 334 | 376 |
| 420 | 42 | 84 | 126 | 168 | 210 | 252 | 294 | 336 | 378 |
| 422 | 42 | 84 | 127 | 169 | 211 | 253 | 295 | 338 | 380 |
| 424 | 42 | 85 | 127 | 170 | 212 | 254 | 297 | 339 | 382 |
| 426 | 43 | 85 | 128 | 170 | 213 | 256 | 298 | 341 | 383 |
| 428 | 43 | 86 | 128 | 171 | 214 | 257 | 300 | 342 | 385 |
| 430 | 43 | 86 | 129 | 172 | 215 | 258 | 301 | 344 | 387 |
| 432 | 43 | 86 | 130 | 173 | 216 | 259 | 302 | 346 | 389 |
| 434 | 43 | 87 | 130 | 174 | 217 | 260 | 304 | 347 | 391 |

## LOGARITHMS OF NUMBERS

No. 1150 to 1499 Log. 060698 to 175802

| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 115 | 060698 | 061075 | 061452 | 061829 | 062206 | 062582 | 062958 | 063333 | 063709 | 064083 | 376 |
| 116 | 064458 | 064832 | 065206 | 065580 | 065953 | 066326 | 066699 | 067071 | 067443 | 067815 | 373 |
| 117 | 068186 | 068557 | 068927 | 069298 | 069668 | 070038 | 070407 | 070776 | 071145 | 071514 | 370 |
| 118 | 071882 | 072250 | 072617 | 072985 | 073352 | 073718 | 074085 | 074451 | 074816 | 075182 | 366 |
| 119 | 075547 | 075912 | 076276 | 076640 | 077004 | 077368 | 077731 | 078094 | 078457 | 078819 | 363 |
| 120 | 079181 | 079543 | 079904 | 080266 | 080626 | 080987 | 081347 | 081707 | 082067 | 082426 | 360 |
| 121 | 082785 | 083144 | 083503 | 083861 | 084219 | 084576 | 084934 | 085291 | 085647 | 086004 | 357 |
| 122 | 086360 | 086716 | 087071 | 087426 | 087781 | 088136 | 088490 | 088845 | 089198 | 089552 | 355 |
| 123 | 089905 | 090258 | 090611 | 090963 | 091315 | 091667 | 092018 | 092370 | 092721 | 093071 | 352 |
| 124 | 093422 | 093772 | 094122 | 094471 | 094820 | 095169 | 095518 | 095866 | 096215 | 096562 | 349 |
| 125 | 096910 | 097257 | 097604 | 097951 | 098298 | 098644 | 098990 | 099335 | 099681 | 100026 | 346 |
| 126 | 100371 | 100715 | 101059 | 101403 | 101747 | 102091 | 102434 | 102777 | 103119 | 103462 | 343 |
| 127 | 103804 | 104146 | 104487 | 104828 | 105169 | 105510 | 105851 | 106191 | 106531 | 106871 | 341 |
| 128 | 107210 | 107549 | 107888 | 108227 | 108565 | 108903 | 109241 | 109579 | 109916 | 110253 | 338 |
| 129 | 110590 | 110926 | 111263 | 111599 | 111934 | 112270 | 112605 | 112940 | 113275 | 113609 | 335 |
| 130 | 113943 | 114277 | 114611 | 114944 | 115278 | 115611 | 115943 | 116276 | 116608 | 116940 | 333 |
| 131 | 117271 | 117603 | 117934 | 118265 | 118595 | 118926 | 119256 | 119586 | 119915 | 120245 | 330 |
| 132 | 120574 | 120903 | 121231 | 121560 | 121888 | 122216 | 122544 | 122871 | 123198 | 123525 | 328 |
| 133 | 123852 | 124178 | 124504 | 124830 | 125156 | 125481 | 125806 | 126131 | 126456 | 126781 | 325 |
| 134 | 127105 | 127429 | 127753 | 128076 | 128399 | 128722 | 129045 | 129368 | 129690 | 130012 | 323 |
| 135 | 130334 | 130655 | 130977 | 131298 | 131619 | 131939 | 132260 | 132580 | 132900 | 133219 | 321 |
| 136 | 133539 | 133858 | 134177 | 134496 | 134814 | 135133 | 135451 | 135769 | 136086 | 136403 | 318 |
| 137 | 136721 | 137037 | 137354 | 137671 | 137987 | 138303 | 138618 | 138934 | 139249 | 139564 | 316 |
| 138 | 139879 | 140194 | 140508 | 140822 | 141136 | 141450 | 141763 | 142076 | 142389 | 142702 | 314 |
| 139 | 143015 | 143327 | 143639 | 143951 | 144263 | 144574 | 144885 | 145196 | 145507 | 145818 | 311 |
| 140 | 146128 | 146438 | 146748 | 147058 | 147367 | 147676 | 147985 | 148294 | 148603 | 148911 | 309 |
| 141 | 149219 | 149527 | 149835 | 150142 | 150449 | 150756 | 151063 | 151370 | 151676 | 151982 | 307 |
| 142 | 152288 | 152594 | 152900 | 153205 | 153510 | 153815 | 154120 | 154424 | 154728 | 155032 | 305 |
| 143 | 155336 | 155640 | 155943 | 156246 | 156549 | 156852 | 157154 | 157457 | 157759 | 158061 | 303 |
| 144 | 158362 | 158664 | 158965 | 159266 | 159567 | 159868 | 160168 | 160469 | 160769 | 161068 | 301 |
| 145 | 161368 | 161667 | 161967 | 162266 | 162564 | 162863 | 163161 | 163460 | 163758 | 164055 | 299 |
| 146 | 164353 | 164650 | 164947 | 165244 | 165541 | 165838 | 166134 | 166430 | 166726 | 167022 | 297 |
| 147 | 167317 | 167613 | 167908 | 168203 | 168497 | 168792 | 169086 | 169380 | 169674 | 169968 | 295 |
| 148 | 170262 | 170555 | 170848 | 171141 | 171434 | 171726 | 172019 | 172311 | 172603 | 172895 | 293 |
| 149 | 173186 | 173478 | 173769 | 174060 | 174351 | 174641 | 174932 | 175222 | 175512 | 175802 | 291 |
| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. |

| D. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 290 | 29 | 58 | 87 | 116 | 145 | 174 | 203 | 232 | 261 | 334 | 33 | 67 | 100 | 134 | 167 | 200 | 234 | 267 | 301 |
| 292 | 29 | 58 | 88 | 117 | 146 | 175 | 204 | 234 | 263 | 336 | 34 | 67 | 101 | 134 | 168 | 202 | 235 | 269 | 302 |
| 294 | 29 | 59 | 88 | 118 | 147 | 176 | 206 | 235 | 265 | 338 | 34 | 68 | 101 | 135 | 169 | 203 | 237 | 270 | 304 |
| 296 | 30 | 59 | 89 | 118 | 148 | 178 | 207 | 237 | 266 | 340 | 34 | 68 | 102 | 136 | 170 | 204 | 238 | 272 | 306 |
| 298 | 30 | 60 | 89 | 119 | 149 | 179 | 209 | 238 | 268 | 342 | 34 | 68 | 103 | 137 | 171 | 205 | 239 | 274 | 308 |
| 300 | 30 | 60 | 90 | 120 | 150 | 180 | 210 | 240 | 270 | 344 | 34 | 69 | 103 | 138 | 172 | 206 | 241 | 275 | 310 |
| 302 | 30 | 60 | 91 | 121 | 151 | 181 | 211 | 242 | 272 | 346 | 35 | 69 | 104 | 138 | 173 | 208 | 242 | 277 | 311 |
| 304 | 30 | 61 | 91 | 122 | 152 | 182 | 213 | 243 | 274 | 348 | 35 | 70 | 104 | 139 | 174 | 209 | 244 | 278 | 313 |
| 306 | 31 | 61 | 92 | 122 | 153 | 184 | 214 | 245 | 275 | 350 | 35 | 70 | 105 | 140 | 175 | 210 | 245 | 280 | 315 |
| 308 | 31 | 62 | 92 | 123 | 154 | 185 | 216 | 246 | 277 | 352 | 35 | 70 | 106 | 141 | 176 | 211 | 246 | 282 | 317 |
| 310 | 31 | 62 | 93 | 124 | 155 | 186 | 217 | 248 | 279 | 354 | 35 | 71 | 106 | 142 | 177 | 212 | 248 | 283 | 319 |
| 312 | 31 | 62 | 94 | 125 | 156 | 187 | 218 | 250 | 281 | 356 | 36 | 71 | 107 | 142 | 178 | 214 | 249 | 285 | 320 |
| 314 | 31 | 63 | 94 | 126 | 157 | 188 | 220 | 251 | 283 | 358 | 36 | 72 | 107 | 143 | 179 | 215 | 251 | 286 | 322 |
| 316 | 32 | 63 | 95 | 126 | 158 | 190 | 221 | 253 | 284 | 360 | 36 | 72 | 108 | 144 | 180 | 216 | 252 | 288 | 324 |
| 318 | 32 | 64 | 95 | 127 | 159 | 191 | 223 | 254 | 286 | 362 | 36 | 72 | 109 | 145 | 181 | 217 | 253 | 290 | 326 |
| 320 | 32 | 64 | 96 | 128 | 160 | 192 | 224 | 256 | 288 | 364 | 36 | 73 | 109 | 146 | 182 | 218 | 255 | 291 | 328 |
| 322 | 32 | 64 | 97 | 129 | 161 | 193 | 225 | 258 | 290 | 366 | 37 | 73 | 110 | 146 | 183 | 220 | 256 | 293 | 329 |
| 324 | 32 | 65 | 97 | 130 | 162 | 194 | 227 | 259 | 292 | 368 | 37 | 74 | 110 | 147 | 184 | 221 | 258 | 294 | 331 |
| 326 | 33 | 65 | 98 | 130 | 163 | 196 | 228 | 261 | 293 | 370 | 37 | 74 | 111 | 148 | 185 | 222 | 259 | 296 | 333 |
| 328 | 33 | 66 | 98 | 131 | 164 | 197 | 230 | 262 | 295 | 372 | 37 | 74 | 112 | 149 | 186 | 223 | 260 | 298 | 335 |
| 330 | 33 | 66 | 99 | 132 | 165 | 198 | 231 | 264 | 297 | 374 | 37 | 75 | 112 | 150 | 187 | 224 | 262 | 299 | 337 |
| 332 | 33 | 66 | 100 | 133 | 166 | 199 | 232 | 266 | 299 | 376 | 38 | 75 | 113 | 150 | 188 | 226 | 263 | 301 | 338 |

## LOGARITHMS OF NUMBERS

**No. 1500 to 1899** **Log. 176091 to 278525**

| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 150 | 176091 | 176381 | 176670 | 176959 | 177248 | 177536 | 177825 | 178113 | 178401 | 178689 | 289 |
| 151 | 178977 | 179264 | 179552 | 179839 | 180126 | 180413 | 180699 | 180986 | 181272 | 181558 | 287 |
| 152 | 181844 | 182129 | 182415 | 182700 | 182985 | 183270 | 183555 | 183839 | 184123 | 184407 | 285 |
| 153 | 184691 | 184975 | 185259 | 185542 | 185825 | 186108 | 186391 | 186674 | 186956 | 187239 | 283 |
| 154 | 187521 | 187803 | 188084 | 188366 | 188647 | 188928 | 189209 | 189490 | 189771 | 190051 | 281 |
| 155 | 190332 | 190612 | 190892 | 191171 | 191451 | 191730 | 192010 | 192289 | 192567 | 192846 | 279 |
| 156 | 193125 | 193403 | 193681 | 193959 | 194237 | 194514 | 194792 | 195069 | 195346 | 195623 | 278 |
| 157 | 195900 | 196176 | 196453 | 196729 | 197005 | 197281 | 197556 | 197832 | 198107 | 198382 | 276 |
| 158 | 198657 | 198932 | 199206 | 199481 | 199755 | 200029 | 200303 | 200577 | 200850 | 201124 | 274 |
| 159 | 201397 | 201670 | 201943 | 202216 | 202488 | 202761 | 203033 | 203305 | 203577 | 203848 | 272 |
| 160 | 204120 | 204391 | 204663 | 204934 | 205204 | 205475 | 205746 | 206016 | 206286 | 206556 | 271 |
| 161 | 206826 | 207096 | 207365 | 207634 | 207904 | 208173 | 208441 | 208710 | 208979 | 209247 | 269 |
| 162 | 209515 | 209783 | 210051 | 210319 | 210586 | 210853 | 211121 | 211388 | 211654 | 211921 | 267 |
| 163 | 212188 | 212454 | 212720 | 212986 | 213252 | 213518 | 213783 | 214049 | 214314 | 214579 | 266 |
| 164 | 214844 | 215109 | 215373 | 215638 | 215902 | 216166 | 216430 | 216694 | 216957 | 217221 | 264 |
| 165 | 217484 | 217747 | 218010 | 218273 | 218536 | 218798 | 219060 | 219323 | 219585 | 219846 | 262 |
| 166 | 220108 | 220370 | 220631 | 220892 | 221153 | 221414 | 221675 | 221936 | 222196 | 222456 | 261 |
| 167 | 222716 | 222976 | 223236 | 223496 | 223755 | 224015 | 224274 | 224533 | 224792 | 225051 | 259 |
| 168 | 225309 | 225568 | 225826 | 226084 | 226342 | 226600 | 226858 | 227115 | 227372 | 227630 | 258 |
| 169 | 227887 | 228144 | 228400 | 228657 | 228913 | 229170 | 229426 | 229682 | 229938 | 230193 | 256 |
| 170 | 230449 | 230704 | 230960 | 231215 | 231470 | 231724 | 231979 | 232234 | 232488 | 232742 | 255 |
| 171 | 232996 | 233250 | 233504 | 233757 | 234011 | 234264 | 234517 | 234770 | 235023 | 235276 | 253 |
| 172 | 235528 | 235781 | 236033 | 236285 | 236537 | 236789 | 237041 | 237292 | 237544 | 237795 | 252 |
| 173 | 238046 | 238297 | 238548 | 238799 | 239049 | 239299 | 239550 | 239800 | 240050 | 240300 | 250 |
| 174 | 240549 | 240799 | 241048 | 241297 | 241546 | 241795 | 242044 | 242293 | 242541 | 242790 | 249 |
| 175 | 243038 | 243286 | 243534 | 243782 | 244030 | 244277 | 244525 | 244772 | 245019 | 245266 | 248 |
| 176 | 245513 | 245759 | 246006 | 246252 | 246499 | 246745 | 246991 | 247237 | 247482 | 247728 | 246 |
| 177 | 247973 | 248219 | 248464 | 248709 | 248954 | 249198 | 249443 | 249687 | 249932 | 250176 | 245 |
| 178 | 250420 | 250664 | 250908 | 251151 | 251395 | 251638 | 251881 | 252125 | 252368 | 252610 | 243 |
| 179 | 252853 | 253096 | 253338 | 253580 | 253822 | 254064 | 254306 | 254548 | 254790 | 255031 | 242 |
| 180 | 255273 | 255514 | 255755 | 255996 | 256237 | 256477 | 256718 | 256958 | 257198 | 257439 | 241 |
| 181 | 257679 | 257918 | 258158 | 258398 | 258637 | 258877 | 259116 | 259355 | 259594 | 259833 | 239 |
| 182 | 260071 | 260310 | 260548 | 260787 | 261025 | 261263 | 261501 | 261739 | 261976 | 262214 | 238 |
| 183 | 262451 | 262688 | 262925 | 263162 | 263399 | 263636 | 263873 | 264109 | 264346 | 264582 | 237 |
| 184 | 264818 | 265054 | 265290 | 265525 | 265761 | 265996 | 266232 | 266467 | 266702 | 266937 | 235 |
| 185 | 267172 | 267406 | 267641 | 267875 | 268110 | 268344 | 268578 | 268812 | 269046 | 269279 | 234 |
| 186 | 269513 | 269746 | 269980 | 270213 | 270446 | 270679 | 270912 | 271144 | 271377 | 271609 | 233 |
| 187 | 271842 | 272074 | 272306 | 272538 | 272770 | 273001 | 273233 | 273464 | 273696 | 273927 | 232 |
| 188 | 274158 | 274389 | 274620 | 274850 | 275081 | 275311 | 275542 | 275772 | 276002 | 276232 | 230 |
| 189 | 276462 | 276692 | 276921 | 277151 | 277380 | 277609 | 277838 | 278067 | 278296 | 278525 | 229 |
| No | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. |

| D. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 228 | 23 | 46 | 68 | 91 | 114 | 137 | 160 | 182 | 205 | 260 | 26 | 52 | 78 | 104 | 130 | 156 | 182 | 208 | 234 |
| 230 | 23 | 46 | 69 | 92 | 115 | 138 | 161 | 184 | 207 | 262 | 26 | 52 | 79 | 105 | 131 | 157 | 183 | 210 | 236 |
| 232 | 23 | 46 | 70 | 93 | 116 | 139 | 162 | 186 | 209 | 264 | 26 | 53 | 79 | 106 | 132 | 158 | 185 | 211 | 238 |
| 234 | 23 | 47 | 70 | 94 | 117 | 140 | 164 | 187 | 211 | 266 | 27 | 53 | 80 | 106 | 133 | 160 | 186 | 213 | 239 |
| 236 | 24 | 47 | 71 | 94 | 118 | 142 | 165 | 189 | 212 | 268 | 27 | 54 | 80 | 107 | 134 | 161 | 188 | 214 | 241 |
| 238 | 24 | 48 | 71 | 95 | 119 | 143 | 167 | 190 | 214 | 270 | 27 | 54 | 81 | 108 | 135 | 162 | 189 | 216 | 243 |
| 240 | 24 | 48 | 72 | 96 | 120 | 144 | 168 | 192 | 216 | 272 | 27 | 54 | 82 | 109 | 136 | 163 | 190 | 218 | 245 |
| 242 | 24 | 48 | 73 | 97 | 121 | 145 | 169 | 194 | 218 | 274 | 27 | 55 | 82 | 110 | 137 | 164 | 192 | 219 | 247 |
| 244 | 24 | 49 | 73 | 98 | 122 | 146 | 171 | 195 | 220 | 276 | 28 | 55 | 83 | 110 | 138 | 166 | 193 | 221 | 248 |
| 246 | 25 | 49 | 74 | 98 | 123 | 148 | 172 | 197 | 221 | 278 | 28 | 56 | 83 | 111 | 139 | 167 | 195 | 222 | 250 |
| 248 | 25 | 50 | 74 | 99 | 124 | 149 | 174 | 198 | 223 | 280 | 28 | 56 | 84 | 112 | 140 | 168 | 196 | 224 | 252 |
| 250 | 25 | 50 | 75 | 100 | 125 | 150 | 175 | 200 | 225 | 282 | 28 | 56 | 85 | 113 | 141 | 169 | 197 | 226 | 254 |
| 252 | 25 | 50 | 76 | 101 | 126 | 151 | 176 | 202 | 227 | 284 | 28 | 57 | 85 | 114 | 142 | 170 | 199 | 227 | 256 |
| 254 | 25 | 51 | 76 | 102 | 127 | 152 | 178 | 203 | 229 | 286 | 29 | 57 | 86 | 114 | 143 | 172 | 200 | 229 | 257 |
| 256 | 26 | 51 | 77 | 102 | 128 | 154 | 179 | 205 | 230 | 288 | 29 | 58 | 86 | 115 | 144 | 173 | 202 | 230 | 259 |
| 258 | 26 | 52 | 77 | 103 | 129 | 155 | 181 | 206 | 232 | 290 | 29 | 58 | 87 | 116 | 145 | 174 | 203 | 232 | 261 |

## LOGARITHMS OF NUMBERS

**No. 1900 to 2349** — **Log. 278754 to 370883**

| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 190 | 278754 | 278982 | 279211 | 279439 | 279667 | 279895 | 280123 | 280351 | 280578 | 280806 | 228 |
| 191 | 281033 | 281261 | 281488 | 281715 | 281942 | 282169 | 282396 | 282622 | 282849 | 283075 | 227 |
| 192 | 283301 | 283527 | 283753 | 283979 | 284205 | 284431 | 284656 | 284882 | 285107 | 285332 | 226 |
| 193 | 285557 | 285782 | 286007 | 286232 | 286456 | 286681 | 286905 | 287130 | 287354 | 287578 | 225 |
| 194 | 287802 | 288026 | 288249 | 288473 | 288696 | 288920 | 289143 | 289366 | 289589 | 289812 | 223 |
| 195 | 290035 | 290257 | 290480 | 290702 | 290925 | 291147 | 291369 | 291591 | 291813 | 292034 | 222 |
| 196 | 292256 | 292478 | 292699 | 292920 | 293141 | 293363 | 293584 | 293804 | 294025 | 294246 | 221 |
| 197 | 294466 | 294687 | 294907 | 295127 | 295347 | 295567 | 295787 | 296007 | 296226 | 296446 | 220 |
| 198 | 296665 | 296884 | 297104 | 297323 | 297542 | 297761 | 297979 | 298198 | 298416 | 298635 | 219 |
| 199 | 298853 | 299071 | 299289 | 299507 | 299725 | 290943 | 300161 | 300378 | 300595 | 300813 | 218 |
| 200 | 301030 | 301247 | 301464 | 301681 | 301898 | 302114 | 302331 | 302547 | 302764 | 302980 | 217 |
| 201 | 303196 | 303412 | 303628 | 303844 | 304059 | 304275 | 304491 | 304706 | 304921 | 305136 | 216 |
| 202 | 305351 | 305566 | 305781 | 305996 | 306211 | 306425 | 306639 | 306854 | 307068 | 307282 | 215 |
| 203 | 307496 | 307710 | 307924 | 308137 | 308351 | 308564 | 308778 | 308991 | 309204 | 309417 | 213 |
| 204 | 309630 | 309843 | 310056 | 310268 | 310481 | 310693 | 310906 | 311118 | 311330 | 311542 | 212 |
| 205 | 311754 | 311966 | 312177 | 312389 | 312600 | 312812 | 313023 | 313234 | 313445 | 313656 | 211 |
| 206 | 313867 | 314078 | 314289 | 314499 | 314710 | 314920 | 315130 | 315340 | 315551 | 315760 | 210 |
| 207 | 315970 | 316180 | 316390 | 316599 | 316809 | 317018 | 317227 | 317436 | 317646 | 317854 | 209 |
| 208 | 318063 | 318272 | 318481 | 318689 | 318898 | 319106 | 319314 | 319522 | 319730 | 319938 | 208 |
| 209 | 320146 | 320354 | 320562 | 320769 | 320977 | 321184 | 321391 | 321598 | 321805 | 322012 | 207 |
| 210 | 322219 | 322426 | 322633 | 322839 | 323046 | 323252 | 323458 | 323665 | 323871 | 324077 | 206 |
| 211 | 324282 | 324488 | 324694 | 324899 | 325105 | 325310 | 325516 | 325721 | 325926 | 326131 | 205 |
| 212 | 326336 | 326541 | 326745 | 326950 | 327155 | 327359 | 327563 | 327767 | 327972 | 328176 | 204 |
| 213 | 328380 | 328583 | 328787 | 328991 | 329194 | 329398 | 329601 | 329805 | 330008 | 330211 | 203 |
| 214 | 330414 | 330617 | 330819 | 331022 | 331225 | 331427 | 331630 | 331832 | 332034 | 332236 | 202 |
| 215 | 332438 | 332640 | 332842 | 333044 | 333246 | 333447 | 333649 | 333850 | 334051 | 334253 | 202 |
| 216 | 334454 | 334655 | 334856 | 335057 | 335257 | 335458 | 335658 | 335859 | 336059 | 336260 | 201 |
| 217 | 336460 | 336660 | 336860 | 337060 | 337260 | 337459 | 337659 | 337858 | 338058 | 338257 | 200 |
| 218 | 338456 | 338656 | 338855 | 339054 | 339253 | 339451 | 339650 | 339849 | 340047 | 340246 | 199 |
| 219 | 340444 | 340642 | 340841 | 341039 | 341237 | 341435 | 341632 | 341830 | 342028 | 342225 | 198 |
| 220 | 342423 | 342620 | 342817 | 343014 | 343212 | 343409 | 343606 | 343802 | 343999 | 344196 | 197 |
| 221 | 344392 | 344589 | 344785 | 344981 | 345178 | 345374 | 345570 | 345766 | 345962 | 346157 | 196 |
| 222 | 346353 | 346549 | 346744 | 346939 | 347135 | 347330 | 347525 | 347720 | 347915 | 348110 | 195 |
| 223 | 348305 | 348500 | 348694 | 348889 | 349083 | 349278 | 349472 | 349666 | 349860 | 350054 | 194 |
| 224 | 350248 | 350442 | 350636 | 350829 | 351023 | 351216 | 351410 | 351603 | 351796 | 351989 | 193 |
| 225 | 352183 | 352375 | 352568 | 352761 | 352954 | 353147 | 353339 | 353532 | 353724 | 353916 | 193 |
| 226 | 354108 | 354301 | 354493 | 354685 | 354876 | 355068 | 355260 | 355452 | 355643 | 355834 | 192 |
| 227 | 356026 | 356217 | 356408 | 356599 | 356790 | 356981 | 357172 | 357363 | 357554 | 357744 | 191 |
| 228 | 357935 | 358125 | 358316 | 358506 | 358696 | 358886 | 359076 | 359266 | 359456 | 359646 | 190 |
| 229 | 359835 | 360025 | 360215 | 360404 | 360593 | 360783 | 360972 | 361161 | 361350 | 361539 | 189 |
| 230 | 361728 | 361917 | 362105 | 362294 | 362482 | 362671 | 362859 | 363048 | 363236 | 363424 | 188 |
| 231 | 363612 | 363800 | 363988 | 364176 | 364363 | 364551 | 364739 | 364926 | 365113 | 365301 | 188 |
| 232 | 365488 | 365675 | 365862 | 366049 | 366236 | 366423 | 366610 | 366796 | 366983 | 367169 | 187 |
| 233 | 367356 | 367542 | 367729 | 367915 | 368101 | 368287 | 368473 | 368659 | 368845 | 369030 | 186 |
| 234 | 369216 | 369401 | 369587 | 369772 | 369958 | 370143 | 370328 | 370513 | 370698 | 370883 | 185 |
| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. |

| D. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 184 | 18 | 37 | 55 | 74 | 92 | 110 | 129 | 147 | 166 |
| 186 | 19 | 37 | 56 | 74 | 93 | 112 | 130 | 149 | 167 |
| 188 | 19 | 38 | 56 | 75 | 94 | 113 | 132 | 150 | 169 |
| 190 | 19 | 38 | 57 | 76 | 95 | 114 | 133 | 152 | 171 |
| 192 | 19 | 38 | 58 | 77 | 96 | 115 | 134 | 154 | 173 |
| 194 | 19 | 39 | 58 | 78 | 97 | 116 | 136 | 155 | 175 |
| 196 | 20 | 39 | 59 | 78 | 98 | 118 | 137 | 157 | 176 |
| 198 | 20 | 40 | 59 | 79 | 99 | 119 | 139 | 158 | 178 |
| 200 | 20 | 40 | 60 | 80 | 100 | 120 | 140 | 160 | 180 |
| 202 | 20 | 40 | 61 | 81 | 101 | 121 | 141 | 162 | 182 |
| 204 | 20 | 41 | 61 | 82 | 102 | 122 | 143 | 163 | 184 |
| 206 | 21 | 41 | 62 | 82 | 103 | 124 | 144 | 165 | 185 |

| D. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 208 | 21 | 42 | 62 | 83 | 104 | 125 | 146 | 166 | 187 |
| 210 | 21 | 42 | 63 | 84 | 105 | 126 | 147 | 168 | 189 |
| 212 | 21 | 42 | 64 | 85 | 106 | 127 | 148 | 170 | 191 |
| 214 | 21 | 43 | 64 | 86 | 107 | 128 | 150 | 171 | 193 |
| 216 | 22 | 43 | 65 | 86 | 108 | 130 | 151 | 173 | 194 |
| 218 | 22 | 44 | 65 | 87 | 109 | 131 | 153 | 174 | 196 |
| 220 | 22 | 44 | 66 | 88 | 110 | 132 | 154 | 176 | 198 |
| 222 | 22 | 44 | 67 | 89 | 111 | 133 | 155 | 178 | 200 |
| 224 | 22 | 45 | 67 | 90 | 112 | 134 | 157 | 179 | 202 |
| 226 | 23 | 45 | 68 | 90 | 113 | 136 | 158 | 181 | 203 |
| 228 | 23 | 46 | 68 | 91 | 114 | 137 | 160 | 182 | 205 |

## LOGARITHMS OF NUMBERS

No. 3350 to 3899 | Log. 525045 to 590953

| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 335 | 525045 | 525174 | 525304 | 525434 | 525563 | 525693 | 525822 | 525951 | 526081 | 526210 | 129 |
| 336 | 526339 | 526469 | 526598 | 526727 | 526856 | 526985 | 527114 | 527243 | 527372 | 527501 | 129 |
| 337 | 527630 | 527759 | 527888 | 528016 | 528145 | 528274 | 528402 | 528531 | 528660 | 528788 | 129 |
| 338 | 528917 | 529045 | 529174 | 529302 | 529430 | 529559 | 529687 | 529815 | 529943 | 530072 | 128 |
| 339 | 530200 | 530328 | 530456 | 530584 | 530712 | 530840 | 530968 | 531096 | 531223 | 531351 | 128 |
| 340 | 531479 | 531607 | 531734 | 531862 | 531990 | 532117 | 532245 | 532372 | 532500 | 532627 | 128 |
| 341 | 532754 | 532882 | 533009 | 533136 | 533264 | 533391 | 533518 | 533645 | 533772 | 533899 | 127 |
| 342 | 534026 | 534153 | 534280 | 534407 | 534534 | 534661 | 534787 | 534914 | 535041 | 535167 | 127 |
| 343 | 535294 | 535421 | 535547 | 535674 | 535800 | 535927 | 536053 | 536180 | 536306 | 536432 | 126 |
| 344 | 536558 | 536685 | 536811 | 536937 | 537063 | 537189 | 537315 | 537441 | 537567 | 537693 | 126 |
| 345 | 537819 | 537945 | 538071 | 538197 | 538322 | 538448 | 538574 | 538699 | 538825 | 538951 | 126 |
| 346 | 539076 | 539202 | 539327 | 539452 | 539578 | 539703 | 539829 | 539954 | 540079 | 540204 | 125 |
| 347 | 540329 | 540455 | 540580 | 540705 | 540830 | 540955 | 541080 | 541205 | 541330 | 541454 | 125 |
| 348 | 541579 | 541704 | 541829 | 541953 | 542078 | 542203 | 542327 | 542452 | 542576 | 542701 | 125 |
| 349 | 542825 | 542950 | 543074 | 543199 | 543323 | 543447 | 543571 | 543696 | 543820 | 543944 | 124 |
| 350 | 544068 | 544192 | 544316 | 544440 | 544564 | 544688 | 544812 | 544936 | 545060 | 545183 | 124 |
| 351 | 545307 | 545431 | 545555 | 545678 | 545802 | 545925 | 546049 | 546172 | 546296 | 546419 | 124 |
| 352 | 546543 | 546666 | 546789 | 546913 | 547036 | 547159 | 547282 | 547405 | 547529 | 547652 | 123 |
| 353 | 547775 | 547898 | 548021 | 548144 | 548267 | 548389 | 548512 | 548635 | 548758 | 548881 | 123 |
| 354 | 549003 | 549126 | 549249 | 549371 | 549494 | 549616 | 549739 | 549861 | 549984 | 550106 | 123 |
| 355 | 550228 | 550351 | 550473 | 550595 | 550717 | 550840 | 550962 | 551084 | 551206 | 551328 | 122 |
| 356 | 551450 | 551572 | 551694 | 551816 | 551938 | 552060 | 552181 | 552303 | 552425 | 552547 | 122 |
| 357 | 552668 | 552790 | 552911 | 553033 | 553155 | 553276 | 553398 | 553519 | 553640 | 553762 | 121 |
| 358 | 553883 | 554004 | 554126 | 554247 | 554368 | 554489 | 554610 | 554731 | 554852 | 554973 | 121 |
| 359 | 555094 | 555215 | 555336 | 555457 | 555578 | 555699 | 555820 | 555940 | 556061 | 556182 | 121 |
| 360 | 556303 | 556423 | 556544 | 556664 | 556785 | 556905 | 557026 | 557146 | 557267 | 557387 | 120 |
| 361 | 557507 | 557627 | 557748 | 557868 | 557988 | 558108 | 558228 | 558349 | 558469 | 558589 | 120 |
| 362 | 558709 | 558829 | 558948 | 559068 | 559188 | 559308 | 559428 | 559548 | 559667 | 559787 | 120 |
| 363 | 559907 | 560026 | 560146 | 560265 | 560385 | 560504 | 560624 | 560743 | 560863 | 560982 | 119 |
| 364 | 561101 | 561221 | 561340 | 561459 | 561578 | 561698 | 561817 | 561936 | 562055 | 562174 | 119 |
| 365 | 562293 | 562412 | 562531 | 562650 | 562769 | 562887 | 563006 | 563125 | 563244 | 563362 | 119 |
| 366 | 563481 | 563600 | 563718 | 563837 | 563955 | 564074 | 564192 | 564311 | 564429 | 564548 | 119 |
| 367 | 564666 | 564784 | 564903 | 565021 | 565139 | 565257 | 565376 | 565494 | 565612 | 565730 | 118 |
| 368 | 565848 | 565966 | 566084 | 566202 | 566320 | 566437 | 566555 | 566673 | 566791 | 566909 | 118 |
| 369 | 567026 | 567144 | 567262 | 567379 | 567497 | 567614 | 567732 | 567849 | 567967 | 568084 | 118 |
| 370 | 568202 | 568319 | 568436 | 568554 | 568671 | 568788 | 568905 | 569023 | 569140 | 569257 | 117 |
| 371 | 569374 | 569491 | 569608 | 569725 | 569842 | 569959 | 570076 | 570193 | 570309 | 570426 | 117 |
| 372 | 570543 | 570660 | 570776 | 570893 | 571010 | 571126 | 571243 | 571359 | 571476 | 571592 | 117 |
| 373 | 571709 | 571825 | 571942 | 572058 | 572174 | 572291 | 572407 | 572523 | 572639 | 572755 | 116 |
| 374 | 572872 | 572988 | 573104 | 573220 | 573336 | 573452 | 573568 | 573684 | 573800 | 573915 | 116 |
| 375 | 574031 | 574147 | 574263 | 574379 | 574494 | 574610 | 574726 | 574841 | 574957 | 575072 | 116 |
| 376 | 575188 | 575303 | 575419 | 575534 | 575650 | 575765 | 575880 | 575996 | 576111 | 576226 | 115 |
| 377 | 576341 | 576457 | 576572 | 576687 | 576802 | 576917 | 577032 | 577147 | 577262 | 577377 | 115 |
| 378 | 577492 | 577607 | 577722 | 577836 | 577951 | 578066 | 578181 | 578295 | 578410 | 578525 | 115 |
| 379 | 578639 | 578754 | 578868 | 578983 | 579097 | 579212 | 579326 | 579441 | 579555 | 579669 | 114 |
| 380 | 579784 | 579898 | 580012 | 580126 | 580241 | 580355 | 580469 | 580583 | 580697 | 580811 | 114 |
| 381 | 580925 | 581039 | 581153 | 581267 | 581381 | 581495 | 581608 | 581722 | 581836 | 581950 | 114 |
| 382 | 582063 | 582177 | 582291 | 582404 | 582518 | 582631 | 582745 | 582858 | 582972 | 583085 | 114 |
| 383 | 583199 | 583312 | 583426 | 583539 | 583652 | 583765 | 583879 | 583992 | 584105 | 584218 | 113 |
| 384 | 584331 | 584444 | 584557 | 584670 | 584783 | 584896 | 585009 | 585122 | 585235 | 585348 | 113 |
| 385 | 585461 | 585574 | 585686 | 585799 | 585912 | 586024 | 586137 | 586250 | 586362 | 586475 | 113 |
| 386 | 586587 | 586700 | 586812 | 586925 | 587037 | 587149 | 587262 | 587374 | 587486 | 587599 | 112 |
| 387 | 587711 | 587823 | 587935 | 588047 | 588160 | 588272 | 588384 | 588496 | 588608 | 588720 | 112 |
| 388 | 588832 | 588944 | 589056 | 589167 | 589279 | 589391 | 589503 | 589615 | 589726 | 589838 | 112 |
| 389 | 589950 | 590061 | 590173 | 590284 | 590396 | 590507 | 590619 | 590730 | 590842 | 590953 | 112 |
| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. |

| D. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 112 | 11 | 22 | 34 | 45 | 56 | 67 | 78 | 90 | 101 | 122 | 12 | 24 | 37 | 49 | 61 | 73 | 85 | 98 | 110 |
| 114 | 11 | 23 | 34 | 46 | 57 | 68 | 80 | 91 | 103 | 124 | 12 | 25 | 37 | 50 | 62 | 74 | 87 | 99 | 112 |
| 116 | 12 | 23 | 35 | 46 | 58 | 70 | 81 | 93 | 104 | 126 | 13 | 25 | 38 | 50 | 63 | 76 | 88 | 101 | 113 |
| 118 | 12 | 24 | 35 | 47 | 59 | 71 | 83 | 94 | 106 | 128 | 13 | 26 | 38 | 51 | 64 | 77 | 90 | 102 | 115 |
| 120 | 12 | 24 | 36 | 48 | 60 | 72 | 84 | 96 | 108 | 130 | 13 | 26 | 39 | 52 | 65 | 78 | 91 | 104 | 117 |

## LOGARITHMS OF NUMBERS

No. 3900 to 4449 — Log. 591065 to 648262

| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 390 | 591065 | 591176 | 591287 | 591399 | 591510 | 591621 | 591732 | 591843 | 591955 | 592066 | 111 |
| 391 | 592177 | 592288 | 592399 | 592510 | 592621 | 592732 | 592843 | 592954 | 593064 | 593175 | 111 |
| 392 | 593286 | 593397 | 593508 | 593618 | 593729 | 593840 | 593950 | 594061 | 594171 | 594282 | 111 |
| 393 | 594393 | 594503 | 594614 | 594724 | 594834 | 594945 | 595055 | 595165 | 595276 | 595386 | 110 |
| 394 | 595496 | 595606 | 595717 | 595827 | 595937 | 596047 | 596157 | 596267 | 596377 | 596487 | 110 |
| 395 | 596597 | 596707 | 596817 | 596927 | 597037 | 597146 | 597256 | 597366 | 597476 | 597586 | 110 |
| 396 | 597695 | 597805 | 597914 | 598024 | 598134 | 598243 | 598353 | 598462 | 598572 | 598681 | 110 |
| 397 | 598791 | 598900 | 599009 | 599119 | 599228 | 599337 | 599446 | 599556 | 599665 | 599774 | 109 |
| 398 | 599883 | 599992 | 600101 | 600210 | 600319 | 600428 | 600537 | 600646 | 600755 | 600864 | 109 |
| 399 | 600973 | 601082 | 601191 | 601299 | 601408 | 601517 | 601625 | 601734 | 601843 | 601951 | 109 |
| 400 | 602060 | 602169 | 602277 | 602386 | 602494 | 602603 | 602711 | 602819 | 602928 | 603036 | 108 |
| 401 | 603144 | 603253 | 603361 | 603469 | 603577 | 603686 | 603794 | 603902 | 604010 | 604118 | 108 |
| 402 | 604226 | 604334 | 604442 | 604550 | 604658 | 604766 | 604874 | 604982 | 605089 | 605197 | 108 |
| 403 | 605305 | 605413 | 605521 | 605628 | 605736 | 605844 | 605951 | 606059 | 606166 | 606274 | 108 |
| 404 | 606381 | 606489 | 606596 | 606704 | 606811 | 606919 | 607026 | 607133 | 607241 | 607348 | 107 |
| 405 | 607455 | 607562 | 607669 | 607777 | 607884 | 607991 | 608098 | 608205 | 608312 | 608419 | 107 |
| 406 | 608526 | 608633 | 608740 | 608847 | 608954 | 609061 | 609167 | 609274 | 609381 | 609488 | 107 |
| 407 | 609594 | 609701 | 609808 | 609914 | 610021 | 610128 | 610234 | 610341 | 610447 | 610554 | 107 |
| 408 | 610660 | 610767 | 610873 | 610979 | 611086 | 611192 | 611298 | 611405 | 611511 | 611617 | 106 |
| 409 | 611723 | 611829 | 611936 | 612042 | 612148 | 612254 | 612360 | 612466 | 612572 | 612678 | 106 |
| 410 | 612784 | 612890 | 612996 | 613102 | 613207 | 613313 | 613419 | 613525 | 613630 | 613736 | 106 |
| 411 | 613842 | 613947 | 614053 | 614159 | 614264 | 614370 | 614475 | 614581 | 614686 | 614792 | 106 |
| 412 | 614897 | 615003 | 615108 | 615213 | 615319 | 615424 | 615529 | 615634 | 615740 | 615845 | 105 |
| 413 | 615950 | 616055 | 616160 | 616265 | 616370 | 616476 | 616581 | 616686 | 616790 | 616895 | 105 |
| 414 | 617000 | 617105 | 617210 | 617315 | 617420 | 617525 | 617629 | 617734 | 617839 | 617943 | 105 |
| 415 | 618048 | 618153 | 618257 | 618362 | 618466 | 618571 | 618676 | 618780 | 618884 | 618989 | 105 |
| 416 | 619093 | 619198 | 619302 | 619406 | 619511 | 619615 | 619719 | 619824 | 619928 | 620032 | 104 |
| 417 | 620136 | 620240 | 620344 | 620448 | 620552 | 620656 | 620760 | 620864 | 620968 | 621072 | 104 |
| 418 | 621176 | 621280 | 621384 | 621488 | 621592 | 621695 | 621799 | 621903 | 622007 | 622110 | 104 |
| 419 | 622214 | 622318 | 622421 | 622525 | 622628 | 622732 | 622835 | 622939 | 623042 | 623146 | 104 |
| 420 | 623249 | 623353 | 623456 | 623559 | 623663 | 623766 | 623869 | 623973 | 624076 | 624179 | 103 |
| 421 | 624282 | 624385 | 624488 | 624591 | 624695 | 624798 | 624901 | 625004 | 625107 | 625210 | 103 |
| 422 | 625312 | 625415 | 625518 | 625621 | 625724 | 625827 | 625929 | 626032 | 626135 | 626238 | 103 |
| 423 | 626340 | 626443 | 626546 | 626648 | 626751 | 626853 | 626956 | 627058 | 627161 | 627263 | 103 |
| 424 | 627366 | 627468 | 627571 | 627673 | 627775 | 627878 | 627980 | 628082 | 628185 | 628287 | 102 |
| 425 | 628389 | 628491 | 628593 | 628695 | 628797 | 628900 | 629002 | 629104 | 629206 | 629308 | 102 |
| 426 | 629410 | 629512 | 629613 | 629715 | 629817 | 629919 | 630021 | 630123 | 630224 | 630326 | 102 |
| 427 | 630428 | 630530 | 630631 | 630733 | 630835 | 630936 | 631038 | 631139 | 631241 | 631342 | 102 |
| 428 | 631444 | 631545 | 631647 | 631748 | 631849 | 631951 | 632052 | 632153 | 632255 | 632356 | 101 |
| 429 | 632457 | 632559 | 632660 | 632761 | 632862 | 632963 | 633064 | 633165 | 633266 | 633367 | 101 |
| 430 | 633468 | 633569 | 633670 | 633771 | 633872 | 633973 | 634074 | 634175 | 634276 | 634376 | 101 |
| 431 | 634477 | 634578 | 634679 | 634779 | 634880 | 634981 | 635081 | 635182 | 635283 | 635383 | 101 |
| 432 | 635484 | 635584 | 635685 | 635785 | 635886 | 635986 | 636087 | 636187 | 636287 | 636388 | 100 |
| 433 | 636488 | 636588 | 636688 | 636789 | 636889 | 636989 | 637089 | 637189 | 637290 | 637390 | 100 |
| 434 | 637490 | 637590 | 637690 | 637790 | 637890 | 637990 | 638090 | 638190 | 638290 | 638389 | 100 |
| 435 | 638489 | 638589 | 638689 | 638789 | 638888 | 638988 | 639088 | 639188 | 639287 | 639387 | 100 |
| 436 | 639486 | 639586 | 639686 | 639785 | 639885 | 639984 | 640084 | 640183 | 640283 | 640382 | 99 |
| 437 | 640481 | 640581 | 640680 | 640779 | 640879 | 640978 | 641077 | 641177 | 641276 | 641375 | 99 |
| 438 | 641474 | 641573 | 641672 | 641771 | 641871 | 641970 | 642069 | 642168 | 642267 | 642366 | 99 |
| 439 | 642465 | 642563 | 642662 | 642761 | 642860 | 642959 | 643058 | 643156 | 643255 | 643354 | 99 |
| 440 | 643453 | 643551 | 643650 | 643749 | 643847 | 643946 | 644044 | 644143 | 644242 | 644340 | 99 |
| 441 | 644439 | 644537 | 644636 | 644734 | 644832 | 644931 | 645029 | 645127 | 645226 | 645324 | 98 |
| 442 | 645422 | 645521 | 645619 | 645717 | 645815 | 645913 | 646011 | 646110 | 646208 | 646306 | 98 |
| 443 | 646404 | 646502 | 646600 | 646698 | 646796 | 646894 | 646992 | 647089 | 647187 | 647285 | 98 |
| 444 | 647383 | 647481 | 647579 | 647676 | 647774 | 647872 | 647969 | 648067 | 648165 | 648262 | 98 |
| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. |

| D. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 98 | 10 | 20 | 29 | 39 | 49 | 59 | 69 | 78 | 88 | 106 | 11 | 21 | 32 | 42 | 53 | 64 | 74 | 85 | 95 |
| 100 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 108 | 11 | 22 | 32 | 43 | 54 | 65 | 76 | 86 | 97 |
| 102 | 10 | 20 | 31 | 41 | 51 | 61 | 71 | 82 | 92 | 110 | 11 | 22 | 33 | 44 | 55 | 66 | 77 | 88 | 99 |
| 104 | 10 | 21 | 31 | 42 | 52 | 62 | 73 | 83 | 94 | 112 | 11 | 22 | 34 | 45 | 56 | 67 | 78 | 90 | 101 |

## LOGARITHMS OF NUMBERS

**No. 4450 to 4999** **Log. 648360 to 698883**

| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 445 | 648360 | 648458 | 648555 | 648653 | 648750 | 648848 | 648945 | 649043 | 649140 | 649237 | 97 |
| 446 | 649335 | 649432 | 549530 | 649627 | 649724 | 649821 | 649919 | 650016 | 650113 | 650210 | 97 |
| 447 | 650308 | 650405 | 650502 | 650599 | 650696 | 650793 | 650890 | 650987 | 651084 | 651181 | 97 |
| 448 | 651278 | 651375 | 651472 | 651569 | 651666 | 651762 | 651859 | 651956 | 652053 | 652150 | 97 |
| 449 | 652246 | 652343 | 652440 | 652536 | 652633 | 652730 | 652826 | 652923 | 653019 | 653116 | 97 |
| 450 | 653213 | 653309 | 653405 | 653502 | 653598 | 653695 | 653791 | 653888 | 653984 | 654080 | 96 |
| 451 | 654177 | 654273 | 654369 | 654465 | 654562 | 654658 | 654754 | 654850 | 654946 | 655042 | 96 |
| 452 | 655138 | 655235 | 655331 | 655427 | 655523 | 655619 | 655715 | 655810 | 655906 | 656002 | 96 |
| 453 | 656098 | 656194 | 656290 | 656386 | 656482 | 656577 | 656673 | 656769 | 656864 | 656960 | 96 |
| 454 | 657056 | 657152 | 657247 | 657343 | 657438 | 657534 | 657629 | 657725 | 657820 | 657916 | 96 |
| 455 | 658011 | 658107 | 658202 | 658298 | 658393 | 658488 | 658584 | 658679 | 658774 | 658870 | 95 |
| 456 | 658965 | 659060 | 659155 | 659250 | 659346 | 659441 | 659536 | 659631 | 659726 | 659821 | 95 |
| 457 | 659916 | 660011 | 660106 | 660201 | 660296 | 660391 | 660486 | 660581 | 660676 | 660771 | 95 |
| 458 | 660865 | 660960 | 661055 | 661150 | 661245 | 661339 | 661434 | 661529 | 661623 | 661718 | 95 |
| 459 | 661813 | 661907 | 662002 | 662096 | 662191 | 662286 | 662380 | 662475 | 662569 | 662663 | 95 |
| 460 | 662758 | 662852 | 662947 | 663041 | 663135 | 663230 | 663324 | 663418 | 663512 | 663607 | 94 |
| 461 | 663701 | 663795 | 663889 | 663983 | 664078 | 664172 | 664266 | 664360 | 664454 | 664548 | 94 |
| 462 | 664642 | 664736 | 664830 | 664924 | 665018 | 665112 | 665206 | 665299 | 665393 | 665487 | 94 |
| 463 | 665581 | 665675 | 665769 | 665862 | 665956 | 666050 | 666143 | 666237 | 666331 | 666424 | 94 |
| 464 | 666518 | 666612 | 666705 | 666799 | 666892 | 666986 | 667079 | 667173 | 667266 | 667360 | 94 |
| 465 | 667453 | 667546 | 667640 | 667733 | 667826 | 667920 | 668013 | 668106 | 668199 | 668293 | 93 |
| 466 | 668386 | 668479 | 668572 | 668665 | 668759 | 668852 | 668945 | 669038 | 669131 | 669224 | 93 |
| 467 | 669317 | 669410 | 669503 | 669596 | 669689 | 669782 | 669875 | 669967 | 670060 | 670153 | 93 |
| 468 | 670246 | 670339 | 670431 | 670524 | 670617 | 670710 | 670802 | 670895 | 670988 | 671080 | 93 |
| 469 | 671173 | 671265 | 671358 | 671451 | 671543 | 671636 | 671728 | 671821 | 671913 | 672005 | 93 |
| 470 | 672098 | 672190 | 672283 | 672375 | 672467 | 672560 | 672652 | 672744 | 672836 | 672929 | 92 |
| 471 | 673021 | 673113 | 673205 | 673297 | 673390 | 673482 | 673574 | 673666 | 673758 | 673850 | 92 |
| 472 | 673942 | 674034 | 674126 | 674218 | 674310 | 674402 | 674494 | 674586 | 674677 | 674769 | 92 |
| 473 | 674861 | 674953 | 675045 | 675137 | 675228 | 675320 | 675412 | 675503 | 675595 | 675687 | 92 |
| 474 | 675778 | 675870 | 675962 | 676053 | 676145 | 676236 | 676328 | 676419 | 676511 | 676602 | 92 |
| 475 | 676694 | 676785 | 676876 | 676968 | 677059 | 677151 | 677242 | 677333 | 677424 | 677516 | 91 |
| 476 | 677607 | 677698 | 677789 | 677881 | 677972 | 678063 | 678154 | 678245 | 678336 | 678427 | 91 |
| 477 | 678518 | 678609 | 678700 | 678791 | 678882 | 678973 | 679064 | 679155 | 679246 | 679337 | 91 |
| 478 | 679428 | 679519 | 679610 | 679700 | 679791 | 679882 | 679973 | 680063 | 680154 | 680245 | 91 |
| 479 | 680336 | 680426 | 680517 | 680607 | 680698 | 680789 | 680879 | 680970 | 681060 | 681151 | 91 |
| 480 | 681241 | 681332 | 681422 | 681513 | 681603 | 681693 | 681784 | 681874 | 681964 | 682055 | 90 |
| 481 | 682145 | 682235 | 682326 | 682416 | 682506 | 682596 | 682686 | 682777 | 682867 | 682957 | 90 |
| 482 | 683047 | 683137 | 683227 | 683317 | 683407 | 683497 | 683587 | 683677 | 683767 | 683857 | 90 |
| 483 | 683947 | 684037 | 684127 | 684217 | 684307 | 684396 | 684486 | 684576 | 684666 | 684756 | 90 |
| 484 | 684845 | 684935 | 685025 | 685114 | 685204 | 685294 | 685383 | 685473 | 685563 | 685652 | 90 |
| 485 | 685742 | 685831 | 685921 | 686010 | 686100 | 686189 | 686279 | 686368 | 686458 | 686547 | 89 |
| 486 | 686636 | 686726 | 686815 | 686904 | 686994 | 687083 | 687172 | 687261 | 687351 | 687440 | 89 |
| 487 | 687529 | 687618 | 687707 | 687796 | 687886 | 687975 | 688064 | 688153 | 688242 | 688331 | 89 |
| 488 | 688420 | 688509 | 688598 | 688687 | 688776 | 688865 | 688953 | 689042 | 689131 | 689220 | 89 |
| 489 | 689309 | 689398 | 689486 | 689575 | 689664 | 689753 | 689841 | 689930 | 690019 | 690107 | 89 |
| 490 | 690196 | 690285 | 690373 | 690462 | 690550 | 690639 | 690728 | 690816 | 690905 | 690993 | 89 |
| 491 | 691081 | 691170 | 691258 | 691347 | 691435 | 691524 | 691612 | 691700 | 691789 | 691877 | 88 |
| 492 | 691965 | 692053 | 692142 | 692230 | 692318 | 692406 | 692494 | 692583 | 692671 | 692759 | 88 |
| 493 | 692847 | 692935 | 693023 | 693111 | 693199 | 693287 | 693375 | 693463 | 693551 | 693639 | 88 |
| 494 | 693727 | 693815 | 693903 | 693991 | 694078 | 694166 | 694254 | 694342 | 694430 | 694517 | 88 |
| 495 | 694605 | 694693 | 694781 | 694868 | 694956 | 695044 | 695131 | 695219 | 695307 | 695394 | 88 |
| 496 | 695482 | 695569 | 695657 | 695744 | 695832 | 695919 | 696007 | 696094 | 696182 | 696269 | 87 |
| 497 | 696356 | 696444 | 696531 | 696618 | 696706 | 696793 | 696880 | 696968 | 697055 | 697142 | 87 |
| 498 | 697229 | 697317 | 697404 | 697491 | 697578 | 697665 | 697752 | 697839 | 697926 | 698014 | 87 |
| 499 | 698101 | 698188 | 698275 | 698362 | 698449 | 698535 | 698622 | 698709 | 698796 | 698883 | 87 |
| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. |

| D. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 88 | 9 | 18 | 26 | 35 | 44 | 53 | 62 | 70 | 79 | 93 | 9 | 19 | 28 | 37 | 46 | 56 | 65 | 74 | 84 |
| 89 | 9 | 18 | 27 | 36 | 44 | 53 | 62 | 71 | 80 | 94 | 9 | 19 | 28 | 38 | 47 | 56 | 66 | 75 | 85 |
| 90 | 9 | 18 | 27 | 36 | 45 | 54 | 63 | 72 | 81 | 95 | 9 | 19 | 28 | 38 | 47 | 57 | 66 | 76 | 86 |
| 91 | 9 | 18 | 27 | 36 | 45 | 55 | 64 | 73 | 82 | 96 | 10 | 19 | 29 | 38 | 48 | 58 | 67 | 77 | 86 |
| 92 | 9 | 18 | 28 | 37 | 46 | 55 | 64 | 74 | 83 | 97 | 10 | 19 | 29 | 39 | 48 | 58 | 68 | 78 | 87 |

## LOGARITHMS OF NUMBERS

**No. 5000 to 5549** **Log. 698970 to 744215**

| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 500 | 698970 | 699057 | 699144 | 699231 | 699317 | 699404 | 699491 | 699578 | 699664 | 699751 | 87 |
| 501 | 699838 | 699924 | 700011 | 700098 | 700184 | 700271 | 700358 | 700444 | 700531 | 700617 | 87 |
| 502 | 700704 | 700790 | 700877 | 700963 | 701050 | 701136 | 701222 | 701309 | 701395 | 701482 | 86 |
| 503 | 701568 | 701654 | 701741 | 701827 | 701913 | 701999 | 702086 | 702172 | 702258 | 702344 | 86 |
| 504 | 702431 | 702517 | 702603 | 702689 | 702775 | 702861 | 702947 | 703033 | 703119 | 703205 | 86 |
| 505 | 703291 | 703377 | 703463 | 703549 | 703635 | 703721 | 703807 | 703893 | 703979 | 704065 | 86 |
| 506 | 704151 | 704236 | 704322 | 704408 | 704494 | 704579 | 704665 | 704751 | 704837 | 704922 | 86 |
| 507 | 705008 | 705094 | 705179 | 705265 | 705350 | 705436 | 705522 | 705607 | 705693 | 705778 | 86 |
| 508 | 705864 | 705949 | 706035 | 706120 | 706206 | 706291 | 706376 | 706462 | 706547 | 706632 | 85 |
| 509 | 706718 | 706803 | 706888 | 706974 | 707059 | 707144 | 707229 | 707315 | 707400 | 707485 | 85 |
| 510 | 707570 | 707655 | 707740 | 707826 | 707911 | 707996 | 708081 | 708166 | 708251 | 708336 | 85 |
| 511 | 708421 | 708506 | 708591 | 708676 | 708761 | 708846 | 708931 | 709015 | 709100 | 709185 | 85 |
| 512 | 709270 | 709355 | 709440 | 709524 | 709609 | 709694 | 709779 | 709863 | 709948 | 710033 | 85 |
| 513 | 710117 | 710202 | 710287 | 710371 | 710456 | 710540 | 710625 | 710710 | 710794 | 710879 | 85 |
| 514 | 710963 | 711048 | 711132 | 711217 | 711301 | 711385 | 711470 | 711554 | 711639 | 711723 | 84 |
| 515 | 711807 | 711892 | 711976 | 712060 | 712144 | 712229 | 712313 | 712397 | 712481 | 712566 | 84 |
| 516 | 712650 | 712734 | 712818 | 712902 | 712986 | 713070 | 713154 | 713238 | 713323 | 713407 | 84 |
| 517 | 713491 | 713575 | 713659 | 713742 | 713826 | 713910 | 713994 | 714078 | 714162 | 714246 | 84 |
| 518 | 714330 | 714414 | 714497 | 714581 | 714665 | 714749 | 714833 | 714916 | 715000 | 715084 | 84 |
| 519 | 715167 | 715251 | 715335 | 715418 | 715502 | 715586 | 715669 | 715753 | 715836 | 715920 | 84 |
| 520 | 716003 | 716087 | 716170 | 716254 | 716337 | 716421 | 716504 | 716588 | 716671 | 716754 | 83 |
| 521 | 716838 | 716921 | 717004 | 717088 | 717171 | 717254 | 717338 | 717421 | 717504 | 717587 | 83 |
| 522 | 717671 | 717754 | 717837 | 717920 | 718003 | 718086 | 718169 | 718253 | 718336 | 718419 | 83 |
| 523 | 718502 | 718585 | 718668 | 718751 | 718834 | 718917 | 719000 | 719083 | 719165 | 719248 | 83 |
| 524 | 719331 | 719414 | 719497 | 719580 | 719663 | 719745 | 719828 | 719911 | 719994 | 720077 | 83 |
| 525 | 720159 | 720242 | 720325 | 720407 | 720490 | 720573 | 720655 | 720738 | 720821 | 720903 | 83 |
| 526 | 720986 | 721068 | 721151 | 721233 | 721316 | 721398 | 721481 | 721563 | 721646 | 721728 | 82 |
| 527 | 721811 | 721893 | 721975 | 722058 | 722140 | 722222 | 722305 | 722387 | 722469 | 722552 | 82 |
| 528 | 722634 | 722716 | 722798 | 722881 | 722963 | 723045 | 723127 | 723209 | 723291 | 723374 | 82 |
| 529 | 723456 | 723538 | 723620 | 723702 | 723784 | 723866 | 723948 | 724030 | 724112 | 724194 | 82 |
| 530 | 724276 | 724358 | 724440 | 724522 | 724604 | 724685 | 724767 | 724849 | 724931 | 725013 | 82 |
| 531 | 725095 | 725176 | 725258 | 725340 | 725422 | 725503 | 725585 | 725667 | 725748 | 725830 | 82 |
| 532 | 725912 | 725993 | 726075 | 726156 | 726238 | 726320 | 726401 | 726483 | 726564 | 726646 | 82 |
| 533 | 726727 | 726809 | 726890 | 726972 | 727053 | 727134 | 727216 | 727297 | 727379 | 727460 | 81 |
| 534 | 727541 | 727623 | 727704 | 727785 | 727866 | 727948 | 728029 | 728110 | 728191 | 728273 | 81 |
| 535 | 728354 | 728435 | 728516 | 728597 | 728678 | 728759 | 728841 | 728922 | 729003 | 729084 | 81 |
| 536 | 729165 | 729246 | 729327 | 729408 | 729489 | 729570 | 729651 | 729732 | 729813 | 729893 | 81 |
| 537 | 729974 | 730055 | 730136 | 730217 | 730298 | 730378 | 730459 | 730540 | 730621 | 730702 | 81 |
| 538 | 730782 | 730863 | 730944 | 731024 | 731105 | 731186 | 731266 | 731347 | 731428 | 731508 | 81 |
| 539 | 731589 | 731669 | 731750 | 731830 | 731911 | 731991 | 732072 | 732152 | 732233 | 732313 | 81 |
| 540 | 732394 | 732474 | 732555 | 732635 | 732715 | 732796 | 732876 | 732956 | 733037 | 733117 | 80 |
| 541 | 733197 | 733278 | 733358 | 733438 | 733518 | 733598 | 733679 | 733759 | 733839 | 733919 | 80 |
| 542 | 733999 | 734079 | 734160 | 734240 | 734320 | 734400 | 734480 | 734560 | 734640 | 734720 | 80 |
| 543 | 734800 | 734880 | 734960 | 735040 | 735120 | 735200 | 735279 | 735359 | 735439 | 735519 | 80 |
| 544 | 735599 | 735679 | 735759 | 735838 | 735918 | 735998 | 736078 | 736157 | 736237 | 736317 | 80 |
| 545 | 736397 | 736476 | 736556 | 736635 | 736715 | 736795 | 736874 | 736954 | 737034 | 737113 | 80 |
| 546 | 737193 | 737272 | 737352 | 737431 | 737511 | 737590 | 737670 | 737749 | 737829 | 737908 | 79 |
| 547 | 737987 | 738067 | 738146 | 738225 | 738305 | 738384 | 738463 | 738543 | 738622 | 738701 | 79 |
| 548 | 738781 | 738860 | 738939 | 739018 | 739097 | 739177 | 739256 | 739335 | 739414 | 739493 | 79 |
| 549 | 739572 | 739651 | 739731 | 739810 | 739889 | 739968 | 740047 | 740126 | 740205 | 740284 | 79 |
| 550 | 740363 | 740442 | 740521 | 740600 | 740678 | 740757 | 740836 | 740915 | 740994 | 741073 | 79 |
| 551 | 741152 | 741230 | 741309 | 741388 | 741467 | 741546 | 741624 | 741703 | 741782 | 741860 | 79 |
| 552 | 741939 | 742018 | 742096 | 742175 | 742254 | 742332 | 742411 | 742489 | 742568 | 742647 | 79 |
| 553 | 742725 | 742804 | 742882 | 742961 | 743039 | 743118 | 743196 | 743275 | 743353 | 743431 | 78 |
| 554 | 743510 | 743588 | 743667 | 743745 | 743823 | 743902 | 743980 | 744058 | 744136 | 744215 | 78 |
| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. |

| D. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 78 | 8 | 16 | 23 | 31 | 39 | 47 | 55 | 62 | 70 | 83 | 8 | 17 | 25 | 33 | 41 | 50 | 58 | 66 | 75 |
| 79 | 8 | 16 | 24 | 32 | 39 | 47 | 55 | 63 | 71 | 84 | 8 | 17 | 25 | 34 | 42 | 50 | 59 | 67 | 76 |
| 80 | 8 | 16 | 24 | 32 | 40 | 48 | 56 | 64 | 72 | 85 | 8 | 17 | 25 | 34 | 42 | 51 | 59 | 68 | 76 |
| 81 | 8 | 16 | 24 | 32 | 40 | 49 | 57 | 65 | 73 | 86 | 9 | 17 | 26 | 34 | 43 | 52 | 60 | 69 | 77 |
| 82 | 8 | 16 | 25 | 33 | 41 | 49 | 57 | 66 | 74 | 87 | 9 | 17 | 26 | 35 | 43 | 52 | 61 | 70 | 78 |

## LOGARITHMS OF NUMBERS

**No. 5550 to 6099** **Log. 744293 to 785259**

| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 555 | 744293 | 744371 | 744449 | 744528 | 744606 | 744684 | 744762 | 744840 | 744919 | 744997 | 78 |
| 556 | 745075 | 745153 | 745231 | 745309 | 745387 | 745465 | 745543 | 745621 | 745699 | 745777 | 78 |
| 557 | 745855 | 745933 | 746011 | 746089 | 746167 | 746245 | 746323 | 746401 | 746479 | 746556 | 78 |
| 558 | 746634 | 746712 | 746790 | 746868 | 746945 | 747023 | 747101 | 747179 | 747256 | 747334 | 78 |
| 559 | 747412 | 747489 | 747567 | 747645 | 747722 | 747800 | 747878 | 747955 | 748033 | 748110 | 78 |
| 560 | 748188 | 748266 | 748343 | 748421 | 748498 | 748576 | 748653 | 748731 | 748808 | 748885 | 77 |
| 561 | 748963 | 749040 | 749118 | 749195 | 749272 | 749350 | 749427 | 749504 | 749582 | 749659 | 77 |
| 562 | 749736 | 749814 | 749891 | 749968 | 750045 | 750123 | 750200 | 750277 | 750354 | 750431 | 77 |
| 563 | 750508 | 750586 | 750663 | 750740 | 750817 | 750894 | 750971 | 751048 | 751125 | 751202 | 77 |
| 564 | 751279 | 751356 | 751433 | 751510 | 751587 | 751664 | 751741 | 751818 | 751895 | 751972 | 77 |
| 565 | 752048 | 752125 | 752202 | 752279 | 752356 | 752433 | 752509 | 752586 | 752663 | 752740 | 77 |
| 566 | 752816 | 752893 | 752970 | 753047 | 753123 | 753200 | 753277 | 753353 | 753430 | 753506 | 77 |
| 567 | 753583 | 753660 | 753736 | 753813 | 753889 | 753966 | 754042 | 754119 | 754195 | 754272 | 77 |
| 568 | 754348 | 754425 | 754501 | 754578 | 754654 | 754730 | 754807 | 754883 | 754960 | 755036 | 76 |
| 569 | 755112 | 755189 | 755265 | 755341 | 755417 | 755494 | 755570 | 755646 | 755722 | 755799 | 76 |
| 570 | 755875 | 755951 | 756027 | 756103 | 756180 | 756256 | 756332 | 756408 | 756484 | 756560 | 76 |
| 571 | 756636 | 756712 | 756788 | 756864 | 756940 | 757016 | 757092 | 757168 | 757244 | 757320 | 76 |
| 572 | 757396 | 757472 | 757548 | 757624 | 757700 | 757775 | 757851 | 757927 | 758003 | 758079 | 76 |
| 573 | 758155 | 758230 | 758306 | 758382 | 758458 | 758533 | 758609 | 758685 | 758761 | 758836 | 76 |
| 574 | 758912 | 758988 | 759063 | 759139 | 759214 | 759290 | 759366 | 759441 | 759517 | 759592 | 76 |
| 575 | 759668 | 759743 | 759819 | 759894 | 759970 | 760045 | 760121 | 760196 | 760272 | 760347 | 75 |
| 576 | 760422 | 760498 | 760573 | 760649 | 760724 | 760799 | 760875 | 760950 | 761025 | 761101 | 75 |
| 577 | 761176 | 761251 | 761326 | 761402 | 761477 | 761552 | 761627 | 761702 | 761778 | 761853 | 75 |
| 578 | 761928 | 762003 | 762078 | 762153 | 762228 | 762303 | 762378 | 762453 | 762529 | 762604 | 75 |
| 579 | 762679 | 762754 | 762829 | 762904 | 762978 | 763053 | 763128 | 763203 | 763278 | 763353 | 75 |
| 580 | 763428 | 763503 | 763578 | 763653 | 763727 | 763802 | 763877 | 763952 | 764027 | 764101 | 75 |
| 581 | 764176 | 764251 | 764326 | 764400 | 764475 | 764550 | 764624 | 764699 | 764774 | 764848 | 75 |
| 582 | 764923 | 764998 | 765072 | 765147 | 765221 | 765296 | 765370 | 765445 | 765520 | 765594 | 75 |
| 583 | 765669 | 765743 | 765818 | 765892 | 765966 | 766041 | 766115 | 766190 | 766264 | 766338 | 74 |
| 584 | 766413 | 766487 | 766562 | 766636 | 766710 | 766785 | 766859 | 766933 | 767007 | 767082 | 74 |
| 585 | 767156 | 767230 | 767304 | 767379 | 767453 | 767527 | 767601 | 767675 | 767749 | 767823 | 74 |
| 586 | 767898 | 767972 | 768046 | 768120 | 768194 | 768268 | 768342 | 768416 | 768490 | 768564 | 74 |
| 587 | 768638 | 768712 | 768786 | 768860 | 768934 | 769008 | 769082 | 769156 | 769230 | 769303 | 74 |
| 588 | 769377 | 769451 | 769525 | 769599 | 769673 | 769746 | 769820 | 769894 | 769968 | 770042 | 74 |
| 589 | 770115 | 770189 | 770263 | 770336 | 770410 | 770484 | 770557 | 770631 | 770705 | 770778 | 74 |
| 590 | 770852 | 770926 | 770999 | 771073 | 771146 | 771220 | 771293 | 771367 | 771440 | 771514 | 74 |
| 591 | 771587 | 771661 | 771734 | 771808 | 771881 | 771955 | 772028 | 772102 | 772175 | 772248 | 73 |
| 592 | 772322 | 772395 | 772468 | 772542 | 772615 | 772688 | 772762 | 772835 | 772908 | 772981 | 73 |
| 593 | 773055 | 773128 | 773201 | 773274 | 773348 | 773421 | 773494 | 773567 | 773640 | 773713 | 73 |
| 594 | 773786 | 773860 | 773933 | 774006 | 774079 | 774152 | 774225 | 774298 | 774371 | 774444 | 73 |
| 595 | 774517 | 774590 | 774663 | 774736 | 774809 | 774882 | 774955 | 775028 | 775100 | 775173 | 73 |
| 596 | 775246 | 775319 | 775392 | 775465 | 775538 | 775610 | 775683 | 775756 | 775829 | 775902 | 73 |
| 597 | 775974 | 776047 | 776120 | 776193 | 776265 | 776338 | 776411 | 776483 | 776556 | 776629 | 73 |
| 598 | 776701 | 776774 | 776846 | 776919 | 776992 | 777064 | 777137 | 777209 | 777282 | 777354 | 73 |
| 599 | 777427 | 777499 | 777572 | 777644 | 777717 | 777789 | 777862 | 777934 | 778006 | 778079 | 72 |
| 600 | 778151 | 778224 | 778296 | 778368 | 778441 | 778513 | 778585 | 778658 | 778730 | 778802 | 72 |
| 601 | 778874 | 778947 | 779019 | 779091 | 779163 | 779236 | 779308 | 779380 | 779452 | 779524 | 72 |
| 602 | 779596 | 779669 | 779741 | 779813 | 779885 | 779957 | 780029 | 780101 | 780173 | 780245 | 72 |
| 603 | 780317 | 780389 | 780461 | 780533 | 780605 | 780677 | 780749 | 780821 | 780893 | 780965 | 72 |
| 604 | 781037 | 781109 | 781181 | 781253 | 781324 | 781396 | 781468 | 781540 | 781612 | 781684 | 72 |
| 605 | 781755 | 781827 | 781899 | 781971 | 782042 | 782114 | 782186 | 782258 | 782329 | 782401 | 72 |
| 606 | 782473 | 782544 | 782616 | 782688 | 782759 | 782831 | 782902 | 782974 | 783046 | 783117 | 72 |
| 607 | 783189 | 783260 | 783332 | 783403 | 783475 | 783546 | 783618 | 783689 | 783761 | 783832 | 71 |
| 608 | 783904 | 783975 | 784046 | 784118 | 784189 | 784261 | 784332 | 784403 | 784475 | 784546 | 71 |
| 609 | 784617 | 784689 | 784760 | 784831 | 784902 | 784974 | 785045 | 785116 | 785187 | 785259 | 71 |
| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. |

| D. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 71 | 7 | 14 | 21 | 28 | 35 | 43 | 50 | 57 | 64 | 75 | 7 | 15 | 22 | 30 | 37 | 45 | 52 | 60 | 67 |
| 72 | 7 | 14 | 22 | 29 | 36 | 43 | 50 | 58 | 65 | 76 | 8 | 15 | 23 | 30 | 38 | 46 | 53 | 61 | 68 |
| 73 | 7 | 15 | 22 | 29 | 36 | 44 | 51 | 58 | 66 | 77 | 8 | 15 | 23 | 31 | 38 | 46 | 54 | 62 | 69 |
| 74 | 7 | 15 | 22 | 30 | 37 | 44 | 52 | 59 | 67 | 78 | 8 | 16 | 23 | 31 | 39 | 47 | 55 | 62 | 70 |

## LOGARITHMS OF NUMBERS

**No. 6100 to 6649** **Log. 785330 to 822756**

| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 610 | 785330 | 785401 | 785472 | 785543 | 785615 | 785686 | 785757 | 785828 | 785899 | 785970 | 71 |
| 611 | 786041 | 786112 | 786183 | 786254 | 786325 | 786396 | 786467 | 786538 | 786609 | 786680 | 71 |
| 612 | 786751 | 786822 | 786893 | 786964 | 787035 | 787106 | 787177 | 787248 | 787319 | 787390 | 71 |
| 613 | 787460 | 787531 | 787602 | 787673 | 787744 | 787815 | 787885 | 787956 | 788027 | 788098 | 71 |
| 614 | 788168 | 788239 | 788310 | 788381 | 788451 | 788522 | 788593 | 788663 | 788734 | 788804 | 71 |
| 615 | 788875 | 788946 | 789016 | 789087 | 789157 | 789228 | 789299 | 789369 | 789440 | 789510 | 71 |
| 616 | 789581 | 789651 | 789722 | 789792 | 789863 | 789933 | 790004 | 790074 | 790144 | 790215 | 70 |
| 617 | 790285 | 790356 | 790426 | 790496 | 790567 | 790637 | 790707 | 790778 | 790848 | 790918 | 70 |
| 618 | 790988 | 791059 | 791129 | 791199 | 791269 | 791340 | 791410 | 791480 | 791550 | 791620 | 70 |
| 619 | 791691 | 791761 | 791831 | 791901 | 791971 | 792041 | 792111 | 792181 | 792252 | 792322 | 70 |
| 620 | 792392 | 792462 | 792532 | 792602 | 792672 | 792742 | 792812 | 792882 | 792952 | 793022 | 70 |
| 621 | 793092 | 793162 | 793231 | 793301 | 793371 | 793441 | 793511 | 793581 | 793651 | 793721 | 70 |
| 622 | 793790 | 793860 | 793930 | 794000 | 794070 | 794139 | 794209 | 794279 | 794349 | 794418 | 70 |
| 623 | 794488 | 794558 | 794627 | 794697 | 794767 | 794836 | 794906 | 794976 | 795045 | 795115 | 70 |
| 624 | 795185 | 795254 | 795324 | 795393 | 795463 | 795532 | 795602 | 795672 | 795741 | 795811 | 70 |
| 625 | 795880 | 795949 | 796019 | 796088 | 796158 | 796227 | 796297 | 796366 | 796436 | 796505 | 69 |
| 626 | 796574 | 796644 | 796713 | 796782 | 796852 | 796921 | 796990 | 797060 | 797129 | 797198 | 69 |
| 627 | 797268 | 797337 | 797406 | 797475 | 797545 | 797614 | 797683 | 797752 | 797821 | 797890 | 69 |
| 628 | 797960 | 798029 | 798098 | 798167 | 798236 | 798305 | 798374 | 798443 | 798513 | 798582 | 69 |
| 629 | 798651 | 798720 | 798789 | 798858 | 798927 | 798996 | 799065 | 799134 | 799203 | 799272 | 69 |
| 630 | 799341 | 799409 | 799478 | 799547 | 799616 | 799685 | 799754 | 799823 | 799892 | 799961 | 69 |
| 631 | 800029 | 800098 | 800167 | 800236 | 800305 | 800373 | 800442 | 800511 | 800580 | 800648 | 69 |
| 632 | 800717 | 800786 | 800854 | 800923 | 800992 | 801061 | 801129 | 801198 | 801266 | 801335 | 69 |
| 633 | 801404 | 801472 | 801541 | 801609 | 801678 | 801747 | 801815 | 801884 | 801952 | 802021 | 69 |
| 634 | 802089 | 802158 | 802226 | 802295 | 802363 | 802432 | 802500 | 802568 | 802637 | 802705 | 69 |
| 635 | 802774 | 802842 | 802910 | 802979 | 803047 | 803116 | 803184 | 803252 | 803321 | 803389 | 68 |
| 636 | 803457 | 803525 | 803594 | 803662 | 803730 | 803798 | 803867 | 803935 | 804003 | 804071 | 68 |
| 637 | 804139 | 804208 | 804276 | 804344 | 804412 | 804480 | 804548 | 804616 | 804685 | 804753 | 68 |
| 638 | 804821 | 804889 | 804957 | 805025 | 805093 | 805161 | 805229 | 805297 | 805365 | 805433 | 68 |
| 639 | 805501 | 805569 | 805637 | 805705 | 805773 | 805841 | 805908 | 805976 | 806044 | 806112 | 68 |
| 640 | 806180 | 806248 | 806316 | 806384 | 806451 | 806519 | 806587 | 806655 | 806723 | 806790 | 68 |
| 641 | 806858 | 806926 | 806994 | 807061 | 807129 | 807197 | 807264 | 807332 | 807400 | 807467 | 68 |
| 642 | 807535 | 807603 | 807670 | 807738 | 807806 | 807873 | 807941 | 808008 | 808076 | 808143 | 68 |
| 643 | 808211 | 808279 | 808346 | 808414 | 808481 | 808549 | 808616 | 808684 | 808751 | 808818 | 67 |
| 644 | 808886 | 808953 | 809021 | 809088 | 809156 | 809223 | 809290 | 809358 | 809425 | 809492 | 67 |
| 645 | 809560 | 809627 | 809694 | 809762 | 809829 | 809896 | 809964 | 810031 | 810098 | 810165 | 67 |
| 646 | 810233 | 810300 | 810367 | 810434 | 810501 | 810569 | 810636 | 810703 | 810770 | 810837 | 67 |
| 647 | 810904 | 810971 | 811039 | 811106 | 811173 | 811240 | 811307 | 811374 | 811441 | 811508 | 67 |
| 648 | 811575 | 811642 | 811709 | 811776 | 811843 | 811910 | 811977 | 812044 | 812111 | 812178 | 67 |
| 649 | 812245 | 812312 | 812379 | 812445 | 812512 | 812579 | 812646 | 812713 | 812780 | 812847 | 67 |
| 650 | 812913 | 812980 | 813047 | 813114 | 813181 | 813247 | 813314 | 813381 | 813448 | 813514 | 67 |
| 651 | 813581 | 813648 | 813714 | 813781 | 813848 | 813914 | 813981 | 814048 | 814114 | 814181 | 67 |
| 652 | 814248 | 814314 | 814381 | 814447 | 814514 | 814581 | 814647 | 814714 | 814780 | 814847 | 67 |
| 653 | 814913 | 814980 | 815046 | 815113 | 815179 | 815246 | 815312 | 815378 | 815445 | 815511 | 66 |
| 654 | 815578 | 815644 | 815711 | 815777 | 815843 | 815910 | 815976 | 816042 | 816109 | 816175 | 66 |
| 655 | 816241 | 816308 | 816374 | 816440 | 816506 | 816573 | 816639 | 816705 | 816771 | 816838 | 66 |
| 656 | 816904 | 816970 | 817036 | 817102 | 817169 | 817235 | 817301 | 817367 | 817433 | 817499 | 66 |
| 657 | 817565 | 817631 | 817698 | 817764 | 817830 | 817896 | 817962 | 818028 | 818094 | 818160 | 66 |
| 658 | 818226 | 818292 | 818358 | 818424 | 818490 | 818556 | 818622 | 818688 | 818754 | 818820 | 66 |
| 659 | 818885 | 818951 | 819017 | 819083 | 819149 | 819215 | 819281 | 819346 | 819412 | 819478 | 66 |
| 660 | 819544 | 819610 | 819676 | 819741 | 819807 | 819873 | 819939 | 820004 | 820070 | 820136 | 66 |
| 661 | 820201 | 820267 | 820333 | 820399 | 820464 | 820530 | 820595 | 820661 | 820727 | 820792 | 66 |
| 662 | 820858 | 820924 | 820989 | 821055 | 821120 | 821186 | 821251 | 821317 | 821382 | 821448 | 66 |
| 663 | 821514 | 821579 | 821645 | 821710 | 821775 | 821841 | 821906 | 821972 | 822037 | 822103 | 65 |
| 664 | 822168 | 822233 | 822299 | 822364 | 822430 | 822495 | 822560 | 822626 | 822691 | 822756 | 65 |
| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. |

| D. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 65 | 6 | 13 | 19 | 26 | 32 | 39 | 45 | 52 | 58 | 68 | 7 | 14 | 20 | 27 | 34 | 41 | 48 | 54 | 61 |
| 66 | 7 | 13 | 20 | 26 | 33 | 40 | 46 | 53 | 59 | 69 | 7 | 14 | 21 | 28 | 34 | 41 | 48 | 55 | 62 |
| 67 | 7 | 13 | 20 | 27 | 33 | 40 | 47 | 54 | 60 | 70 | 7 | 14 | 21 | 28 | 35 | 42 | 49 | 56 | 63 |
| 68 | 7 | 14 | 20 | 27 | 34 | 41 | 48 | 54 | 61 | 71 | 7 | 14 | 21 | 28 | 35 | 43 | 50 | 57 | 64 |

## LOGARITHMS OF NUMBERS

No. 6650 to 7199 — Log. 822822 to 857272

| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 665 | 822822 | 822887 | 822952 | 823018 | 823083 | 823148 | 823213 | 823279 | 823344 | 823409 | 65 |
| 666 | 823474 | 823539 | 823605 | 823670 | 823735 | 823800 | 823865 | 823930 | 823996 | 824061 | 65 |
| 667 | 824126 | 824191 | 824256 | 824321 | 824386 | 824451 | 824516 | 824581 | 824646 | 824711 | 65 |
| 668 | 824776 | 824841 | 824906 | 824971 | 825036 | 825101 | 825166 | 825231 | 825296 | 825361 | 65 |
| 669 | 825426 | 825491 | 825556 | 825621 | 825686 | 825751 | 825815 | 825880 | 825945 | 826010 | 65 |
| 670 | 826075 | 826140 | 826204 | 826269 | 826334 | 826399 | 826464 | 826528 | 826593 | 826658 | 65 |
| 671 | 826723 | 826787 | 826852 | 826917 | 826981 | 827046 | 827111 | 827175 | 827240 | 827305 | 65 |
| 672 | 827369 | 827434 | 827499 | 827563 | 827628 | 827692 | 827757 | 827821 | 827886 | 827951 | 65 |
| 673 | 828015 | 828080 | 828144 | 828209 | 828273 | 828338 | 828402 | 828467 | 828531 | 828595 | 64 |
| 674 | 828660 | 828724 | 828789 | 828853 | 828918 | 828982 | 829046 | 829111 | 829175 | 829239 | 64 |
| 675 | 829304 | 829368 | 829432 | 829497 | 829561 | 829625 | 829690 | 829754 | 829818 | 829882 | 64 |
| 676 | 829947 | 830011 | 830075 | 830139 | 830204 | 830268 | 830332 | 830396 | 830460 | 830525 | 64 |
| 677 | 830589 | 830653 | 830717 | 830781 | 830845 | 830909 | 830973 | 831037 | 831102 | 831166 | 64 |
| 678 | 831230 | 831294 | 831358 | 831422 | 831486 | 831550 | 831614 | 831678 | 831742 | 831806 | 64 |
| 679 | 831870 | 831934 | 831998 | 832062 | 832126 | 832189 | 832253 | 832317 | 832381 | 832445 | 64 |
| 680 | 832509 | 832573 | 832637 | 832700 | 832764 | 832828 | 832892 | 832956 | 833020 | 833083 | 64 |
| 681 | 833147 | 833211 | 833275 | 833338 | 833402 | 833466 | 833530 | 833593 | 833657 | 833721 | 64 |
| 682 | 833784 | 833848 | 833912 | 833975 | 834039 | 834103 | 834166 | 834230 | 834294 | 834357 | 64 |
| 683 | 834421 | 834484 | 834548 | 834611 | 834675 | 834739 | 834802 | 834866 | 834929 | 834993 | 64 |
| 684 | 835056 | 835120 | 835183 | 835247 | 835310 | 835373 | 835437 | 835500 | 835564 | 835627 | 63 |
| 685 | 835691 | 835754 | 835817 | 835881 | 835944 | 836007 | 836071 | 836134 | 836197 | 836261 | 63 |
| 686 | 836324 | 836387 | 836451 | 836514 | 836577 | 836641 | 836704 | 836767 | 836830 | 836894 | 63 |
| 687 | 836957 | 837020 | 837083 | 837146 | 837210 | 837273 | 837336 | 837399 | 837462 | 837525 | 63 |
| 688 | 837588 | 837652 | 837715 | 837778 | 837841 | 837904 | 837967 | 838030 | 838093 | 838156 | 63 |
| 689 | 838219 | 838282 | 838345 | 838408 | 838471 | 838534 | 838597 | 838660 | 838723 | 838786 | 63 |
| 690 | 838849 | 838912 | 838975 | 839038 | 839101 | 839164 | 839227 | 839289 | 839352 | 839415 | 63 |
| 691 | 839478 | 839541 | 839604 | 839667 | 839729 | 839792 | 839855 | 839918 | 839981 | 840043 | 63 |
| 692 | 840106 | 840169 | 840232 | 840294 | 840357 | 840420 | 840482 | 840545 | 840608 | 840671 | 63 |
| 693 | 840733 | 840796 | 840859 | 840921 | 840984 | 841046 | 841109 | 841172 | 841234 | 841297 | 63 |
| 694 | 841359 | 841422 | 841485 | 841547 | 841610 | 841672 | 841735 | 841797 | 841860 | 841922 | 63 |
| 695 | 841985 | 842047 | 842110 | 842172 | 842235 | 842297 | 842360 | 842422 | 842484 | 842547 | 62 |
| 696 | 842609 | 842672 | 842734 | 842796 | 842859 | 842921 | 842983 | 843046 | 843108 | 843170 | 62 |
| 697 | 843233 | 843295 | 843357 | 843420 | 843482 | 843544 | 843606 | 843669 | 843731 | 843793 | 62 |
| 698 | 843855 | 843918 | 843980 | 844042 | 844104 | 844166 | 844229 | 844291 | 844353 | 844415 | 62 |
| 699 | 844477 | 844539 | 844601 | 844664 | 844726 | 844788 | 844850 | 844912 | 844974 | 845036 | 62 |
| 700 | 845098 | 845160 | 845222 | 845284 | 845346 | 845408 | 845470 | 845532 | 845594 | 845656 | 62 |
| 701 | 845718 | 845780 | 845842 | 845904 | 845966 | 846028 | 846090 | 846151 | 846213 | 846275 | 62 |
| 702 | 846337 | 846399 | 846461 | 846523 | 846585 | 846646 | 846708 | 846770 | 846832 | 846894 | 62 |
| 703 | 846955 | 847017 | 847079 | 847141 | 847202 | 847264 | 847326 | 847388 | 847449 | 847511 | 62 |
| 704 | 847573 | 847634 | 847696 | 847758 | 847819 | 847881 | 847943 | 848004 | 848066 | 848128 | 62 |
| 705 | 848189 | 848251 | 848312 | 848374 | 848435 | 848497 | 848559 | 848620 | 848682 | 848743 | 62 |
| 706 | 848805 | 848866 | 848928 | 848989 | 849051 | 849112 | 849174 | 849235 | 849297 | 849358 | 61 |
| 707 | 849419 | 849481 | 849542 | 849604 | 849665 | 849726 | 849788 | 849849 | 849911 | 849972 | 61 |
| 708 | 850033 | 850095 | 850156 | 850217 | 850279 | 850340 | 850401 | 850462 | 850524 | 850585 | 61 |
| 709 | 850646 | 850707 | 850769 | 850830 | 850891 | 850952 | 851014 | 851075 | 851136 | 851197 | 61 |
| 710 | 851258 | 851320 | 851381 | 851442 | 851503 | 851564 | 851625 | 851686 | 851747 | 851809 | 61 |
| 711 | 851870 | 851931 | 851992 | 852053 | 852114 | 852175 | 852236 | 852297 | 852358 | 852419 | 61 |
| 712 | 852480 | 852541 | 852602 | 852663 | 852724 | 852785 | 852846 | 852907 | 852968 | 853029 | 61 |
| 713 | 853090 | 853150 | 853211 | 853272 | 853333 | 853394 | 853455 | 853516 | 853577 | 853637 | 61 |
| 714 | 853698 | 853759 | 853820 | 853881 | 853941 | 854002 | 854063 | 854124 | 854185 | 854245 | 61 |
| 715 | 854306 | 854367 | 854428 | 854488 | 854549 | 854610 | 854670 | 854731 | 854792 | 854852 | 61 |
| 716 | 854913 | 854974 | 855034 | 855095 | 855156 | 855216 | 855277 | 855337 | 855398 | 855459 | 61 |
| 717 | 855519 | 855580 | 855640 | 855701 | 855761 | 855822 | 855882 | 855943 | 856003 | 856064 | 61 |
| 718 | 856124 | 856185 | 856245 | 856306 | 856366 | 856427 | 856487 | 856548 | 856608 | 856668 | 60 |
| 719 | 856729 | 856789 | 856850 | 856910 | 856970 | 857031 | 857091 | 857152 | 857212 | 857272 | 60 |
| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. |

| D. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 60 | 6 | 12 | 18 | 24 | 30 | 36 | 42 | 48 | 54 | 63 | 6 | 13 | 19 | 25 | 31 | 38 | 44 | 50 | 57 |
| 61 | 6 | 12 | 18 | 24 | 30 | 37 | 43 | 49 | 55 | 64 | 6 | 13 | 19 | 26 | 32 | 38 | 45 | 51 | 58 |
| 62 | 6 | 12 | 19 | 25 | 31 | 37 | 43 | 50 | 56 | 65 | 6 | 13 | 19 | 26 | 32 | 39 | 45 | 52 | 58 |

## LOGARITHMS OF NUMBERS

No. 7200 to 7749 Log. 857332 to 889246

| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 720 | 857332 | 857393 | 857453 | 857513 | 857574 | 857634 | 857694 | 857755 | 857815 | 857875 | 60 |
| 721 | 857935 | 857995 | 858056 | 858116 | 858176 | 858236 | 858297 | 858357 | 858417 | 858477 | 60 |
| 722 | 858537 | 858597 | 858657 | 858718 | 858778 | 858838 | 858898 | 858958 | 859018 | 859078 | 60 |
| 723 | 859138 | 859198 | 859258 | 859318 | 859379 | 859439 | 859499 | 859559 | 859619 | 859679 | 60 |
| 724 | 859739 | 859799 | 859859 | 859918 | 859978 | 860038 | 860098 | 860158 | 860218 | 860278 | 60 |
| 725 | 860338 | 860398 | 860458 | 860518 | 860578 | 860637 | 860697 | 860757 | 860817 | 860877 | 60 |
| 726 | 860937 | 860996 | 861056 | 861116 | 861176 | 861236 | 861295 | 861355 | 861415 | 861475 | 60 |
| 727 | 861534 | 861594 | 861654 | 861714 | 861773 | 861833 | 861893 | 861952 | 862012 | 862072 | 60 |
| 728 | 862131 | 862191 | 862251 | 862310 | 862370 | 862430 | 862489 | 862549 | 862608 | 862668 | 60 |
| 729 | 862728 | 862787 | 862847 | 862906 | 862966 | 863025 | 863085 | 863144 | 863204 | 863263 | 60 |
| 730 | 863323 | 863382 | 863442 | 863501 | 863561 | 863620 | 863680 | 863739 | 863799 | 863858 | 59 |
| 731 | 863917 | 863977 | 864036 | 864096 | 864155 | 864214 | 864274 | 864333 | 864392 | 864452 | 59 |
| 732 | 864511 | 864570 | 864630 | 864689 | 864748 | 864808 | 864867 | 864926 | 864985 | 865045 | 59 |
| 733 | 865104 | 865163 | 865222 | 865282 | 865341 | 865400 | 865459 | 865519 | 865578 | 865637 | 59 |
| 734 | 865696 | 865755 | 865814 | 865874 | 865933 | 865992 | 866051 | 866110 | 866169 | 866228 | 59 |
| 735 | 866287 | 866346 | 866405 | 866465 | 866524 | 866583 | 866642 | 866701 | 866760 | 866819 | 59 |
| 736 | 866878 | 866937 | 866996 | 867055 | 867114 | 867173 | 867232 | 867291 | 867350 | 867409 | 59 |
| 737 | 867467 | 867526 | 867585 | 867644 | 867703 | 867762 | 867821 | 867880 | 867939 | 867998 | 59 |
| 738 | 868056 | 868115 | 868174 | 868233 | 868292 | 868350 | 868409 | 868468 | 868527 | 868586 | 59 |
| 739 | 868644 | 868703 | 868762 | 868821 | 868879 | 868938 | 868997 | 869056 | 869114 | 869173 | 59 |
| 740 | 869232 | 869290 | 869349 | 869408 | 869466 | 869525 | 869584 | 869642 | 869701 | 869760 | 59 |
| 741 | 869818 | 869877 | 869935 | 869994 | 870053 | 870111 | 870170 | 870228 | 870287 | 870345 | 59 |
| 742 | 870404 | 870462 | 870521 | 870579 | 870638 | 870696 | 870755 | 870813 | 870872 | 870930 | 58 |
| 743 | 870989 | 871047 | 871106 | 871164 | 871223 | 871281 | 871339 | 871398 | 871456 | 871515 | 58 |
| 744 | 871573 | 871631 | 871690 | 871748 | 871800 | 871865 | 871923 | 871981 | 872040 | 872098 | 58 |
| 745 | 872156 | 872215 | 872273 | 872331 | 872389 | 872448 | 872506 | 872564 | 872622 | 872681 | 58 |
| 746 | 872739 | 872797 | 872855 | 872913 | 872972 | 873030 | 873088 | 873146 | 873204 | 873262 | 58 |
| 747 | 873321 | 873379 | 873437 | 873495 | 873553 | 873611 | 873669 | 873727 | 873785 | 873844 | 58 |
| 748 | 873902 | 873960 | 874018 | 874076 | 874134 | 874192 | 874250 | 874308 | 874366 | 874424 | 58 |
| 749 | 874482 | 874540 | 874598 | 874656 | 874714 | 874772 | 874830 | 874888 | 874945 | 875003 | 58 |
| 750 | 875061 | 875119 | 875177 | 875235 | 875293 | 875351 | 875409 | 875466 | 875524 | 875582 | 58 |
| 751 | 875640 | 875698 | 875756 | 875813 | 875871 | 875929 | 875987 | 876045 | 876102 | 876160 | 58 |
| 752 | 876218 | 876276 | 876333 | 876391 | 876449 | 876507 | 876564 | 876622 | 876680 | 876737 | 58 |
| 753 | 876795 | 876853 | 876910 | 876968 | 877026 | 877083 | 877141 | 877199 | 877256 | 877314 | 58 |
| 754 | 877371 | 877429 | 877487 | 877544 | 877602 | 877659 | 877717 | 877774 | 877832 | 877889 | 58 |
| 755 | 877947 | 878004 | 878062 | 878119 | 878177 | 878234 | 878292 | 878349 | 878407 | 878464 | 57 |
| 756 | 878522 | 878579 | 878637 | 878694 | 878752 | 878809 | 878866 | 878924 | 878981 | 879039 | 57 |
| 757 | 879096 | 879153 | 879211 | 879268 | 879325 | 879383 | 879440 | 879497 | 879555 | 879612 | 57 |
| 758 | 879669 | 879726 | 879784 | 879841 | 879898 | 879956 | 880013 | 880070 | 880127 | 880185 | 57 |
| 759 | 880242 | 880299 | 880356 | 880413 | 880471 | 880528 | 880585 | 880642 | 880699 | 880756 | 57 |
| 760 | 880814 | 880871 | 880928 | 880985 | 881042 | 881099 | 881156 | 881213 | 881271 | 881328 | 57 |
| 761 | 881385 | 881442 | 881499 | 881556 | 881613 | 881670 | 881727 | 881784 | 881841 | 881898 | 57 |
| 762 | 881955 | 882012 | 882069 | 882126 | 882183 | 882240 | 882297 | 882354 | 882411 | 882468 | 57 |
| 763 | 882525 | 882581 | 882638 | 882695 | 882752 | 882809 | 882866 | 882923 | 882980 | 883037 | 57 |
| 764 | 883093 | 883150 | 883207 | 883264 | 883321 | 883377 | 883434 | 883491 | 883548 | 883605 | 57 |
| 765 | 883661 | 883718 | 883775 | 883832 | 883888 | 883945 | 884002 | 884059 | 884115 | 884172 | 57 |
| 766 | 884229 | 884285 | 884342 | 884399 | 884455 | 884512 | 884569 | 884625 | 884682 | 884739 | 57 |
| 767 | 884795 | 884852 | 884909 | 884965 | 885022 | 885078 | 885135 | 885192 | 885248 | 885305 | 57 |
| 768 | 885361 | 885418 | 885474 | 885531 | 885587 | 885644 | 885700 | 885757 | 885813 | 885870 | 57 |
| 769 | 885926 | 885983 | 886039 | 886096 | 886152 | 886200 | 886265 | 886321 | 886378 | 886434 | 56 |
| 770 | 886491 | 886547 | 886604 | 886660 | 886716 | 886773 | 886829 | 886885 | 886942 | 886998 | 56 |
| 771 | 887054 | 887111 | 887167 | 887223 | 887280 | 887336 | 887392 | 887449 | 887505 | 887561 | 56 |
| 772 | 887617 | 887674 | 887730 | 887786 | 887842 | 887898 | 887955 | 888011 | 888067 | 888123 | 56 |
| 773 | 888179 | 888236 | 888292 | 888348 | 888404 | 888460 | 888516 | 888573 | 888629 | 888685 | 56 |
| 774 | 888741 | 888797 | 888853 | 888909 | 888965 | 889021 | 889077 | 889134 | 889190 | 889246 | 56 |
| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. |

| D. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 56 | 6 | 11 | 17 | 22 | 28 | 34 | 39 | 45 | 50 |
| 57 | 6 | 11 | 17 | 23 | 28 | 34 | 40 | 46 | 51 |
| 58 | 6 | 12 | 17 | 23 | 29 | 35 | 41 | 46 | 52 |

| D. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 59 | 6 | 12 | 18 | 24 | 29 | 35 | 41 | 47 | 53 |
| 60 | 6 | 12 | 18 | 24 | 30 | 36 | 42 | 48 | 54 |

# LOGARITHMS OF NUMBERS

No. 7750 to 8299 — Log 889302 to 919026

| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 775 | 889302 | 889358 | 889414 | 889470 | 889526 | 889582 | 889638 | 889694 | 889750 | 889806 | 56 |
| 776 | 889862 | 889918 | 889974 | 890030 | 890086 | 890141 | 890197 | 890253 | 890309 | 890365 | 56 |
| 777 | 890421 | 890477 | 890533 | 890589 | 890645 | 890700 | 890756 | 890812 | 890868 | 890924 | 56 |
| 778 | 890980 | 891035 | 891091 | 891147 | 891203 | 891259 | 891314 | 891370 | 891426 | 891482 | 56 |
| 779 | 891537 | 891593 | 891649 | 891705 | 891760 | 891816 | 891872 | 891928 | 891983 | 892039 | 56 |
| 780 | 892095 | 892150 | 892206 | 892262 | 892317 | 892373 | 892429 | 892484 | 892540 | 892595 | 56 |
| 781 | 892651 | 892707 | 892762 | 892818 | 892873 | 892929 | 892985 | 893040 | 893096 | 893151 | 56 |
| 782 | 893207 | 893262 | 893318 | 893373 | 893429 | 893484 | 893540 | 893595 | 893651 | 893706 | 56 |
| 783 | 893762 | 893817 | 893873 | 893928 | 893984 | 894039 | 894094 | 894150 | 894205 | 894261 | 55 |
| 784 | 894316 | 894371 | 894427 | 894482 | 894538 | 894593 | 894648 | 894704 | 894759 | 894814 | 55 |
| 785 | 894870 | 894925 | 894980 | 895036 | 895091 | 895146 | 895201 | 895257 | 895312 | 895367 | 55 |
| 786 | 895423 | 895478 | 895533 | 895588 | 895644 | 895699 | 895754 | 895809 | 895864 | 895920 | 55 |
| 787 | 895975 | 896030 | 896085 | 896140 | 896195 | 896251 | 896306 | 896361 | 896416 | 896471 | 55 |
| 788 | 896526 | 896581 | 896636 | 896692 | 896747 | 896802 | 896857 | 896912 | 896967 | 897022 | 55 |
| 789 | 897077 | 897132 | 897187 | 897242 | 897297 | 897352 | 897407 | 897462 | 897517 | 897572 | 55 |
| 790 | 897627 | 897682 | 897737 | 897792 | 897847 | 897902 | 897957 | 898012 | 898067 | 898122 | 55 |
| 791 | 898176 | 898231 | 898286 | 898341 | 898396 | 898451 | 898506 | 898561 | 898615 | 898670 | 55 |
| 792 | 898725 | 898780 | 898835 | 898890 | 898944 | 898999 | 899054 | 899109 | 899164 | 899218 | 55 |
| 793 | 899273 | 899328 | 899383 | 899437 | 899492 | 899547 | 899602 | 899656 | 899711 | 899766 | 55 |
| 794 | 899821 | 899875 | 899930 | 899985 | 900039 | 900094 | 900149 | 900203 | 900258 | 900312 | 55 |
| 795 | 900367 | 900422 | 900476 | 900531 | 900586 | 900640 | 900695 | 900749 | 900804 | 900859 | 55 |
| 796 | 900913 | 900968 | 901022 | 901077 | 901131 | 901186 | 901240 | 901295 | 901349 | 901404 | 55 |
| 797 | 901458 | 901513 | 901567 | 901622 | 901676 | 901731 | 901785 | 901840 | 901894 | 901948 | 54 |
| 798 | 902003 | 902057 | 902112 | 902166 | 902221 | 902275 | 902329 | 902384 | 902438 | 902492 | 54 |
| 799 | 902547 | 902601 | 902655 | 902710 | 902764 | 902818 | 902873 | 902927 | 902981 | 903036 | 54 |
| 800 | 903090 | 903144 | 903199 | 903253 | 903307 | 903361 | 903416 | 903470 | 903524 | 903578 | 54 |
| 801 | 903633 | 903687 | 903741 | 903795 | 903849 | 903904 | 903958 | 904012 | 904066 | 904120 | 54 |
| 802 | 904174 | 904229 | 904283 | 904337 | 904391 | 904445 | 904499 | 904553 | 904607 | 904661 | 54 |
| 803 | 904716 | 904770 | 904824 | 904878 | 904932 | 904986 | 905040 | 905094 | 905148 | 905202 | 54 |
| 804 | 905256 | 905310 | 905364 | 905418 | 905472 | 905526 | 905580 | 905634 | 905688 | 905742 | 54 |
| 805 | 905796 | 905850 | 905904 | 905958 | 906012 | 906066 | 906119 | 906173 | 906227 | 906281 | 54 |
| 806 | 906335 | 906389 | 906443 | 906497 | 906551 | 906604 | 906658 | 906712 | 906766 | 906820 | 54 |
| 807 | 906874 | 906927 | 906981 | 907035 | 907089 | 907143 | 907196 | 907250 | 907304 | 907358 | 54 |
| 808 | 907411 | 907465 | 907519 | 907573 | 907626 | 907680 | 907734 | 907787 | 907841 | 907895 | 54 |
| 809 | 907949 | 908002 | 908056 | 908110 | 908163 | 908217 | 908270 | 908324 | 908378 | 908431 | 54 |
| 810 | 908485 | 908539 | 908592 | 908646 | 908699 | 908753 | 908807 | 908860 | 908914 | 908967 | 54 |
| 811 | 909021 | 909074 | 909128 | 909181 | 909235 | 909289 | 909342 | 909396 | 909449 | 909503 | 54 |
| 812 | 909556 | 909610 | 909663 | 909716 | 909770 | 909823 | 909877 | 909930 | 909984 | 910037 | 53 |
| 813 | 910091 | 910144 | 910197 | 910251 | 910304 | 910358 | 910411 | 910464 | 910518 | 910571 | 53 |
| 814 | 910624 | 910678 | 910731 | 910784 | 910838 | 910891 | 910944 | 910998 | 911051 | 911104 | 53 |
| 815 | 911158 | 911211 | 911264 | 911317 | 911371 | 911424 | 911477 | 911530 | 911584 | 911637 | 53 |
| 816 | 911690 | 911743 | 911797 | 911850 | 911903 | 911956 | 912009 | 912063 | 912116 | 912169 | 53 |
| 817 | 912222 | 912275 | 912328 | 912381 | 912435 | 912488 | 912541 | 912594 | 912647 | 912700 | 53 |
| 818 | 912753 | 912806 | 912859 | 912913 | 912966 | 913019 | 913072 | 913125 | 913178 | 913231 | 53 |
| 819 | 913284 | 913337 | 913390 | 913443 | 913496 | 913549 | 913602 | 913655 | 913708 | 913761 | 53 |
| 820 | 913814 | 913867 | 913920 | 913973 | 914026 | 914079 | 914132 | 914184 | 914237 | 914290 | 53 |
| 821 | 914343 | 914396 | 914449 | 914502 | 914555 | 914608 | 914660 | 914713 | 914766 | 914819 | 53 |
| 822 | 914872 | 914925 | 914977 | 915030 | 915083 | 915136 | 915189 | 915241 | 915294 | 915347 | 53 |
| 923 | 915400 | 915453 | 915505 | 915558 | 915611 | 915664 | 915716 | 915769 | 915822 | 915875 | 53 |
| 824 | 915927 | 915980 | 916033 | 916085 | 916138 | 916191 | 916243 | 916296 | 916349 | 916401 | 53 |
| 825 | 916454 | 916507 | 916559 | 916612 | 916664 | 916717 | 916770 | 916822 | 916875 | 916927 | 53 |
| 826 | 916980 | 917033 | 917085 | 917138 | 917190 | 917243 | 917295 | 917348 | 917400 | 917453 | 53 |
| 827 | 917506 | 917558 | 917611 | 917663 | 917716 | 917768 | 917820 | 917873 | 917925 | 917978 | 52 |
| 828 | 918030 | 918083 | 918135 | 918188 | 918240 | 918293 | 918345 | 918397 | 918450 | 918502 | 52 |
| 929 | 918555 | 918607 | 918659 | 918712 | 918764 | 918816 | 918869 | 918921 | 918973 | 919026 | 52 |
| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. |

| D. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 3 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 52 | 5 | 10 | 16 | 21 | 26 | 31 | 36 | 42 | 47 | 55 | 5 | 11 | 16 | 22 | 27 | 33 | 38 | 44 | 49 |
| 53 | 5 | 11 | 16 | 21 | 26 | 32 | 37 | 42 | 48 | 56 | 6 | 11 | 17 | 22 | 28 | 34 | 39 | 45 | 50 |
| 54 | 5 | 11 | 16 | 22 | 27 | 32 | 38 | 43 | 49 | | | | | | | | | | |

## LOGARITHMS OF NUMBERS

No. 8300 to 8849 Log. 919078 to 946894

| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 830 | 919078 | 919130 | 919183 | 919235 | 919287 | 919340 | 919392 | 919444 | 919496 | 919549 | 52 |
| 831 | 919601 | 919653 | 919706 | 919758 | 919810 | 919862 | 919914 | 919967 | 920019 | 920071 | 52 |
| 832 | 920123 | 920176 | 920228 | 920280 | 920332 | 920384 | 920436 | 920489 | 920541 | 920593 | 52 |
| 833 | 920645 | 920697 | 920749 | 920801 | 920853 | 920906 | 920958 | 921010 | 921062 | 921114 | 52 |
| 834 | 921166 | 921218 | 921270 | 921322 | 921374 | 921426 | 921478 | 921530 | 921582 | 921634 | 52 |
| 835 | 921686 | 921738 | 921790 | 921842 | 921894 | 921946 | 921998 | 922050 | 922102 | 922154 | 52 |
| 836 | 922206 | 922258 | 922310 | 922362 | 922414 | 922466 | 922518 | 922570 | 922622 | 922674 | 52 |
| 837 | 922725 | 922777 | 922829 | 922881 | 922933 | 922985 | 923037 | 923089 | 923140 | 923192 | 52 |
| 838 | 923244 | 923296 | 923348 | 923399 | 923451 | 923503 | 923555 | 923607 | 923658 | 923710 | 52 |
| 839 | 923702 | 923814 | 923865 | 923917 | 923969 | 924021 | 924072 | 924124 | 924176 | 924228 | 52 |
| 840 | 924279 | 924331 | 924383 | 924434 | 924486 | 924538 | 924589 | 924641 | 924693 | 924744 | 52 |
| 841 | 924796 | 924848 | 924899 | 924951 | 925003 | 925054 | 925106 | 925157 | 925209 | 925261 | 52 |
| 842 | 925312 | 925364 | 925415 | 925467 | 925518 | 925570 | 925621 | 925673 | 925725 | 925776 | 52 |
| 843 | 925828 | 925879 | 925931 | 925982 | 926034 | 926085 | 926137 | 926188 | 926240 | 926291 | 51 |
| 844 | 926342 | 926394 | 926445 | 926497 | 926548 | 926600 | 926651 | 926702 | 926754 | 926805 | 51 |
| 845 | 926857 | 926908 | 926959 | 927011 | 927062 | 927114 | 927165 | 927216 | 927268 | 927319 | 51 |
| 846 | 927370 | 927422 | 927473 | 927524 | 927576 | 927627 | 927678 | 927730 | 927781 | 927832 | 51 |
| 847 | 927883 | 927935 | 927986 | 928037 | 928088 | 928140 | 928191 | 928242 | 928293 | 928345 | 51 |
| 848 | 928396 | 928447 | 928498 | 928549 | 928601 | 928652 | 928703 | 928754 | 928805 | 928857 | 51 |
| 849 | 928908 | 928959 | 929010 | 929061 | 929112 | 929163 | 929215 | 929266 | 929317 | 929368 | 51 |
| 850 | 929419 | 929470 | 929521 | 929572 | 929623 | 929674 | 929725 | 929776 | 929827 | 929879 | 51 |
| 851 | 929930 | 929981 | 930032 | 930083 | 930134 | 930185 | 930236 | 930287 | 930338 | 930389 | 51 |
| 852 | 930440 | 930491 | 930542 | 930592 | 930643 | 930694 | 930745 | 930796 | 930847 | 930898 | 51 |
| 853 | 930949 | 931000 | 931051 | 931102 | 931153 | 931203 | 931254 | 931305 | 931356 | 931407 | 51 |
| 854 | 931458 | 931509 | 931560 | 931610 | 931661 | 931712 | 931763 | 931814 | 931865 | 931915 | 51 |
| 855 | 931966 | 932017 | 932068 | 932118 | 932169 | 932220 | 932271 | 932322 | 932372 | 932423 | 51 |
| 856 | 932474 | 932524 | 932575 | 932626 | 932677 | 932727 | 932778 | 932829 | 932879 | 932930 | 51 |
| 857 | 932981 | 933031 | 933082 | 933133 | 933183 | 933234 | 933285 | 933335 | 933386 | 933437 | 51 |
| 858 | 933487 | 933538 | 933589 | 933639 | 933690 | 933740 | 933791 | 933841 | 933892 | 933943 | 51 |
| 859 | 933993 | 934044 | 934094 | 934145 | 934195 | 934246 | 934296 | 934347 | 934397 | 934448 | 51 |
| 860 | 934498 | 934549 | 934599 | 934650 | 934700 | 934751 | 934801 | 934852 | 934902 | 934953 | 50 |
| 861 | 935003 | 935054 | 935104 | 935154 | 935205 | 935255 | 935306 | 935356 | 935406 | 935457 | 50 |
| 862 | 935507 | 935558 | 935608 | 935658 | 935709 | 935759 | 935809 | 935860 | 935910 | 935960 | 50 |
| 863 | 936011 | 936061 | 936111 | 936162 | 936212 | 936262 | 936313 | 936363 | 936413 | 936463 | 50 |
| 864 | 936514 | 936564 | 936614 | 936665 | 936715 | 936765 | 936815 | 936865 | 936916 | 936966 | 50 |
| 865 | 937016 | 937066 | 937117 | 937167 | 937217 | 937267 | 937317 | 937367 | 937418 | 937468 | 50 |
| 866 | 937518 | 937568 | 937618 | 937668 | 937718 | 937769 | 937819 | 937869 | 937919 | 937969 | 50 |
| 867 | 938019 | 938069 | 938119 | 938169 | 938219 | 938269 | 938319 | 938370 | 938420 | 938470 | 50 |
| 868 | 938520 | 938570 | 938620 | 938670 | 938720 | 938770 | 938820 | 938870 | 938920 | 938970 | 50 |
| 869 | 939020 | 939070 | 939120 | 939170 | 939220 | 939270 | 939320 | 939369 | 939419 | 939469 | 50 |
| 870 | 939519 | 939569 | 939619 | 939669 | 939719 | 939769 | 939819 | 939869 | 939918 | 939968 | 50 |
| 871 | 940018 | 940068 | 940118 | 940168 | 940218 | 940267 | 940317 | 940367 | 940417 | 940467 | 50 |
| 872 | 940516 | 940566 | 940616 | 940666 | 940716 | 940765 | 940815 | 940865 | 940915 | 940964 | 50 |
| 873 | 941014 | 941064 | 941114 | 941163 | 941213 | 941263 | 941313 | 941362 | 941412 | 941462 | 50 |
| 874 | 941511 | 941561 | 941611 | 941660 | 941710 | 941760 | 941809 | 941859 | 941909 | 941958 | 50 |
| 875 | 942008 | 942058 | 942107 | 942157 | 942207 | 942256 | 942306 | 942355 | 942405 | 942455 | 50 |
| 876 | 942504 | 942554 | 942603 | 942653 | 942702 | 942752 | 942801 | 942851 | 942901 | 942950 | 50 |
| 877 | 943000 | 943049 | 943099 | 943148 | 943198 | 943247 | 943297 | 943346 | 943396 | 943445 | 49 |
| 878 | 943495 | 943544 | 943593 | 943643 | 943692 | 943742 | 943791 | 943841 | 943890 | 943939 | 49 |
| 879 | 943989 | 944038 | 944088 | 944137 | 944186 | 944236 | 944285 | 944335 | 944384 | 944433 | 49 |
| 880 | 944483 | 944532 | 944581 | 944631 | 944680 | 944729 | 944779 | 944828 | 944877 | 944927 | 49 |
| 881 | 944976 | 945025 | 945074 | 945124 | 945173 | 945222 | 945272 | 945321 | 945370 | 945419 | 49 |
| 882 | 945469 | 945518 | 945567 | 945616 | 945665 | 945715 | 945764 | 945813 | 945862 | 945912 | 49 |
| 883 | 945961 | 946010 | 946059 | 946108 | 946157 | 946207 | 946256 | 946305 | 946354 | 946403 | 49 |
| 884 | 946452 | 946501 | 946551 | 946600 | 946649 | 946698 | 946747 | 946796 | 946845 | 946894 | 49 |
| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. |

| D. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 49 | 5 | 10 | 15 | 20 | 24 | 29 | 34 | 39 | 44 | 51 | 5 | 10 | 15 | 20 | 25 | 31 | 36 | 41 | 46 |
| 50 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 52 | 5 | 10 | 16 | 21 | 26 | 31 | 36 | 42 | 4 |

## LOGARITHMS OF NUMBERS

No. 8850 to 9419 Log. 946943 to 974005

| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 885 | 946943 | 946992 | 947041 | 947090 | 947140 | 947189 | 947238 | 947287 | 947336 | 947385 | 49 |
| 886 | 947434 | 947483 | 947532 | 947581 | 947630 | 947679 | 947728 | 947777 | 947826 | 947875 | 49 |
| 887 | 947924 | 947973 | 948022 | 948070 | 948119 | 948168 | 948217 | 948266 | 948315 | 948364 | 49 |
| 888 | 948413 | 948462 | 948511 | 948560 | 948609 | 948657 | 948706 | 948755 | 948804 | 948853 | 49 |
| 889 | 948902 | 948951 | 948999 | 949048 | 949097 | 949146 | 949195 | 949244 | 949292 | 949341 | 49 |
| 890 | 949390 | 949439 | 949488 | 949536 | 949585 | 949634 | 949683 | 949731 | 949780 | 949829 | 49 |
| 891 | 949878 | 949926 | 949975 | 950024 | 950073 | 950121 | 950170 | 950219 | 950267 | 950316 | 49 |
| 892 | 950365 | 950414 | 950462 | 950511 | 950560 | 950608 | 950657 | 950706 | 950754 | 950803 | 49 |
| 893 | 950851 | 950900 | 950949 | 950997 | 951046 | 951095 | 951143 | 951192 | 951240 | 951289 | 49 |
| 894 | 951338 | 951386 | 951435 | 951483 | 951532 | 951580 | 951629 | 951677 | 951726 | 951775 | 49 |
| 895 | 951823 | 951872 | 951920 | 951969 | 952017 | 952066 | 952114 | 952163 | 952211 | 952260 | 48 |
| 896 | 952308 | 952356 | 952405 | 952453 | 952502 | 952550 | 952599 | 952647 | 952696 | 952744 | 48 |
| 897 | 952792 | 952841 | 952889 | 952938 | 952986 | 953034 | 953083 | 953131 | 953180 | 953228 | 48 |
| 898 | 953276 | 953325 | 953373 | 953421 | 953470 | 953518 | 953566 | 953615 | 953663 | 953711 | 48 |
| 899 | 953760 | 953808 | 953856 | 953905 | 953953 | 954001 | 954049 | 954098 | 954146 | 954194 | 48 |
| 900 | 954243 | 954291 | 954339 | 954387 | 954435 | 954484 | 954532 | 954580 | 954628 | 954677 | 48 |
| 901 | 954725 | 954773 | 954821 | 954869 | 954918 | 954966 | 955014 | 955062 | 955110 | 955158 | 48 |
| 902 | 955207 | 955255 | 955303 | 955351 | 955399 | 955447 | 955495 | 955543 | 955592 | 955640 | 48 |
| 903 | 955688 | 955736 | 955784 | 955832 | 955880 | 955928 | 955976 | 956024 | 956072 | 956120 | 48 |
| 904 | 956168 | 956216 | 956265 | 956313 | 956361 | 956409 | 956457 | 956505 | 956553 | 956601 | 48 |
| 905 | 956649 | 956697 | 956745 | 956793 | 956840 | 956888 | 956936 | 956984 | 957032 | 957080 | 48 |
| 906 | 957128 | 957176 | 957224 | 957272 | 957320 | 957368 | 957416 | 957464 | 957512 | 957559 | 48 |
| 907 | 957607 | 957655 | 957703 | 957751 | 957799 | 957847 | 957894 | 957942 | 957990 | 958038 | 48 |
| 908 | 958086 | 958134 | 958181 | 958229 | 958277 | 958325 | 958373 | 958421 | 958468 | 958516 | 48 |
| 909 | 958564 | 958612 | 958659 | 958707 | 958755 | 958803 | 958850 | 958898 | 958946 | 958994 | 48 |
| 910 | 959041 | 959089 | 959137 | 959185 | 959232 | 959280 | 959328 | 959375 | 959423 | 959471 | 48 |
| 911 | 959518 | 959566 | 959614 | 959661 | 959709 | 959757 | 959804 | 959852 | 959900 | 959947 | 48 |
| 912 | 959995 | 960042 | 960090 | 960138 | 960185 | 960233 | 960280 | 960328 | 960376 | 960423 | 48 |
| 913 | 960471 | 960518 | 960566 | 960613 | 960661 | 960709 | 960756 | 960804 | 960851 | 960899 | 48 |
| 914 | 960946 | 960994 | 961041 | 961089 | 961136 | 961184 | 961231 | 961279 | 961326 | 961374 | 47 |
| 915 | 961421 | 961469 | 961516 | 961563 | 961611 | 961658 | 961706 | 961753 | 961801 | 961848 | 47 |
| 916 | 961895 | 961943 | 961990 | 962038 | 962085 | 962132 | 962180 | 962227 | 962275 | 962322 | 47 |
| 917 | 962369 | 962417 | 962464 | 962511 | 962559 | 962606 | 962653 | 962701 | 962748 | 962795 | 47 |
| 918 | 962843 | 962890 | 962937 | 962985 | 963032 | 963079 | 963126 | 963174 | 963221 | 963268 | 47 |
| 919 | 963316 | 963363 | 963410 | 963457 | 963504 | 963552 | 963599 | 963646 | 963693 | 963741 | 47 |
| 920 | 963788 | 963835 | 963882 | 963929 | 963977 | 964024 | 964071 | 964118 | 964165 | 964212 | 47 |
| 921 | 964260 | 964307 | 964354 | 964401 | 964448 | 964495 | 964542 | 964590 | 964637 | 964684 | 47 |
| 922 | 964731 | 964778 | 964825 | 964872 | 964919 | 964966 | 965013 | 965061 | 965108 | 965155 | 47 |
| 923 | 965202 | 965249 | 965296 | 965343 | 965390 | 965437 | 965484 | 965531 | 965578 | 965625 | 47 |
| 924 | 965672 | 965719 | 965766 | 965813 | 965860 | 965907 | 965954 | 966001 | 966048 | 966095 | 47 |
| 925 | 966142 | 966189 | 966236 | 966283 | 966329 | 966376 | 966423 | 966470 | 966517 | 966564 | 47 |
| 926 | 966611 | 966658 | 966705 | 966752 | 966799 | 966845 | 966892 | 966939 | 966986 | 967033 | 47 |
| 927 | 967080 | 967127 | 967173 | 967220 | 967267 | 967314 | 967361 | 967408 | 967454 | 967501 | 47 |
| 928 | 967548 | 967595 | 967642 | 967688 | 967735 | 967782 | 967829 | 967875 | 967922 | 967969 | 47 |
| 929 | 968016 | 968062 | 968109 | 968156 | 968203 | 968249 | 968296 | 968343 | 968390 | 968436 | 47 |
| 930 | 968483 | 968530 | 968576 | 968623 | 968670 | 968716 | 968763 | 968810 | 968856 | 968903 | 47 |
| 931 | 968950 | 968996 | 969043 | 969090 | 969136 | 969183 | 969229 | 969276 | 969323 | 969369 | 47 |
| 932 | 969416 | 969463 | 969509 | 969556 | 969602 | 969649 | 969695 | 969742 | 969789 | 969835 | 47 |
| 933 | 969882 | 969928 | 969975 | 970021 | 970068 | 970114 | 970161 | 970207 | 970254 | 970300 | 47 |
| 934 | 970347 | 970393 | 970440 | 970486 | 970533 | 970579 | 970626 | 970672 | 970719 | 970765 | 46 |
| 935 | 970812 | 970858 | 970904 | 970951 | 970997 | 971044 | 971090 | 971137 | 971183 | 971229 | 46 |
| 936 | 971276 | 971322 | 971369 | 971415 | 971461 | 971508 | 971554 | 971601 | 971647 | 971693 | 46 |
| 937 | 971740 | 971786 | 971832 | 971879 | 971925 | 971971 | 972018 | 972064 | 972110 | 972157 | 46 |
| 938 | 972203 | 972249 | 972295 | 972342 | 972388 | 972434 | 972481 | 972527 | 972573 | 972619 | 46 |
| 939 | 972666 | 972712 | 972758 | 972804 | 972851 | 972897 | 972943 | 972989 | 973035 | 973082 | 46 |
| 940 | 973128 | 973174 | 973220 | 973266 | 973313 | 973359 | 973405 | 973451 | 973497 | 973543 | 46 |
| 941 | 973590 | 973636 | 973682 | 973728 | 973774 | 973820 | 973866 | 973913 | 973959 | 974005 | 46 |
| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. |

| D. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 46 | 5 | 9 | 14 | 18 | 23 | 28 | 32 | 37 | 41 | 48 | 5 | 10 | 14 | 19 | 24 | 29 | 34 | 38 | 43 |
| 47 | 5 | 9 | 14 | 19 | 23 | 28 | 33 | 38 | 42 | 49 | 5 | 10 | 15 | 20 | 24 | 29 | 34 | 39 | 44 |

## LOGARITHMS OF NUMBERS

No. 9420 to 9999 Log. 974051 to 999957

| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 942 | 974051 | 974097 | 974143 | 974189 | 974235 | 974281 | 974327 | 974374 | 974420 | 974466 | 46 |
| 943 | 974512 | 974558 | 974604 | 974650 | 974696 | 974742 | 974788 | 974834 | 974880 | 974926 | 46 |
| 944 | 974972 | 975018 | 975064 | 975110 | 975156 | 975202 | 975248 | 975294 | 975340 | 975386 | 46 |
| 945 | 975432 | 975478 | 975524 | 975570 | 975616 | 975662 | 975707 | 975753 | 975799 | 975845 | 46 |
| 946 | 975891 | 975937 | 975983 | 976029 | 976075 | 976121 | 976167 | 976212 | 976258 | 976304 | 46 |
| 947 | 976350 | 976396 | 976442 | 976488 | 976533 | 976579 | 976625 | 976671 | 976717 | 976763 | 46 |
| 948 | 976808 | 976854 | 976900 | 976946 | 976992 | 977037 | 977083 | 977129 | 977175 | 977220 | 46 |
| 949 | 977266 | 977312 | 977358 | 977403 | 977449 | 977495 | 977541 | 977586 | 977632 | 977678 | 46 |
| 950 | 977724 | 977769 | 977815 | 977861 | 977906 | 977952 | 977998 | 978043 | 978089 | 978135 | 46 |
| 951 | 978181 | 978226 | 978272 | 978317 | 978363 | 978409 | 978454 | 978500 | 978546 | 978591 | 46 |
| 952 | 978637 | 978683 | 978728 | 978774 | 978819 | 978865 | 978911 | 978956 | 979002 | 979047 | 46 |
| 953 | 979093 | 979138 | 979184 | 979230 | 979275 | 979321 | 979366 | 979412 | 979457 | 979503 | 46 |
| 954 | 979548 | 979594 | 979639 | 979685 | 979730 | 979776 | 979821 | 979867 | 979912 | 979958 | 46 |
| 955 | 980003 | 980049 | 980094 | 980140 | 980185 | 980231 | 980276 | 980322 | 980367 | 980412 | 45 |
| 956 | 980458 | 980503 | 980549 | 980594 | 980640 | 980685 | 980730 | 980776 | 980821 | 980867 | 45 |
| 957 | 980912 | 980957 | 981003 | 981048 | 981093 | 981139 | 981184 | 981229 | 981275 | 981320 | 45 |
| 958 | 981366 | 981411 | 981456 | 981501 | 981547 | 981592 | 981637 | 981683 | 981728 | 981773 | 45 |
| 959 | 981819 | 981864 | 981909 | 981954 | 982000 | 982045 | 982090 | 982135 | 982181 | 982226 | 45 |
| 960 | 982271 | 982316 | 982362 | 982407 | 982452 | 982497 | 982543 | 982588 | 982633 | 982678 | 45 |
| 961 | 982723 | 982769 | 982814 | 982859 | 982904 | 982949 | 982994 | 983040 | 983085 | 983130 | 45 |
| 962 | 983175 | 983220 | 983265 | 983310 | 983356 | 983401 | 983446 | 983491 | 983536 | 983581 | 45 |
| 963 | 983626 | 983671 | 983716 | 983762 | 983807 | 983852 | 983897 | 983942 | 983987 | 984032 | 45 |
| 964 | 984077 | 984122 | 984167 | 984212 | 984257 | 984302 | 984347 | 984392 | 984437 | 984482 | 45 |
| 965 | 984527 | 984572 | 984617 | 984662 | 984707 | 984752 | 984797 | 984842 | 984887 | 984932 | 45 |
| 966 | 984977 | 985022 | 985067 | 985112 | 985157 | 985202 | 985247 | 985292 | 985337 | 985382 | 45 |
| 967 | 985426 | 985471 | 985516 | 985561 | 985606 | 985651 | 985696 | 985741 | 985786 | 985830 | 45 |
| 968 | 985875 | 985920 | 985965 | 986010 | 986055 | 986100 | 986144 | 986189 | 986234 | 986279 | 45 |
| 969 | 986324 | 986369 | 986413 | 986458 | 986503 | 986548 | 986593 | 986637 | 986682 | 986727 | 45 |
| 970 | 986772 | 986817 | 986861 | 986906 | 986951 | 986996 | 987040 | 987085 | 987130 | 987175 | 45 |
| 971 | 987219 | 987264 | 987309 | 987353 | 987398 | 987443 | 987488 | 987532 | 987577 | 987622 | 45 |
| 972 | 987666 | 987711 | 987756 | 987800 | 987845 | 987890 | 987934 | 987979 | 988024 | 988068 | 45 |
| 973 | 988113 | 988157 | 988202 | 988247 | 988291 | 988336 | 988381 | 988425 | 988470 | 988514 | 45 |
| 974 | 988559 | 988604 | 988648 | 988693 | 988737 | 988782 | 988826 | 988871 | 988916 | 988960 | 45 |
| 975 | 989005 | 989049 | 989094 | 989138 | 989183 | 989227 | 989272 | 989316 | 989361 | 989405 | 45 |
| 976 | 989450 | 989494 | 989539 | 989583 | 989628 | 989672 | 989717 | 989761 | 989806 | 989850 | 44 |
| 977 | 989895 | 989939 | 989983 | 990028 | 990072 | 990117 | 990161 | 990206 | 990250 | 990294 | 44 |
| 978 | 990339 | 990383 | 990428 | 990472 | 990516 | 990561 | 990605 | 990650 | 990694 | 990738 | 44 |
| 979 | 990783 | 990827 | 990871 | 990916 | 990960 | 991004 | 991049 | 991093 | 991137 | 991182 | 44 |
| 980 | 991226 | 991270 | 991315 | 991359 | 991403 | 991448 | 991492 | 991536 | 991580 | 991625 | 44 |
| 981 | 991669 | 991713 | 991758 | 991802 | 991846 | 991890 | 991935 | 991979 | 992023 | 992067 | 44 |
| 982 | 992111 | 992156 | 992200 | 992244 | 992288 | 992333 | 992377 | 992421 | 992465 | 992509 | 44 |
| 983 | 992554 | 992598 | 992642 | 992686 | 992730 | 992774 | 992819 | 992863 | 992907 | 992951 | 44 |
| 984 | 992995 | 993039 | 993083 | 993127 | 993172 | 993216 | 993260 | 993304 | 993348 | 993392 | 44 |
| 985 | 993436 | 993480 | 993524 | 993568 | 993613 | 993657 | 993701 | 993745 | 993789 | 993833 | 44 |
| 986 | 993877 | 993921 | 993965 | 994009 | 994053 | 994097 | 994141 | 994185 | 994229 | 994273 | 44 |
| 987 | 994317 | 994361 | 994405 | 994449 | 994493 | 994537 | 994581 | 994625 | 994669 | 994713 | 44 |
| 988 | 994757 | 994801 | 994845 | 994889 | 994933 | 994977 | 995021 | 995065 | 995108 | 995152 | 44 |
| 989 | 995196 | 995240 | 995284 | 995328 | 995372 | 995416 | 995460 | 995504 | 995547 | 995591 | 44 |
| 990 | 995635 | 995679 | 995723 | 995767 | 995811 | 995854 | 995898 | 995942 | 995986 | 996030 | 44 |
| 991 | 996074 | 996117 | 996161 | 996205 | 996249 | 996293 | 996337 | 996380 | 996424 | 996468 | 44 |
| 992 | 996512 | 996555 | 996599 | 996643 | 996687 | 996731 | 996774 | 996818 | 996862 | 996907 | 44 |
| 993 | 996949 | 996993 | 997037 | 997080 | 997124 | 997168 | 997212 | 997255 | 997299 | 997343 | 44 |
| 994 | 997386 | 997430 | 997474 | 997517 | 997561 | 997605 | 997648 | 997692 | 997736 | 997779 | 44 |
| 995 | 997823 | 997867 | 997910 | 997954 | 997998 | 998041 | 998085 | 998129 | 998172 | 998216 | 44 |
| 996 | 998259 | 998303 | 998347 | 998390 | 998434 | 998477 | 998521 | 998564 | 998608 | 998652 | 44 |
| 997 | 998695 | 998739 | 998782 | 998826 | 998869 | 998913 | 998956 | 999000 | 999043 | 999087 | 44 |
| 998 | 999131 | 999174 | 999218 | 999261 | 999305 | 999348 | 999392 | 999435 | 999479 | 999522 | 44 |
| 999 | 999565 | 999609 | 999652 | 999696 | 999739 | 999783 | 999826 | 999870 | 999913 | 999957 | 43 |
| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. |

| D. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | D. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 43 | 4 | 9 | 13 | 17 | 21 | 26 | 30 | 34 | 39 | 45 | 4 | 9 | 13 | 18 | 22 | 27 | 31 | 36 | 40 |
| 44 | 4 | 9 | 13 | 18 | 22 | 26 | 31 | 35 | 40 | 46 | 5 | 9 | 14 | 18 | 23 | 28 | 32 | 37 | 41 |

## SPHEROIDAL TABLES. COMPRESSION $\frac{1}{299}$.

| Latitude. | | | | | Longitude. | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Latitude. | Length of one degree in statute miles. | Length in feet of a | | | Latitude. | Length of one degree in minutes of latitude or nautical miles.* | Length in feet of a | | |
| | | Degree. | Minute. | Second. | | | Degree. | Minute. | Second. |
| 0° | 68·704 | 362755·6 | 6045·93 | 100·77 | 0° | 60·410 | 365233·7 | 6087·23 | 101·454 |
| 2 | 68·704 | 362760·1 | 6046·00 | 100·77 | 2 | 60·373 | 365012·7 | 6083·54 | 101·392 |
| 4 | 68·707 | 362773·6 | 6046·23 | 100·77 | 4 | 60·261 | 364350·0 | 6072·50 | 101·208 |
| 6 | 68·711 | 362795·9 | 6046·60 | 100·78 | 6 | 60·074 | 363246·3 | 6054·11 | 100·902 |
| 8 | 68·717 | 362827·1 | 6047·12 | 100·79 | 8 | 59·814 | 361703·0 | 6028·38 | 100·473 |
| 10 | 68·725 | 362866·9 | 6047·78 | 100·80 | 10 | 59·480 | 359721·7 | 5995·36 | 99·923 |
| 12 | 68·734 | 362815·2 | 6048·59 | 100·81 | 12 | 59·072 | 357304·8 | 5955·08 | 99·251 |
| 14 | 68·745 | 362971·8 | 6049·53 | 100·83 | 14 | 58·592 | 354455·1 | 5907·59 | 98·460 |
| 16 | 68·757 | 363036·3 | 6050·61 | 100·84 | 16 | 58·040 | 351175·7 | 5852·93 | 97·549 |
| 18 | 68·771 | 363108·4 | 6051·81 | 100·86 | 18 | 57·416 | 347470·5 | 5791·18 | 96·520 |
| 20 | 68·786 | 363187·9 | 6053·13 | 100·89 | 20 | 56·722 | 343343·7 | 5722·40 | 95·373 |
| 22 | 68·801 | 363274·3 | 6054·57 | 100·91 | 22 | 55·958 | 338800·1 | 5646·67 | 94·111 |
| 24 | 68·819 | 363367·2 | 6056·12 | 100·94 | 24 | 55·125 | 333845·0 | 5564·08 | 92·735 |
| 26 | 68·838 | 363466·2 | 6057·77 | 100·96 | 26 | 54·225 | 328484·1 | 5474·74 | 91·245 |
| 28 | 68·858 | 363570·8 | 6059·51 | 100·99 | 28 | 53·259 | 322723·6 | 5378·73 | 89·645 |
| 30 | 68·879 | 363680·5 | 6061·34 | 101·02 | 30 | 52·228 | 316570·3 | 5276·17 | 87·936 |
| 32 | 68·900 | 363794·8 | 6063·25 | 101·05 | 32 | 51·133 | 310031·2 | 5167·19 | 86·119 |
| 34 | 68·923 | 363913·1 | 6065·22 | 101·09 | 34 | 49·976 | 303114·2 | 5051·90 | 84·198 |
| 36 | 68·946 | 364034·9 | 6067·25 | 101·12 | 36 | 48·758 | 295827·2 | 4930·45 | 82·174 |
| 38 | 68·970 | 364159·5 | 6069·33 | 101·16 | 38 | 47·481 | 288178·9 | 4802·98 | 80·050 |
| 40 | 68·994 | 364286·3 | 6071·44 | 101·19 | 40 | 46·146 | 280178·2 | 4669·64 | 77·827 |
| 42 | 69·018 | 364414·9 | 6073·58 | 101·23 | 42 | 44·757 | 271834·7 | 4530·58 | 75·509 |
| 44 | 69·042 | 364544·4 | 6075·74 | 101·26 | 44 | 43·313 | 263158·3 | 4385·97 | 73·100 |
| 46 | 69·067 | 364674·4 | 6077·91 | 101·30 | 46 | 41·817 | 254159·2 | 4235·99 | 70·600 |
| 48 | 69·092 | 364804·1 | 6080·07 | 101·33 | 48 | 40·270 | 244848·2 | 4080·80 | 68·013 |
| 50 | 69·116 | 364932·9 | 6082·22 | 101·37 | 50 | 38·676 | 235236·5 | 3920·61 | 65·343 |
| 52 | 69·140 | 365060·2 | 6084·34 | 101·41 | 52 | 37·035 | 225335·5 | 3755·59 | 62·593 |
| 54 | 69·164 | 365185·4 | 6086·42 | 101·44 | 54 | 35·350 | 215157·2 | 3585·95 | 59·706 |
| 56 | 69·187 | 365307·9 | 6088·47 | 101·47 | 56 | 33·623 | 204714·0 | 3411·90 | 56·865 |
| 58 | 69·210 | 365427·0 | 6090·45 | 101·51 | 58 | 31·856 | 19,018·3 | 3233·64 | 53·891 |
| 60 | 69·231 | 365542·2 | 6092·37 | 101·54 | 60 | 30·051 | 183083·3 | 3051·39 | 50·856 |
| 62 | 69·252 | 365652·9 | 6094·22 | 101·57 | 62 | 28·211 | 171922·1 | 2865·37 | 47·756 |
| 64 | 69·272 | 365758·5 | 6095·98 | 101·60 | 64 | 26·337 | 160548·6 | 2675·81 | 44·597 |
| 66 | 69·291 | 365858·6 | 6097·64 | 101·63 | 66 | 24·432 | 148976·3 | 2482·94 | 41·382 |
| 68 | 69·309 | 365952·7 | 6099·21 | 101·65 | 68 | 22·498 | 137219·7 | 2287·00 | 38·110 |
| 70 | 69·326 | 366040·2 | 6100·67 | 101·68 | 70 | 20·538 | 125293·2 | 2088·22 | 34·804 |
| 72 | 69·341 | 366120·7 | 6102·01 | 101·70 | 72 | 18·553 | 113211·4 | 1886·86 | 31·448 |
| 74 | 69·355 | 366193·9 | 6103·23 | 101·72 | 74 | 16·547 | 100989·1 | 1683·15 | 28·053 |
| 76 | 69·367 | 366259·6 | 6104·32 | 101·74 | 76 | 14·521 | 88641·6 | 1477·36 | 24·623 |
| 78 | 69·378 | 366316·7 | 6105·28 | 101·75 | 78 | 12·478 | 76184·0 | 1269·73 | 21·162 |
| 80 | 69·387 | 366365·8 | 6106·10 | 101·77 | 80 | 10·421 | 63631·8 | 1060·53 | 17·676 |
| 82 | 69·395 | 366,06·3 | 6106·77 | 101·78 | 82 | 8·352 | 51000·6 | 850·01 | 14·167 |
| 84 | 69·401 | 366438·0 | 6107·30 | 101·79 | 84 | 6·272 | 38306·1 | 638·44 | 10·641 |
| 86 | 69·405 | 366460·7 | 6107·68 | 101·79 | 86 | 4·186 | 25563·9 | 426·07 | 7·101 |
| 88 | 69·408 | 366474·4 | 6107·91 | 101·80 | 88 | 2·094 | 1.789·9 | 213·17 | 3·553 |
| 90 | 69·409 | 366479·0 | 6107·98 | 101·80 | 90 | 0·0 | 0·0 | 0·0 | 0·0 |

* The figures in this column, divided by 6, will give the length, in cables, of a minute of longitude in it's corresponding latitude, thus: in latitude 84° 6·272 + 6 = 1·05 cable in a minute of longitude.

NOTE.—These tables have been calculated for every ten minutes of latitude, and are published by J. D. Potter, 145 Minories, E.

# TABLE 65.

## NATURAL SINES, COSINES, &c.

| ° | Sine. | Cosec. | Tangent. | Cotang. | Secant. | Cosine. | ° |
|---|---|---|---|---|---|---|---|
| 0 | ·0000 | Infinite | ·0000 | Infinite | 1·0000 | 1·0000 | 90 |
| 1 | ·0175 | 57·2987 | ·0175 | 57·2900 | 1·0002 | ·9998 | 89 |
| 2 | ·0349 | 28·6537 | ·0349 | 28·6363 | 1·0006 | ·9994 | 88 |
| 3 | ·0523 | 19·1073 | ·0524 | 19·0811 | 1·0014 | ·9986 | 87 |
| 4 | ·0698 | 14·3356 | ·0699 | 14·3007 | 1·0024 | ·9976 | 86 |
| 5 | ·0872 | 11·4737 | ·0875 | 11·4301 | 1·0038 | ·9962 | 85 |
| 6 | ·1045 | 9·5668 | ·1051 | 9·5144 | 1·0055 | ·9945 | 84 |
| 7 | ·1219 | 8·2055 | ·1228 | 8·1443 | 1·0075 | ·9925 | 83 |
| 8 | ·1392 | 7·1853 | ·1405 | 7·1154 | 1·0098 | ·9903 | 82 |
| 9 | ·1564 | 6·3925 | ·1584 | 6·3138 | 1·0125 | ·9877 | 81 |
| 10 | ·1736 | 5·7588 | ·1763 | 5·6713 | 1·0154 | ·9848 | 80 |
| 11 | ·1908 | 5·2408 | ·1944 | 5·1446 | 1·0187 | ·9816 | 79 |
| 12 | ·2079 | 4·8097 | ·2126 | 4·7046 | 1·0223 | ·9781 | 78 |
| 13 | ·2250 | 4·4454 | ·2309 | 4·3315 | 1·0263 | ·9744 | 77 |
| 14 | ·2419 | 4·1336 | ·2493 | 4·0108 | 1·0306 | ·9703 | 76 |
| 15 | ·2588 | 3·8637 | ·2679 | 3·7321 | 1·0353 | ·9659 | 75 |
| 16 | ·2756 | 3·6280 | ·2867 | 3·4874 | 1·0403 | ·9613 | 74 |
| 17 | ·2924 | 3·4203 | ·3057 | 3·2709 | 1·0457 | ·9563 | 73 |
| 18 | ·3090 | 3·2361 | ·3249 | 3·0777 | 1·0515 | ·9511 | 72 |
| 19 | ·3256 | 3·0716 | ·3443 | 2·9042 | 1·0576 | ·9455 | 71 |
| 20 | ·3420 | 2·9238 | ·3640 | 2·7475 | 1·0642 | ·9397 | 70 |
| 21 | ·3584 | 2·7904 | ·3839 | 2·6051 | 1·0711 | ·9336 | 69 |
| 22 | ·3746 | 2·6695 | ·4040 | 2·4751 | 1·0785 | ·9272 | 68 |
| 23 | ·3907 | 2·5593 | ·4245 | 2·3559 | 1·0864 | ·9205 | 67 |
| 24 | ·4067 | 2·4586 | ·4452 | 2·2460 | 1·0946 | ·9135 | 66 |
| 25 | ·4226 | 2·3662 | ·4663 | 2·1445 | 1·1034 | ·9063 | 65 |
| 26 | ·4384 | 2·2812 | ·4877 | 2·0503 | 1·1126 | ·8988 | 64 |
| 27 | ·4540 | 2·2027 | ·5095 | 1·9626 | 1·1223 | ·8910 | 63 |
| 28 | ·4695 | 2·1301 | ·5317 | 1·8807 | 1·1326 | ·8829 | 62 |
| 29 | ·4848 | 2·0627 | ·5543 | 1·8040 | 1·1434 | ·8746 | 61 |
| 30 | ·5000 | 2·0000 | ·5774 | 1·7320 | 1·1547 | ·8660 | 60 |
| 31 | ·5150 | 1·9416 | ·6009 | 1·6643 | 1·1666 | ·8572 | 59 |
| 32 | ·5299 | 1·8871 | ·6249 | 1·6003 | 1·1792 | ·8480 | 58 |
| 33 | ·5446 | 1·8361 | ·6494 | 1·5399 | 1·1924 | ·8387 | 57 |
| 34 | ·5592 | 1·7883 | ·6745 | 1·4826 | 1·2062 | ·8290 | 56 |
| 35 | ·5736 | 1·7434 | ·7002 | 1·4281 | 1·2208 | ·8192 | 55 |
| 36 | ·5878 | 1·7013 | ·7265 | 1·3764 | 1·2361 | ·8090 | 54 |
| 37 | ·6018 | 1·6616 | ·7536 | 1·3270 | 1·2521 | ·7986 | 53 |
| 38 | ·6157 | 1·6243 | ·7813 | 1·2799 | 1·2690 | ·7880 | 52 |
| 39 | ·6293 | 1·5890 | ·8098 | 1·2349 | 1·2868 | ·7771 | 51 |
| 40 | ·6428 | 1·5572 | ·8391 | 1·1918 | 1·3054 | ·7660 | 50 |
| 41 | ·6561 | 1·5243 | ·8693 | 1·1504 | 1·3250 | ·7547 | 49 |
| 42 | ·6691 | 1·4945 | ·9004 | 1·1106 | 1·3456 | ·7431 | 48 |
| 43 | ·6820 | 1·4663 | ·9325 | 1·0724 | 1·3673 | ·7314 | 47 |
| 44 | ·6947 | 1·4396 | ·9657 | 1·0355 | 1·3902 | ·7193 | 46 |
| 45 | ·7071 | 1·4142 | 1·0000 | 1·0000 | 1·4142 | ·7071 | 45 |
| ° | Cosine. | Secant. | Cotang. | Tangent. | Cosec. | Sine. | ° |

## LOG SINES OF SMALL ARCS TO EACH SECOND

| ″ | 0° 0′ | 0° 1′ | 0° 2′ | 0° 3′ | 0° 4′ | 0° 5′ | 0° 6′ | 0° 7′ | 0° 8′ | 0° 9′ | ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 6· | 6· | | 7· | 7· | 7· | 7· | 7· | 7· | |
| 0 | − ∞ | 46373 | 76476 | 6·94085 | 06579 | 16270 | 24188 | 30882 | 36682 | 41797 | 60 |
| 1 | 4·68557 | 47090 | 76836 | 6·94325 | 06759 | 16414 | 24308 | 30986 | 36772 | 41877 | 59 |
| 2 | 4·98660 | 47797 | 77193 | 6·94565 | 06939 | 16558 | 24428 | 31089 | 36862 | 41957 | 58 |
| 3 | 5·16270 | 48492 | 77548 | 6·94803 | 07118 | 16702 | 24548 | 31191 | 36952 | 42037 | 57 |
| 4 | 5·28763 | 49175 | 77900 | 6·95039 | 07296 | 16845 | 24668 | 31294 | 37042 | 42117 | 56 |
| 5 | 5·38454 | 49849 | 78248 | 6·95275 | 07474 | 16987 | 24787 | 31396 | 37132 | 42197 | 55 |
| 6 | 5·46373 | 50512 | 78595 | 6·95509 | 07651 | 17130 | 24906 | 31498 | 37221 | 42277 | 54 |
| 7 | 5·53067 | 51165 | 78938 | 6·95742 | 07827 | 17271 | 25024 | 31600 | 37310 | 42356 | 53 |
| 8 | 5·58866 | 51808 | 79278 | 6·95973 | 08003 | 17413 | 25142 | 31702 | 37399 | 42435 | 52 |
| 9 | 5·63982 | 52442 | 79616 | 6·96204 | 08177 | 17553 | 25260 | 31803 | 37488 | 42515 | 51 |
| 10 | 5·68557 | 53067 | 79952 | 6·96433 | 08351 | 17694 | 25378 | 31904 | 37577 | 42594 | 50 |
| 11 | 5·72697 | 53683 | 80285 | 6·96661 | 08525 | 17834 | 25495 | 32005 | 37666 | 42673 | 49 |
| 12 | 5·76476 | 54291 | 80615 | 6·96888 | 08698 | 17973 | 25612 | 32106 | 37754 | 42751 | 48 |
| 13 | 5·79952 | 54890 | 80943 | 6·97113 | 08870 | 18112 | 25728 | 32206 | 37842 | 42830 | 47 |
| 14 | 5·83170 | 55481 | 81268 | 6·97338 | 09041 | 18250 | 25845 | 32306 | 37930 | 42908 | 46 |
| 15 | 5·86167 | 56064 | 81591 | 6·97561 | 09211 | 18389 | 25961 | 32406 | 38018 | 42987 | 45 |
| 16 | 5·88969 | 56639 | 81911 | 6·97783 | 09381 | 18526 | 26076 | 32506 | 38106 | 43065 | 44 |
| 17 | 5·91602 | 57207 | 82230 | 6·98004 | 09551 | 18663 | 26192 | 32606 | 38193 | 43143 | 43 |
| 18 | 5·94085 | 57767 | 82545 | 6·98224 | 09719 | 18800 | 26307 | 32705 | 38280 | 43221 | 42 |
| 19 | 5·96433 | 58320 | 82859 | 6·98443 | 09887 | 18937 | 26421 | 32804 | 38367 | 43299 | 41 |
| 20 | 5·98660 | 58866 | 83170 | 6·98660 | 10055 | 19072 | 26536 | 32903 | 38454 | 43376 | 40 |
| 21 | 6·00779 | 59406 | 83479 | 6·98877 | 10222 | 19208 | 26650 | 33001 | 38541 | 43454 | 39 |
| 22 | 6·02800 | 59939 | 83786 | 6·99093 | 10388 | 19343 | 26764 | 33100 | 38628 | 43531 | 38 |
| 23 | 6·04730 | 60465 | 84091 | 6·99307 | 10553 | 19478 | 26877 | 33198 | 38714 | 43608 | 37 |
| 24 | 6·06579 | 60985 | 84394 | 6·99520 | 10718 | 19612 | 26991 | 33296 | 38800 | 43685 | 36 |
| 25 | 6·08351 | 61499 | 84694 | 6·99733 | 10882 | 19746 | 27104 | 33393 | 38887 | 43762 | 35 |
| 26 | 6·10055 | 62007 | 84993 | 6·99944 | 11046 | 19879 | 27216 | 33491 | 38972 | 43839 | 34 |
| 27 | 6·11694 | 62509 | 85289 | 7·00155 | 11209 | 20012 | 27329 | 33588 | 39058 | 43916 | 33 |
| 28 | 6·13273 | 63006 | 85584 | 7·00364 | 11371 | 20145 | 27441 | 33685 | 39144 | 43992 | 32 |
| 29 | 6·14797 | 63496 | 85876 | 7·00572 | 11533 | 20277 | 27552 | 33782 | 39229 | 44069 | 31 |
| 30 | 6·16270 | 63982 | 86167 | 7·00779 | 11694 | 20409 | 27664 | 33879 | 39314 | 44145 | 30 |
| 31 | 6·17694 | 64462 | 86455 | 7·00986 | 11854 | 20540 | 27775 | 33975 | 39400 | 44221 | 29 |
| 32 | 6·19072 | 64936 | 86742 | 7·01191 | 12014 | 20671 | 27886 | 34071 | 39484 | 44297 | 28 |
| 33 | 6·20409 | 65406 | 87027 | 7·01395 | 12174 | 20802 | 27997 | 34167 | 39569 | 44373 | 27 |
| 34 | 6·21705 | 65870 | 87310 | 7·01599 | 12333 | 20932 | 28107 | 34263 | 39654 | 44449 | 26 |
| 35 | 6·22964 | 66330 | 87591 | 7·01801 | 12491 | 21062 | 28217 | 34359 | 39738 | 44524 | 25 |
| 36 | 6·24188 | 66785 | 87870 | 7·02003 | 12648 | 21191 | 28327 | 34454 | 39822 | 44600 | 24 |
| 37 | 6·25378 | 67235 | 88147 | 7·02203 | 12805 | 21320 | 28437 | 34549 | 39906 | 44675 | 23 |
| 38 | 6·26536 | 67680 | 88423 | 7·02403 | 12962 | 21449 | 28546 | 34644 | 39990 | 44750 | 22 |
| 39 | 6·27664 | 68121 | 88697 | 7·02602 | 13118 | 21577 | 28655 | 34739 | 40074 | 44825 | 21 |
| 40 | 6·28763 | 68557 | 88969 | 7·02800 | 13273 | 21705 | 28763 | 34833 | 40158 | 44900 | 20 |
| 41 | 6·29836 | 68990 | 89240 | 7·02997 | 13428 | 21833 | 28872 | 34928 | 40241 | 44975 | 19 |
| 42 | 6·30882 | 69418 | 89509 | 7·03193 | 13582 | 21960 | 28980 | 35022 | 40324 | 45050 | 18 |
| 43 | 6·31904 | 69841 | 89776 | 7·03388 | 13736 | 22087 | 29088 | 35116 | 40408 | 45124 | 17 |
| 44 | 6·32903 | 70261 | 90042 | 7·03582 | 13889 | 22213 | 29196 | 35209 | 40491 | 45199 | 16 |
| 45 | 6.33879 | 70676 | 90306 | 7·03776 | 14042 | 22339 | 29303 | 35303 | 40573 | 45273 | 15 |
| 46 | 6·34833 | 71088 | 90568 | 7·03968 | 14194 | 22465 | 29410 | 35396 | 40656 | 45347 | 14 |
| 47 | 6·35767 | 71496 | 90829 | 7·04160 | 14346 | 22590 | 29517 | 35489 | 40739 | 45421 | 13 |
| 48 | 6·36682 | 71900 | 91088 | 7·04351 | 14497 | 22715 | 29623 | 35582 | 40821 | 45495 | 12 |
| 49 | 6·37577 | 72300 | 91346 | 7·04541 | 14647 | 22840 | 29730 | 35675 | 40903 | 45569 | 11 |
| 50 | 6·38454 | 72697 | 91602 | 7·04730 | 14797 | 22964 | 29836 | 35767 | 40985 | 45643 | 10 |
| 51 | 6·39315 | 73090 | 91857 | 7·04919 | 14947 | 23088 | 29942 | 35860 | 41067 | 45716 | 9 |
| 52 | 6·40158 | 73479 | 92110 | 7·05106 | 15096 | 23212 | 30047 | 35952 | 41149 | 45790 | 8 |
| 53 | 6·40985 | 73865 | 92362 | 7·05293 | 15244 | 23335 | 30152 | 36044 | 41230 | 45863 | 7 |
| 54 | 6·41797 | 74248 | 92612 | 7·05479 | 15392 | 23458 | 30257 | 36135 | 41312 | 45936 | 6 |
| 55 | 6·42594 | 74627 | 92861 | 7·05664 | 15540 | 23580 | 30362 | 36227 | 41393 | 46009 | 5 |
| 56 | 6·43376 | 75003 | 93109 | 7·05849 | 15687 | 23702 | 30467 | 36318 | 41474 | 46082 | 4 |
| 57 | 6·44145 | 75376 | 93355 | 7·06032 | 15833 | 23824 | 30571 | 36409 | 41555 | 46155 | 3 |
| 58 | 6·44900 | 75746 | 93599 | 7·06215 | 15979 | 23946 | 30675 | 36500 | 41636 | 46228 | 2 |
| 59 | 6·45643 | 76112 | 93843 | 7·06397 | 16125 | 24067 | 30779 | 36591 | 41716 | 46300 | 1 |
| 60 | 6·46373 | 76476 | 94085 | 7·06579 | 16270 | 24188 | 30882 | 36682 | 41797 | 46373 | 0 |
| ″ | 89° 59′ | 89° 58′ | 89° 57′ | 89° 56′ | 89° 55′ | 89° 54′ | 89° 53′ | 89° 52′ | 89° 51′ | 89° 50′ | ″ |

COSINE

## LOG. SINES OF SMALL ARCS TO EACH SECOND

| '' | 0° 10' | 0° 11' | 0° 12' | 0° 13' | 0° 14' | 0° 15' | 0° 16' | 0° 17' | 0° 18' | 0° 19' | '' |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7. | 7. | 7. | 7. | 7. | 7. | 7. | 7. | 7. | 7. | |
| 0 | 46373 | 50512 | 54291 | 57767 | 60985 | 63982 | 66784 | 69417 | 71900 | 74248 | 60 |
| 1 | 46445 | 50578 | 54351 | 57822 | 61037 | 64030 | 66830 | 69460 | 71940 | 74286 | 59 |
| 2 | 46517 | 50643 | 54411 | 57878 | 61089 | 64078 | 66875 | 69502 | 71980 | 74324 | 58 |
| 3 | 46589 | 50709 | 54471 | 57934 | 61140 | 64126 | 66920 | 69545 | 72020 | 74362 | 57 |
| 4 | 46661 | 50774 | 54531 | 57989 | 61192 | 64174 | 66965 | 69587 | 72060 | 74400 | 56 |
| 5 | 46733 | 50840 | 54591 | 58044 | 61243 | 64222 | 67010 | 69630 | 72100 | 74438 | 55 |
| 6 | 46805 | 50905 | 54651 | 58100 | 61294 | 64270 | 67055 | 69672 | 72140 | 74476 | 54 |
| 7 | 46876 | 50970 | 54711 | 58155 | 61346 | 64318 | 67100 | 69714 | 72180 | 74514 | 53 |
| 8 | 46948 | 51035 | 54771 | 58210 | 61397 | 64366 | 67145 | 69757 | 72220 | 74551 | 52 |
| 9 | 47019 | 51100 | 54830 | 58265 | 61448 | 64414 | 67190 | 69799 | 72260 | 74589 | 51 |
| 10 | 47090 | 51165 | 54890 | 58320 | 61499 | 64461 | 67234 | 69841 | 72300 | 74627 | 50 |
| 11 | 47162 | 51230 | 54949 | 58375 | 61550 | 64509 | 67279 | 69883 | 72340 | 74665 | 49 |
| 12 | 47233 | 51294 | 55008 | 58430 | 61601 | 64557 | 67324 | 69925 | 72380 | 74703 | 48 |
| 13 | 47303 | 51359 | 55068 | 58485 | 61652 | 64604 | 67369 | 69967 | 72419 | 74740 | 47 |
| 14 | 47374 | 51423 | 55127 | 58539 | 61703 | 64652 | 67413 | 70009 | 72459 | 74778 | 46 |
| 15 | 47445 | 51488 | 55186 | 58594 | 61754 | 64699 | 67458 | 70051 | 72499 | 74815 | 45 |
| 16 | 47515 | 51552 | 55245 | 58649 | 61805 | 64747 | 67502 | 70093 | 72538 | 74853 | 44 |
| 17 | 47586 | 51616 | 55304 | 58703 | 61855 | 64794 | 67547 | 70135 | 72578 | 74891 | 43 |
| 18 | 47656 | 51680 | 55363 | 58758 | 61906 | 64842 | 67591 | 70177 | 72618 | 74928 | 42 |
| 19 | 47726 | 51744 | 55422 | 58812 | 61957 | 64889 | 67636 | 70219 | 72657 | 74966 | 41 |
| 20 | 47797 | 51808 | 55481 | 58866 | 62007 | 64936 | 67680 | 70261 | 72697 | 75003 | 40 |
| 21 | 47867 | 51872 | 55539 | 58921 | 62058 | 64983 | 67724 | 70302 | 72736 | 75040 | 39 |
| 22 | 47936 | 51936 | 55598 | 58975 | 62108 | 65030 | 67768 | 70344 | 72775 | 75078 | 38 |
| 23 | 48006 | 51999 | 55656 | 59029 | 62158 | 65078 | 67813 | 70386 | 72815 | 75115 | 37 |
| 24 | 48076 | 52063 | 55715 | 59083 | 62209 | 65125 | 67857 | 70427 | 72854 | 75153 | 36 |
| 25 | 48145 | 52126 | 55773 | 59137 | 62259 | 65172 | 67901 | 70469 | 72894 | 75190 | 35 |
| 26 | 48215 | 52190 | 55831 | 59191 | 62309 | 65218 | 67945 | 70510 | 72933 | 75227 | 34 |
| 27 | 48284 | 52253 | 55889 | 59245 | 62359 | 65265 | 67989 | 70552 | 72972 | 75264 | 33 |
| 28 | 48353 | 52316 | 55948 | 59299 | 62409 | 65312 | 68033 | 70593 | 73011 | 75302 | 32 |
| 29 | 48422 | 52379 | 56006 | 59352 | 62459 | 65359 | 68077 | 70635 | 73050 | 75339 | 31 |
| 30 | 48491 | 52442 | 56064 | 59406 | 62509 | 65406 | 68121 | 70676 | 73090 | 75376 | 30 |
| 31 | 48560 | 52505 | 56121 | 59459 | 62559 | 65452 | 68165 | 70718 | 73129 | 75413 | 29 |
| 32 | 48629 | 52568 | 56179 | 59513 | 62609 | 65499 | 68208 | 70759 | 73168 | 75450 | 28 |
| 33 | 48698 | 52631 | 56237 | 59566 | 62659 | 65545 | 68252 | 70800 | 73207 | 75487 | 27 |
| 34 | 48766 | 52693 | 56295 | 59620 | 62708 | 65592 | 68296 | 70841 | 73246 | 75524 | 26 |
| 35 | 48835 | 52756 | 56352 | 59673 | 62758 | 65638 | 68340 | 70883 | 73285 | 75561 | 25 |
| 36 | 48903 | 52818 | 56410 | 59726 | 62808 | 65685 | 68383 | 70924 | 73324 | 75598 | 24 |
| 37 | 48971 | 52881 | 56467 | 59780 | 62857 | 65731 | 68427 | 70965 | 73363 | 75635 | 23 |
| 38 | 49039 | 52943 | 56524 | 59833 | 62907 | 65778 | 68470 | 71006 | 73401 | 75672 | 22 |
| 39 | 49107 | 53005 | 56582 | 59886 | 62956 | 65824 | 68514 | 71047 | 73440 | 75709 | 21 |
| 40 | 49175 | 53067 | 56639 | 59939 | 63006 | 65870 | 68557 | 71088 | 73479 | 75745 | 20 |
| 41 | 49243 | 53129 | 56696 | 59992 | 63055 | 65916 | 68601 | 71129 | 73518 | 75782 | 19 |
| 42 | 49311 | 53191 | 56753 | 60045 | 63104 | 65962 | 68644 | 71170 | 73557 | 75819 | 18 |
| 43 | 49379 | 53253 | 56810 | 60097 | 63153 | 66008 | 68687 | 71211 | 73595 | 75856 | 17 |
| 44 | 49446 | 53315 | 56867 | 60150 | 63203 | 66055 | 68731 | 71251 | 73634 | 75892 | 16 |
| 45 | 49513 | 53376 | 56924 | 60203 | 63252 | 66101 | 68774 | 71292 | 73673 | 75929 | 15 |
| 46 | 49581 | 53438 | 56980 | 60255 | 63301 | 66146 | 68817 | 71333 | 73711 | 75966 | 14 |
| 47 | 49648 | 53499 | 57037 | 60308 | 63350 | 66192 | 68860 | 71374 | 73750 | 76002 | 13 |
| 48 | 49715 | 53561 | 57094 | 60360 | 63399 | 66238 | 68903 | 71414 | 73788 | 76039 | 12 |
| 49 | 49782 | 53622 | 57150 | 60413 | 63448 | 66284 | 68946 | 71455 | 73827 | 76075 | 11 |
| 50 | 49849 | 53683 | 57206 | 60465 | 63496 | 66330 | 68989 | 71496 | 73865 | 76112 | 10 |
| 51 | 49916 | 53744 | 57263 | 60517 | 63545 | 66375 | 69032 | 71536 | 73904 | 76148 | 9 |
| 52 | 49982 | 53805 | 57319 | 60570 | 63594 | 66421 | 69075 | 71577 | 73942 | 76185 | 8 |
| 53 | 50049 | 53866 | 57375 | 60622 | 63642 | 66467 | 69118 | 71617 | 73980 | 76221 | 7 |
| 54 | 50115 | 53927 | 57431 | 60674 | 63691 | 66512 | 69161 | 71658 | 74019 | 76258 | 6 |
| 55 | 50182 | 53988 | 57488 | 60726 | 63740 | 66558 | 69204 | 71698 | 74057 | 76294 | 5 |
| 56 | 50248 | 54049 | 57544 | 60778 | 63788 | 66603 | 69247 | 71739 | 74095 | 76330 | 4 |
| 57 | 50314 | 54109 | 57599 | 60830 | 63837 | 66649 | 69289 | 71779 | 74133 | 76367 | 3 |
| 58 | 50380 | 54170 | 57655 | 60882 | 63885 | 66694 | 69332 | 71819 | 74171 | 76403 | 2 |
| 59 | 50446 | 54230 | 57711 | 60934 | 63933 | 66739 | 69375 | 71859 | 74210 | 76439 | 1 |
| 60 | 50512 | 54291 | 57767 | 60985 | 63982 | 66784 | 69417 | 71900 | 74248 | 76475 | 0 |
| '' | 89° 49' | 89° 48' | 89° 47' | 89° 46' | 89° 45' | 89° 44' | 89° 43' | 89° 42' | 89° 41' | 89° 40' | '' |

COSINE

## LOG. SINES OF SMALL ARCS TO EACH SECOND

| ″ | 0° 20′ | 0° 21′ | 0° 22′ | 0° 23′ | 0° 24′ | 0° 25′ | 0° 26′ | 0° 27′ | 0° 28′ | 0° 29′ | ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7. | 7. | 7. | 7. | 7. | 7. | 7. | 7. | 7. | 7. | |
| 0 | 76475 | 78594 | 80615 | 82545 | 84393 | 86166 | 87870 | 89509 | 91088 | 92612 | 60 |
| 1 | 76512 | 78629 | 80647 | 82577 | 84424 | 86195 | 87897 | 89535 | 91114 | 92637 | 59 |
| 2 | 76548 | 78663 | 80680 | 82608 | 84454 | 86224 | 87925 | 89562 | 91140 | 92662 | 58 |
| 3 | 76584 | 78698 | 80713 | 82639 | 84484 | 86253 | 87953 | 89589 | 91165 | 92687 | 57 |
| 4 | 76620 | 78732 | 80746 | 82671 | 84514 | 86282 | 87981 | 89616 | 91191 | 92712 | 56 |
| 5 | 76656 | 78766 | 80779 | 82702 | 84544 | 86311 | 88008 | 89642 | 91217 | 92737 | 55 |
| 6 | 76692 | 78801 | 80812 | 82733 | 84574 | 86340 | 88036 | 89669 | 91243 | 92761 | 54 |
| 7 | 76728 | 78835 | 80844 | 82765 | 84604 | 86368 | 88064 | 89696 | 91269 | 92786 | 53 |
| 8 | 76764 | 78869 | 80877 | 82796 | 84634 | 86397 | 88092 | 89722 | 91294 | 92811 | 52 |
| 9 | 76800 | 78903 | 80910 | 82827 | 84664 | 86426 | 88119 | 89749 | 91320 | 92836 | 51 |
| 10 | 76836 | 78938 | 80942 | 82859 | 84694 | 86455 | 88147 | 89776 | 91346 | 92861 | 50 |
| 11 | 76872 | 78972 | 80975 | 82890 | 84724 | 86484 | 88175 | 89802 | 91371 | 92886 | 49 |
| 12 | 76907 | 79006 | 81008 | 82921 | 84754 | 86512 | 88202 | 89829 | 91397 | 92910 | 48 |
| 13 | 76943 | 79040 | 81040 | 82952 | 84784 | 86541 | 88230 | 89856 | 91423 | 92935 | 47 |
| 14 | 76979 | 79074 | 81073 | 82983 | 84814 | 86570 | 88258 | 89882 | 91448 | 92960 | 46 |
| 15 | 77015 | 79108 | 81105 | 83015 | 84843 | 86598 | 88285 | 89909 | 91474 | 92985 | 45 |
| 16 | 77051 | 79142 | 81138 | 83046 | 84873 | 86627 | 88313 | 89935 | 91500 | 93009 | 44 |
| 17 | 77086 | 79176 | 81170 | 83077 | 84903 | 86656 | 88340 | 89962 | 91525 | 93034 | 43 |
| 18 | 77122 | 79210 | 81203 | 83108 | 84933 | 86684 | 88368 | 89988 | 91551 | 93059 | 42 |
| 19 | 77158 | 79244 | 81235 | 83139 | 84963 | 86713 | 88395 | 90015 | 91576 | 93084 | 41 |
| 20 | 77193 | 79278 | 81268 | 83170 | 84992 | 86741 | 88423 | 90041 | 91602 | 93108 | 40 |
| 21 | 77229 | 79312 | 81300 | 83201 | 85022 | 86770 | 88450 | 90068 | 91627 | 93133 | 39 |
| 22 | 77264 | 79346 | 81332 | 83232 | 85052 | 86799 | 88478 | 90094 | 91653 | 93158 | 38 |
| 23 | 77300 | 79380 | 81365 | 83263 | 85082 | 86827 | 88505 | 90121 | 91678 | 93182 | 37 |
| 24 | 77335 | 79414 | 81397 | 83294 | 85111 | 86856 | 88533 | 90147 | 91704 | 93207 | 36 |
| 25 | 77371 | 79448 | 81429 | 83325 | 85141 | 86884 | 88560 | 90174 | 91729 | 93231 | 35 |
| 26 | 77406 | 79481 | 81462 | 83356 | 85171 | 86913 | 88587 | 90200 | 91755 | 93256 | 34 |
| 27 | 77442 | 79515 | 81494 | 83387 | 85200 | 86941 | 88615 | 90226 | 91780 | 93281 | 33 |
| 28 | 77477 | 79549 | 81526 | 83417 | 85230 | 86969 | 88642 | 90253 | 91806 | 93305 | 32 |
| 29 | 77512 | 79582 | 81558 | 83448 | 85259 | 86998 | 88669 | 90279 | 91831 | 93330 | 31 |
| 30 | 77548 | 79616 | 81591 | 83479 | 85289 | 87026 | 88697 | 90305 | 91857 | 93354 | 30 |
| 31 | 77583 | 79650 | 81623 | 83510 | 85318 | 87055 | 88724 | 90332 | 91882 | 93379 | 29 |
| 32 | 77618 | 79683 | 81655 | 83541 | 85348 | 87083 | 88751 | 90358 | 91907 | 93403 | 28 |
| 33 | 77654 | 79717 | 81687 | 83571 | 85377 | 87111 | 88779 | 90384 | 91933 | 93428 | 27 |
| 34 | 77689 | 79751 | 81719 | 83602 | 85407 | 87140 | 88806 | 90411 | 91958 | 93452 | 26 |
| 35 | 77724 | 79784 | 81751 | 83633 | 85436 | 87168 | 88833 | 90437 | 91983 | 93477 | 25 |
| 36 | 77759 | 79818 | 81783 | 83663 | 85466 | 87196 | 88860 | 90463 | 92009 | 93501 | 24 |
| 37 | 77794 | 79851 | 81815 | 83694 | 85495 | 87224 | 88888 | 90489 | 92034 | 93526 | 23 |
| 38 | 77829 | 79885 | 81847 | 83725 | 85525 | 87253 | 88915 | 90515 | 92059 | 93550 | 22 |
| 39 | 77864 | 79918 | 81879 | 83755 | 85554 | 87281 | 88942 | 90542 | 92085 | 93575 | 21 |
| 40 | 77899 | 79952 | 81911 | 83786 | 85583 | 87309 | 88969 | 90568 | 92110 | 93599 | 20 |
| 41 | 77934 | 79985 | 81943 | 83817 | 85613 | 87337 | 88996 | 90594 | 92135 | 93623 | 19 |
| 42 | 77969 | 80018 | 81975 | 83847 | 85642 | 87366 | 89023 | 90620 | 92160 | 93648 | 18 |
| 43 | 78004 | 80052 | 82007 | 83878 | 85671 | 87394 | 89050 | 90646 | 92186 | 93672 | 17 |
| 44 | 78039 | 80085 | 82039 | 83908 | 85700 | 87422 | 89077 | 90672 | 92211 | 93696 | 16 |
| 45 | 78074 | 80118 | 82070 | 83939 | 85730 | 87450 | 89105 | 90698 | 92236 | 93721 | 15 |
| 46 | 78109 | 80152 | 82102 | 83969 | 85759 | 87478 | 89132 | 90725 | 92261 | 93745 | 14 |
| 47 | 78144 | 80185 | 82134 | 84000 | 85788 | 87506 | 89159 | 90751 | 92286 | 93769 | 13 |
| 48 | 78179 | 80218 | 82166 | 84030 | 85817 | 87534 | 89186 | 90777 | 92311 | 93794 | 12 |
| 49 | 78213 | 80251 | 82198 | 84060 | 85847 | 87562 | 89213 | 90803 | 92336 | 93818 | 11 |
| 50 | 78248 | 80284 | 82229 | 84091 | 85876 | 87590 | 89240 | 90829 | 92362 | 93842 | 10 |
| 51 | 78283 | 80317 | 82261 | 84121 | 85905 | 87618 | 89267 | 90855 | 92387 | 93866 | 9 |
| 52 | 78318 | 80351 | 82293 | 84151 | 85934 | 87646 | 89294 | 90881 | 92412 | 93891 | 8 |
| 53 | 78352 | 80384 | 82324 | 84182 | 85963 | 87674 | 89320 | 90907 | 92437 | 93915 | 7 |
| 54 | 78387 | 80417 | 82356 | 84212 | 85992 | 87702 | 89347 | 90933 | 92462 | 93939 | 6 |
| 55 | 78422 | 80450 | 82387 | 84242 | 86021 | 87730 | 89374 | 90958 | 92487 | 93963 | 5 |
| 56 | 78456 | 80483 | 82419 | 84273 | 86050 | 87758 | 89401 | 90984 | 92512 | 93988 | 4 |
| 57 | 78491 | 80516 | 82451 | 84303 | 86079 | 87786 | 89428 | 91010 | 92537 | 94012 | 3 |
| 58 | 78525 | 80549 | 82482 | 84333 | 86108 | 87814 | 89455 | 91036 | 92562 | 94036 | 2 |
| 59 | 78560 | 80582 | 82514 | 84363 | 86137 | 87842 | 89482 | 91062 | 92587 | 94060 | 1 |
| 60 | 78594 | 80615 | 82545 | 84393 | 86166 | 87870 | 89509 | 91088 | 92612 | 94084 | 0 |
| ″ | 89° 39′ | 89° 38′ | 89° 37′ | 89° 36′ | 89° 35′ | 89° 34′ | 89° 33′ | 89° 32′ | 89° 31′ | 89° 30′ | ″ |

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## LOG. SINES OF SMALL ARCS TO EACH SECOND

| ″ | 0° 30′ | 0° 31′ | 0° 32′ | 0° 33′ | 0° 34′ | 0° 35′ | 0° 36′ | 0° 37′ | 0° 38′ | 0° 39′ | ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7· | 7· | 7· | 7· | | 8· | 8· | 8· | 8· | 8· | |
| 0 | 94084 | 95508 | 96887 | 98223 | 7·99520 | 00779 | 02002 | 03192 | 04350 | 05478 | 60 |
| 1 | 94108 | 95532 | 96910 | 98245 | 7·99541 | 00799 | 02022 | 03211 | 04369 | 05497 | 59 |
| 2 | 94132 | 95555 | 96932 | 98267 | 7·99562 | 00820 | 02042 | 03231 | 04388 | 05515 | 58 |
| 3 | 94157 | 95578 | 96955 | 98289 | 7·99584 | 00841 | 02062 | 03251 | 04407 | 05534 | 57 |
| 4 | 94181 | 95601 | 96977 | 98311 | 7·99605 | 00861 | 02082 | 03270 | 04426 | 05552 | 56 |
| 5 | 94205 | 95625 | 97000 | 98333 | 7·99626 | 00882 | 02102 | 03290 | 04445 | 05571 | 55 |
| 6 | 94229 | 95648 | 97022 | 98355 | 7·99647 | 00903 | 02123 | 03309 | 04464 | 05589 | 54 |
| 7 | 94253 | 95671 | 97045 | 98377 | 7·99669 | 00923 | 02143 | 03329 | 04483 | 05608 | 53 |
| 8 | 94277 | 95695 | 97068 | 98398 | 7·99690 | 00944 | 02163 | 03348 | 04502 | 05626 | 52 |
| 9 | 94301 | 95718 | 97090 | 98420 | 7·99711 | 00964 | 02183 | 03368 | 04521 | 05645 | 51 |
| 10 | 94325 | 95741 | 97113 | 98442 | 7·99732 | 00985 | 02203 | 03387 | 04540 | 05663 | 50 |
| 11 | 94349 | 95764 | 97135 | 98464 | 7·99753 | 01006 | 02223 | 03407 | 04559 | 05682 | 49 |
| 12 | 94373 | 95787 | 97158 | 98486 | 7·99775 | 01026 | 02243 | 03426 | 04578 | 05700 | 48 |
| 13 | 94397 | 95811 | 97180 | 98508 | 7·99796 | 01047 | 02263 | 03446 | 04597 | 05719 | 47 |
| 14 | 94421 | 95834 | 97202 | 98529 | 7·99817 | 01067 | 02283 | 03465 | 04616 | 05737 | 46 |
| 15 | 94445 | 95857 | 97225 | 98551 | 7·99838 | 01088 | 02303 | 03484 | 04635 | 05756 | 45 |
| 16 | 94469 | 95880 | 97247 | 98573 | 7·99859 | 01108 | 02323 | 03504 | 04654 | 05774 | 44 |
| 17 | 94492 | 95903 | 97270 | 98595 | 7·99880 | 01129 | 02343 | 03523 | 04673 | 05792 | 43 |
| 18 | 94516 | 95926 | 97292 | 98616 | 7·99901 | 01149 | 02362 | 03543 | 04692 | 05811 | 42 |
| 19 | 94540 | 95950 | 97315 | 98638 | 7·99922 | 01170 | 02382 | 03562 | 04710 | 05829 | 41 |
| 20 | 94564 | 95973 | 97337 | 98660 | 7·99943 | 01190 | 02402 | 03581 | 04729 | 05848 | 40 |
| 21 | 94588 | 95996 | 97359 | 98682 | 7·99965 | 01211 | 02422 | 03601 | 04748 | 05866 | 39 |
| 22 | 94612 | 96019 | 97382 | 98703 | 7·99986 | 01231 | 02442 | 03620 | 04767 | 05885 | 38 |
| 23 | 94636 | 96042 | 97404 | 98725 | 8·00007 | 01252 | 02462 | 03640 | 04786 | 05903 | 37 |
| 24 | 94659 | 96065 | 97426 | 98747 | 8·00028 | 01272 | 02482 | 03659 | 04805 | 05921 | 36 |
| 25 | 94683 | 96088 | 97449 | 98768 | 8·00049 | 01293 | 02502 | 03678 | 04824 | 05940 | 35 |
| 26 | 94707 | 96111 | 97471 | 98790 | 8·00070 | 01313 | 02522 | 03698 | 04843 | 05958 | 34 |
| 27 | 94731 | 96134 | 97493 | 98812 | 8·00091 | 01333 | 02542 | 03717 | 04861 | 05976 | 33 |
| 28 | 94755 | 96157 | 97516 | 98833 | 8·00112 | 01354 | 02561 | 03736 | 04880 | 05995 | 32 |
| 29 | 94778 | 96180 | 97538 | 98855 | 8·00133 | 01374 | 02581 | 03756 | 04899 | 06013 | 31 |
| 30 | 94802 | 96203 | 97560 | 98876 | 8·00154 | 01395 | 02601 | 03775 | 04918 | 06031 | 30 |
| 31 | 94826 | 96226 | 97583 | 98898 | 8·00175 | 01415 | 02621 | 03794 | 04937 | 06050 | 29 |
| 32 | 94849 | 96249 | 97605 | 98920 | 8·00196 | 01435 | 02641 | 03813 | 04955 | 06068 | 28 |
| 33 | 94873 | 96272 | 97627 | 98941 | 8·00217 | 01456 | 02661 | 03833 | 04974 | 06086 | 27 |
| 34 | 94897 | 96295 | 97649 | 98963 | 8·00238 | 01476 | 02680 | 03852 | 04993 | 06105 | 26 |
| 35 | 94921 | 96318 | 97672 | 98984 | 8·00259 | 01496 | 02700 | 03871 | 05012 | 06123 | 25 |
| 36 | 94944 | 96341 | 97694 | 99006 | 8·00279 | 01517 | 02720 | 03891 | 05030 | 06141 | 24 |
| 37 | 94968 | 96364 | 97716 | 99027 | 8·00300 | 01537 | 02740 | 03910 | 05049 | 06159 | 23 |
| 38 | 94991 | 96386 | 97738 | 99049 | 8·00321 | 01557 | 02759 | 03929 | 05068 | 06178 | 22 |
| 39 | 95015 | 96409 | 97760 | 99070 | 8·00342 | 01578 | 02779 | 03948 | 05087 | 06196 | 21 |
| 40 | 95039 | 96432 | 97782 | 99092 | 8·00363 | 01598 | 02799 | 03967 | 05105 | 06214 | 20 |
| 41 | 95062 | 96455 | 97805 | 99113 | 8·00384 | 01618 | 02819 | 03987 | 05124 | 06232 | 19 |
| 42 | 95086 | 96478 | 97827 | 99135 | 8·00405 | 01639 | 02838 | 04006 | 05143 | 06251 | 18 |
| 43 | 95109 | 96501 | 97849 | 99156 | 8·00426 | 01659 | 02858 | 04025 | 05161 | 06269 | 17 |
| 44 | 95133 | 96524 | 97871 | 99178 | 8·00447 | 01679 | 02878 | 04044 | 05180 | 06287 | 16 |
| 45 | 95157 | 96546 | 97893 | 99199 | 8·00467 | 01699 | 02898 | 04063 | 05199 | 06305 | 15 |
| 46 | 95180 | 96569 | 97915 | 99221 | 8·00488 | 01720 | 02917 | 04083 | 05218 | 06324 | 14 |
| 47 | 95204 | 96592 | 97937 | 99242 | 8·00509 | 01740 | 02937 | 04102 | 05236 | 06342 | 13 |
| 48 | 95227 | 96615 | 97959 | 99264 | 8·00530 | 01760 | 02957 | 04121 | 05255 | 06360 | 12 |
| 49 | 95251 | 96637 | 97981 | 99285 | 8·00551 | 01780 | 02976 | 04140 | 05274 | 06378 | 11 |
| 50 | 95274 | 96660 | 98003 | 99306 | 8·00571 | 01801 | 02996 | 04159 | 05292 | 06396 | 10 |
| 51 | 95298 | 96683 | 98025 | 99328 | 8·00592 | 01821 | 03016 | 04178 | 05311 | 06414 | 9 |
| 52 | 95321 | 96706 | 98048 | 99349 | 8·00613 | 01841 | 03035 | 04197 | 05329 | 06433 | 8 |
| 53 | 95344 | 96728 | 98070 | 99371 | 8·00634 | 01861 | 03055 | 04217 | 05348 | 06451 | 7 |
| 54 | 95368 | 96751 | 98092 | 99392 | 8·00654 | 01881 | 03074 | 04236 | 05367 | 06469 | 6 |
| 55 | 95391 | 96774 | 98114 | 99413 | 8·00675 | 01901 | 03094 | 04255 | 05385 | 06487 | 5 |
| 56 | 95415 | 96796 | 98136 | 99435 | 8·00696 | 01922 | 03114 | 04274 | 05404 | 06505 | 4 |
| 57 | 95438 | 96819 | 98157 | 99456 | 8·00717 | 01942 | 03133 | 04293 | 05422 | 06523 | 3 |
| 58 | 95461 | 96842 | 98179 | 99477 | 8·00737 | 01962 | 03153 | 04312 | 05441 | 06541 | 2 |
| 59 | 95485 | 96864 | 98201 | 99498 | 8·00758 | 01982 | 03172 | 04331 | 05460 | 06560 | 1 |
| 60 | 95508 | 96887 | 98223 | 99520 | 8·00779 | 02002 | 03192 | 04350 | 05478 | 06578 | 0 |
| ″ | 89° 29′ | 89° 28′ | 89° 27′ | 89° 26′ | 89° 25′ | 89° 24′ | 89° 23′ | 89° 22′ | 89° 21′ | 89° 20′ | ″ |

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## LOG. SINES OF SMALL ARCS TO EACH SECOND

| ″ | 0° 40′ | 0° 41′ | 0° 42′ | 0° 43′ | 0° 44′ | 0° 45′ | 0° 46′ | 0° 47′ | 0° 48′ | 0° 49′ | ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 8· | 8· | 8· | 8· | 8· | 8· | 8· | 8· | 8· | 8· | |
| 0 | 06578 | 07650 | 08696 | 09718 | 10717 | 11693 | 12647 | 13581 | 14495 | 15391 | 60 |
| 1 | 06596 | 07668 | 08714 | 09735 | 10733 | 11709 | 12663 | 13596 | 14510 | 15406 | 59 |
| 2 | 06614 | 07685 | 08731 | 09752 | 10750 | 11725 | 12679 | 13612 | 14525 | 15420 | 58 |
| 3 | 06632 | 07703 | 08748 | 09769 | 10766 | 11741 | 12694 | 13627 | 14541 | 15435 | 57 |
| 4 | 06650 | 07721 | 08765 | 09786 | 10782 | 11757 | 12710 | 13643 | 14556 | 15450 | 56 |
| 5 | 06668 | 07738 | 08783 | 09802 | 10799 | 11773 | 12726 | 13658 | 14571 | 15465 | 55 |
| 6 | 06686 | 07756 | 08800 | 09819 | 10815 | 11789 | 12741 | 13673 | 14586 | 15479 | 54 |
| 7 | 06704 | 07773 | 08817 | 09836 | 10832 | 11805 | 12757 | 13689 | 14601 | 15494 | 53 |
| 8 | 06722 | 07791 | 08834 | 09853 | 10848 | 11821 | 12773 | 13704 | 14616 | 15509 | 52 |
| 9 | 06740 | 07809 | 08851 | 09870 | 10864 | 11837 | 12788 | 13719 | 14631 | 15523 | 51 |
| 10 | 06758 | 07826 | 08868 | 09886 | 10881 | 11853 | 12804 | 13735 | 14646 | 15538 | 50 |
| 11 | 06776 | 07844 | 08886 | 09903 | 10897 | 11869 | 12820 | 13750 | 14661 | 15553 | 49 |
| 12 | 06794 | 07861 | 08903 | 09920 | 10914 | 11885 | 12835 | 13765 | 14676 | 15568 | 48 |
| 13 | 06812 | 07879 | 08920 | 09937 | 10930 | 11901 | 12851 | 13781 | 14691 | 15582 | 47 |
| 14 | 06830 | 07896 | 08937 | 09953 | 10946 | 11917 | 12867 | 13796 | 14706 | 15597 | 46 |
| 15 | 06848 | 07914 | 08954 | 09970 | 10963 | 11933 | 12882 | 13811 | 14721 | 15612 | 45 |
| 16 | 06866 | 07932 | 08971 | 09987 | 10979 | 11949 | 12898 | 13827 | 14736 | 15626 | 44 |
| 17 | 06884 | 07949 | 08988 | 10004 | 10995 | 11965 | 12914 | 13842 | 14751 | 15641 | 43 |
| 18 | 06902 | 07967 | 09006 | 10020 | 11012 | 11981 | 12929 | 13857 | 14766 | 15656 | 42 |
| 19 | 06920 | 07984 | 09023 | 10037 | 11028 | 11997 | 12945 | 13873 | 14781 | 15670 | 41 |
| 20 | 06938 | 08002 | 09040 | 10054 | 11044 | 12013 | 12961 | 13888 | 14796 | 15685 | 40 |
| 21 | 06956 | 08019 | 09057 | 10070 | 11061 | 12029 | 12976 | 13903 | 14811 | 15700 | 39 |
| 22 | 06974 | 08037 | 09074 | 10087 | 11077 | 12045 | 12992 | 13919 | 14826 | 15714 | 38 |
| 23 | 06992 | 08054 | 09091 | 10104 | 11093 | 12061 | 13007 | 13934 | 14841 | 15729 | 37 |
| 24 | 07010 | 08072 | 09108 | 10120 | 11110 | 12077 | 13023 | 13949 | 14856 | 15744 | 36 |
| 25 | 07028 | 08089 | 09125 | 10137 | 11126 | 12093 | 13039 | 13964 | 14871 | 15758 | 35 |
| 26 | 07046 | 08107 | 09142 | 10154 | 11142 | 12109 | 13054 | 13980 | 14886 | 15773 | 34 |
| 27 | 07063 | 08124 | 09159 | 10170 | 11159 | 12125 | 13070 | 13995 | 14901 | 15788 | 33 |
| 28 | 07081 | 08141 | 09176 | 10187 | 11175 | 12141 | 13085 | 14010 | 14915 | 15802 | 32 |
| 29 | 07099 | 08159 | 09193 | 10204 | 11191 | 12157 | 13101 | 14025 | 14930 | 15817 | 31 |
| 30 | 07117 | 08176 | 09210 | 10220 | 11207 | 12172 | 13117 | 14041 | 14945 | 15832 | 30 |
| 31 | 07135 | 08194 | 09227 | 10237 | 11224 | 12188 | 13132 | 14056 | 14960 | 15846 | 29 |
| 32 | 07153 | 08211 | 09244 | 10254 | 11240 | 12204 | 13148 | 14071 | 14975 | 15861 | 28 |
| 33 | 07171 | 08229 | 09261 | 10270 | 11256 | 12220 | 13163 | 14086 | 14990 | 15875 | 27 |
| 34 | 07189 | 08246 | 09278 | 10287 | 11272 | 12236 | 13179 | 14101 | 15005 | 15890 | 26 |
| 35 | 07206 | 08263 | 09295 | 10303 | 11289 | 12252 | 13194 | 14117 | 15020 | 15905 | 25 |
| 36 | 07224 | 08281 | 09312 | 10320 | 11305 | 12268 | 13210 | 14132 | 15035 | 15919 | 24 |
| 37 | 07242 | 08298 | 09329 | 10337 | 11321 | 12284 | 13225 | 14147 | 15050 | 15934 | 23 |
| 38 | 07260 | 08316 | 09346 | 10353 | 11337 | 12300 | 13241 | 14162 | 15065 | 15948 | 22 |
| 39 | 07278 | 08333 | 09363 | 10370 | 11354 | 12315 | 13256 | 14178 | 15079 | 15963 | 21 |
| 40 | 07295 | 08350 | 09380 | 10386 | 11370 | 12331 | 13272 | 14193 | 15094 | 15978 | 20 |
| 41 | 07313 | 08368 | 09397 | 10403 | 11386 | 12347 | 13287 | 14208 | 15109 | 15992 | 19 |
| 42 | 07331 | 08385 | 09414 | 10420 | 11402 | 12363 | 13303 | 14223 | 15124 | 16007 | 18 |
| 43 | 07349 | 08403 | 09431 | 10436 | 11418 | 12379 | 13318 | 14238 | 15139 | 16021 | 17 |
| 44 | 07367 | 08420 | 09448 | 10453 | 11435 | 12395 | 13334 | 14253 | 15154 | 16036 | 16 |
| 45 | 07384 | 08437 | 09465 | 10469 | 11451 | 12410 | 13349 | 14269 | 15169 | 16050 | 15 |
| 46 | 07402 | 08455 | 09482 | 10486 | 11467 | 12426 | 13365 | 14284 | 15183 | 16065 | 14 |
| 47 | 07420 | 08472 | 09499 | 10502 | 11483 | 12442 | 13380 | 14299 | 15198 | 16079 | 13 |
| 48 | 07438 | 08489 | 09516 | 10519 | 11499 | 12458 | 13396 | 14314 | 15213 | 16094 | 12 |
| 49 | 07455 | 08506 | 09533 | 10535 | 11515 | 12474 | 13411 | 14329 | 15228 | 16109 | 11 |
| 50 | 07473 | 08524 | 09550 | 10552 | 11531 | 12489 | 13427 | 14344 | 15243 | 16123 | 10 |
| 51 | 07491 | 08541 | 09567 | 10568 | 11548 | 12505 | 13442 | 14359 | 15258 | 16138 | 9 |
| 52 | 07509 | 08558 | 09583 | 10585 | 11564 | 12521 | 13458 | 14375 | 15272 | 16152 | 8 |
| 53 | 07526 | 08576 | 09600 | 10601 | 11580 | 12537 | 13473 | 14390 | 15287 | 16167 | 7 |
| 54 | 07544 | 08593 | 09617 | 10618 | 11596 | 12553 | 13489 | 14405 | 15302 | 16181 | 6 |
| 55 | 07562 | 08610 | 09634 | 10634 | 11612 | 12568 | 13504 | 14420 | 15317 | 16196 | 5 |
| 56 | 07579 | 08627 | 09651 | 10651 | 11628 | 12584 | 13519 | 14435 | 15332 | 16210 | 4 |
| 57 | 07597 | 08645 | 09668 | 10667 | 11644 | 12600 | 13535 | 14450 | 15346 | 16225 | 3 |
| 58 | 07615 | 08662 | 09685 | 10684 | 11660 | 12616 | 13550 | 14465 | 15361 | 16239 | 2 |
| 59 | 07632 | 08679 | 09701 | 10700 | 11677 | 12631 | 13566 | 14480 | 15376 | 16254 | 1 |
| 60 | 07650 | 08696 | 09718 | 10717 | 11693 | 12647 | 13581 | 14495 | 15391 | 16268 | 0 |
| ″ | 89° 19′ | 89° 18′ | 89° 17′ | 89° 16′ | 89° 15′ | 89° 14′ | 89° 13′ | 89° 12′ | 89° 11′ | 89° 10′ | ″ |

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## LOG. SINES OF SMALL ARCS TO EACH SECOND

| ″ | 0° 50′ | 0° 51′ | 0° 52′ | 0° 53′ | 0° 54′ | 0° 55′ | 0° 56′ | 0° 57′ | 0° 58′ | 0° 59′ | ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 8· | 8· | 8· | 8· | 8· | 8· | 8· | 8· | 8· | 8· | |
| 0 | 16268 | 17128 | 17971 | 18798 | 19610 | 20407 | 21189 | 21958 | 22713 | 23456 | 60 |
| 1 | 16283 | 17142 | 17985 | 18812 | 19624 | 20420 | 21202 | 21971 | 22726 | 23468 | 59 |
| 2 | 16297 | 17156 | 17999 | 18826 | 19637 | 20433 | 21215 | 21983 | 22738 | 23480 | 58 |
| 3 | 16311 | 17171 | 18013 | 18839 | 19650 | 20446 | 21228 | 21996 | 22751 | 23492 | 57 |
| 4 | 16326 | 17185 | 18027 | 18853 | 19664 | 20460 | 21241 | 22009 | 22763 | 23505 | 56 |
| 5 | 16340 | 17199 | 18041 | 18867 | 19677 | 20473 | 21254 | 22022 | 22776 | 23517 | 55 |
| 6 | 16355 | 17213 | 18055 | 18880 | 19691 | 20486 | 21267 | 22034 | 22788 | 23529 | 54 |
| 7 | 16369 | 17227 | 18069 | 18894 | 19704 | 20499 | 21280 | 22047 | 22801 | 23541 | 53 |
| 8 | 16384 | 17241 | 18082 | 18908 | 19717 | 20512 | 21293 | 22060 | 22813 | 23554 | 52 |
| 9 | 16398 | 17256 | 18096 | 18921 | 19731 | 20525 | 21306 | 22072 | 22826 | 23566 | 51 |
| 10 | 16413 | 17270 | 18110 | 18935 | 19744 | 20538 | 21319 | 22085 | 22838 | 23578 | 50 |
| 11 | 16427 | 17284 | 18124 | 18948 | 19757 | 20552 | 21331 | 22098 | 22850 | 23590 | 49 |
| 12 | 16441 | 17298 | 18138 | 18962 | 19771 | 20565 | 21344 | 22110 | 22863 | 23603 | 48 |
| 13 | 16456 | 17312 | 18152 | 18976 | 19784 | 20578 | 21357 | 22123 | 22875 | 23615 | 47 |
| 14 | 16470 | 17326 | 18166 | 18989 | 19797 | 20591 | 21370 | 22136 | 22888 | 23627 | 46 |
| 15 | 16485 | 17340 | 18180 | 19003 | 19811 | 20604 | 21383 | 22148 | 22900 | 23639 | 45 |
| 16 | 16499 | 17355 | 18193 | 19016 | 19824 | 20617 | 21396 | 22161 | 22913 | 23652 | 44 |
| 17 | 16513 | 17369 | 18207 | 19030 | 19837 | 20630 | 21409 | 22173 | 22925 | 23664 | 43 |
| 18 | 16528 | 17383 | 18221 | 19044 | 19851 | 20643 | 21422 | 22186 | 22937 | 23676 | 42 |
| 19 | 16542 | 17397 | 18235 | 19057 | 19864 | 20656 | 21434 | 22199 | 22950 | 23688 | 41 |
| 20 | 16557 | 17411 | 18249 | 19071 | 19877 | 20669 | 21447 | 22211 | 22962 | 23700 | 40 |
| 21 | 16571 | 17425 | 18263 | 19084 | 19891 | 20682 | 21460 | 22224 | 22975 | 23713 | 39 |
| 22 | 16585 | 17439 | 18276 | 19098 | 19904 | 20696 | 21473 | 22237 | 22987 | 23725 | 38 |
| 23 | 16600 | 17453 | 18290 | 19111 | 19917 | 20709 | 21486 | 22249 | 22999 | 23737 | 37 |
| 24 | 16614 | 17467 | 18304 | 19125 | 19931 | 20722 | 21499 | 22262 | 23012 | 23749 | 36 |
| 25 | 16628 | 17481 | 18318 | 19139 | 19944 | 20735 | 21511 | 22274 | 23024 | 23761 | 35 |
| 26 | 16643 | 17495 | 18332 | 19152 | 19957 | 20748 | 21524 | 22287 | 23037 | 23773 | 34 |
| 27 | 16657 | 17510 | 18345 | 19166 | 19971 | 20761 | 21537 | 22300 | 23049 | 23786 | 33 |
| 28 | 16672 | 17524 | 18359 | 19179 | 19984 | 20774 | 21550 | 22312 | 23061 | 23798 | 32 |
| 29 | 16686 | 17538 | 18373 | 19193 | 19997 | 20787 | 21563 | 22325 | 23074 | 23810 | 31 |
| 30 | 16700 | 17552 | 18387 | 19206 | 20010 | 20800 | 21576 | 22337 | 23086 | 23822 | 30 |
| 31 | 16715 | 17566 | 18401 | 19220 | 20024 | 20813 | 21588 | 22350 | 23098 | 23834 | 29 |
| 32 | 16729 | 17580 | 18414 | 19233 | 20037 | 20826 | 21601 | 22363 | 23111 | 23846 | 28 |
| 33 | 16743 | 17594 | 18428 | 19247 | 20050 | 20839 | 21614 | 22375 | 23123 | 23859 | 27 |
| 34 | 16757 | 17608 | 18442 | 19260 | 20064 | 20852 | 21627 | 22388 | 23136 | 23871 | 26 |
| 35 | 16772 | 17622 | 18456 | 19274 | 20077 | 20865 | 21640 | 22400 | 23148 | 23883 | 25 |
| 36 | 16786 | 17636 | 18469 | 19287 | 20090 | 20878 | 21652 | 22413 | 23160 | 23895 | 24 |
| 37 | 16800 | 17650 | 18483 | 19301 | 20103 | 20891 | 21665 | 22425 | 23173 | 23907 | 23 |
| 38 | 16815 | 17664 | 18497 | 19314 | 20117 | 20904 | 21678 | 22438 | 23185 | 23919 | 22 |
| 39 | 16829 | 17678 | 18511 | 19328 | 20130 | 20917 | 21691 | 22451 | 23197 | 23931 | 21 |
| 40 | 16843 | 17692 | 18524 | 19341 | 20143 | 20930 | 21703 | 22463 | 23210 | 23944 | 20 |
| 41 | 16858 | 17706 | 18538 | 19355 | 20156 | 20943 | 21716 | 22476 | 23222 | 23956 | 19 |
| 42 | 16872 | 17720 | 18552 | 19368 | 20170 | 20956 | 21729 | 22488 | 23234 | 23968 | 18 |
| 43 | 16886 | 17734 | 18566 | 19382 | 20183 | 20969 | 21742 | 22501 | 23247 | 23980 | 17 |
| 44 | 16900 | 17748 | 18579 | 19395 | 20196 | 20982 | 21754 | 22513 | 23259 | 23992 | 16 |
| 45 | 16915 | 17762 | 18593 | 19409 | 20209 | 20995 | 21767 | 22526 | 23271 | 24004 | 15 |
| 46 | 16929 | 17776 | 18607 | 19422 | 20222 | 21008 | 21780 | 22538 | 23284 | 24016 | 14 |
| 47 | 16943 | 17790 | 18621 | 19436 | 20236 | 21021 | 21793 | 22551 | 23296 | 24028 | 13 |
| 48 | 16957 | 17804 | 18634 | 19449 | 20249 | 21034 | 21805 | 22563 | 23308 | 24041 | 12 |
| 49 | 16972 | 17818 | 18648 | 19463 | 20262 | 21047 | 21818 | 22576 | 23321 | 24053 | 11 |
| 50 | 16986 | 17832 | 18662 | 19476 | 20275 | 21060 | 21831 | 22588 | 23333 | 24065 | 10 |
| 51 | 17000 | 17846 | 18675 | 19489 | 20288 | 21073 | 21844 | 22601 | 23345 | 24077 | 9 |
| 52 | 17014 | 17860 | 18689 | 19503 | 20302 | 21086 | 21856 | 22613 | 23357 | 24089 | 8 |
| 53 | 17029 | 17874 | 18703 | 19516 | 20315 | 21099 | 21869 | 22626 | 23370 | 24101 | 7 |
| 54 | 17043 | 17888 | 18716 | 19530 | 20328 | 21112 | 21882 | 22638 | 23382 | 24113 | 6 |
| 55 | 17057 | 17902 | 18730 | 19543 | 20341 | 21125 | 21895 | 22651 | 23394 | 24125 | 5 |
| 56 | 17071 | 17916 | 18744 | 19557 | 20354 | 21138 | 21907 | 22663 | 23407 | 24137 | 4 |
| 57 | 17085 | 17930 | 18757 | 19570 | 20368 | 21151 | 21920 | 22676 | 23419 | 24149 | 3 |
| 58 | 17100 | 17943 | 18771 | 19583 | 20381 | 21164 | 21933 | 22688 | 23431 | 24161 | 2 |
| 59 | 17114 | 17957 | 18785 | 19597 | 20394 | 21177 | 21945 | 22701 | 23443 | 24173 | 1 |
| 60 | 17128 | 17971 | 18798 | 19610 | 20407 | 21189 | 21958 | 22713 | 23456 | 24186 | 0 |
| ″ | 89° 9′ | 89° 8′ | 89° 7′ | 89° 6′ | 89° 5′ | 89° 4′ | 89° 3′ | 89° 2′ | 89° 1′ | 89° 0′ | ″ |

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## LOG. SINES OF SMALL ARCS TO EACH SECOND

| ″ | 1° 0′ | 1° 1′ | 1° 2′ | 1° 3′ | 1° 4′ | 1° 5′ | 1° 6′ | 1° 7′ | 1° 8′ | 1° 9′ | ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 8· | 8· | 8· | 8· | 8· | 8· | 8· | 8· | 8· | 8· | |
| 0 | 241855 | 249033 | 256094 | 263042 | 269881 | 276614 | 283243 | 289773 | 296207 | 302546 | 60 |
| 1 | 241976 | 249152 | 256211 | 263157 | 269994 | 276725 | 283353 | 289881 | 296313 | 302651 | 59 |
| 2 | 242097 | 249270 | 256328 | 263272 | 270107 | 276836 | 283463 | 289989 | 296420 | 302756 | 58 |
| 3 | 242217 | 249389 | 256444 | 263387 | 270220 | 276948 | 283572 | 290097 | 296526 | 302861 | 57 |
| 4 | 242338 | 249507 | 256561 | 263502 | 270333 | 277059 | 283682 | 290205 | 296632 | 302965 | 56 |
| 5 | 242458 | 249626 | 256678 | 263616 | 270446 | 277170 | 283791 | 290313 | 296739 | 303070 | 55 |
| 6 | 242578 | 249744 | 256794 | 263731 | 270559 | 277281 | 283901 | 290421 | 296845 | 303175 | 54 |
| 7 | 242699 | 249863 | 256911 | 263846 | 270672 | 277392 | 284010 | 290529 | 296951 | 303280 | 53 |
| 8 | 242819 | 249981 | 257027 | 263960 | 270785 | 277503 | 284120 | 290637 | 297057 | 303384 | 52 |
| 9 | 242940 | 250100 | 257144 | 264075 | 270898 | 277615 | 284229 | 290745 | 297164 | 303489 | 51 |
| 10 | 243060 | 250218 | 257260 | 264190 | 271010 | 277726 | 284339 | 290852 | 297270 | 303594 | 50 |
| 11 | 243180 | 250336 | 257376 | 264304 | 271123 | 277837 | 284448 | 290960 | 297376 | 303698 | 49 |
| 12 | 243300 | 250455 | 257493 | 264419 | 271236 | 277948 | 284557 | 291068 | 297482 | 303803 | 48 |
| 13 | 243421 | 250573 | 257609 | 264533 | 271349 | 278059 | 284667 | 291175 | 297588 | 303907 | 47 |
| 14 | 243541 | 250691 | 257725 | 264648 | 271461 | 278170 | 284776 | 291283 | 297694 | 304012 | 46 |
| 15 | 243661 | 250809 | 257842 | 264762 | 271574 | 278281 | 284885 | 291391 | 297800 | 304117 | 45 |
| 16 | 243781 | 250927 | 257958 | 264877 | 271687 | 278391 | 284994 | 291498 | 297906 | 304221 | 44 |
| 17 | 243901 | 251045 | 258074 | 264991 | 271799 | 278502 | 285104 | 291606 | 298012 | 304325 | 43 |
| 18 | 244021 | 251164 | 258190 | 265105 | 271912 | 278613 | 285213 | 291713 | 298118 | 304430 | 42 |
| 19 | 244141 | 251282 | 258307 | 265220 | 272024 | 278724 | 285322 | 291821 | 298224 | 304534 | 41 |
| 20 | 244261 | 251400 | 258423 | 265334 | 272137 | 278835 | 285431 | 291928 | 298330 | 304639 | 40 |
| 21 | 244381 | 251518 | 258539 | 265448 | 272249 | 278946 | 285540 | 292036 | 298436 | 304743 | 39 |
| 22 | 244501 | 251636 | 258655 | 265562 | 272362 | 279056 | 285649 | 292143 | 298542 | 304847 | 38 |
| 23 | 244621 | 251754 | 258771 | 265677 | 272474 | 279167 | 285758 | 292251 | 298648 | 304952 | 37 |
| 24 | 244741 | 251871 | 258887 | 265791 | 272587 | 279278 | 285867 | 292358 | 298754 | 305056 | 36 |
| 25 | 244860 | 251989 | 259003 | 265905 | 272699 | 279388 | 285976 | 292466 | 298859 | 305160 | 35 |
| 26 | 244980 | 252107 | 259119 | 266019 | 272811 | 279499 | 286085 | 292573 | 298965 | 305265 | 34 |
| 27 | 245100 | 252225 | 259235 | 266133 | 272924 | 279610 | 286194 | 292680 | 299071 | 305369 | 33 |
| 28 | 245220 | 252343 | 259351 | 266247 | 273036 | 279720 | 286303 | 292787 | 299177 | 305473 | 32 |
| 29 | 245339 | 252460 | 259466 | 266361 | 273148 | 279831 | 286412 | 292895 | 299282 | 305577 | 31 |
| 30 | 245459 | 252578 | 259582 | 266475 | 273260 | 279941 | 286521 | 293002 | 299388 | 305681 | 30 |
| 31 | 245579 | 252696 | 259698 | 266589 | 273373 | 280052 | 286629 | 293109 | 299494 | 305785 | 29 |
| 32 | 245698 | 252813 | 259814 | 266703 | 273485 | 280162 | 286738 | 293216 | 299599 | 305890 | 28 |
| 33 | 245818 | 252931 | 259929 | 266817 | 273597 | 280272 | 286847 | 293324 | 299705 | 305994 | 27 |
| 34 | 245937 | 253049 | 260045 | 266931 | 273709 | 280383 | 286956 | 293431 | 299810 | 306098 | 26 |
| 35 | 246057 | 253166 | 260161 | 267045 | 273821 | 280493 | 287064 | 293538 | 299916 | 306202 | 25 |
| 36 | 246176 | 253284 | 260276 | 267158 | 273933 | 280604 | 287173 | 293645 | 300021 | 306306 | 24 |
| 37 | 246296 | 253401 | 260392 | 267272 | 274045 | 280714 | 287282 | 293752 | 300127 | 306410 | 23 |
| 38 | 246415 | 253519 | 260508 | 267386 | 274157 | 280824 | 287390 | 293859 | 300232 | 306514 | 22 |
| 39 | 246534 | 253636 | 260623 | 267500 | 274269 | 280934 | 287499 | 293966 | 300338 | 306618 | 21 |
| 40 | 246654 | 253753 | 260739 | 267613 | 274381 | 281045 | 287608 | 294073 | 300443 | 306721 | 20 |
| 41 | 246773 | 253871 | 260854 | 267727 | 274493 | 281155 | 287716 | 294180 | 300549 | 306825 | 19 |
| 42 | 246892 | 253988 | 260970 | 267841 | 274605 | 281265 | 287825 | 294287 | 300654 | 306929 | 18 |
| 43 | 247011 | 254105 | 261085 | 267954 | 274717 | 281375 | 287933 | 294394 | 300759 | 307033 | 17 |
| 44 | 247131 | 254223 | 261200 | 268068 | 274828 | 281485 | 288042 | 294500 | 300865 | 307137 | 16 |
| 45 | 247250 | 254340 | 261316 | 268181 | 274940 | 281595 | 288150 | 294607 | 300970 | 307241 | 15 |
| 46 | 247369 | 254457 | 261431 | 268295 | 275052 | 281705 | 288259 | 294714 | 301075 | 307344 | 14 |
| 47 | 247488 | 254574 | 261546 | 268408 | 275164 | 281815 | 288367 | 294821 | 301180 | 307448 | 13 |
| 48 | 247607 | 254691 | 261662 | 268522 | 275275 | 281925 | 288475 | 294928 | 301286 | 307552 | 12 |
| 49 | 247726 | 254808 | 261777 | 268635 | 275387 | 282035 | 288584 | 295034 | 301391 | 307655 | 11 |
| 50 | 247845 | 254925 | 261892 | 268749 | 275499 | 282145 | 288692 | 295141 | 301496 | 307759 | 10 |
| 51 | 247964 | 255042 | 262007 | 268862 | 275610 | 282255 | 288800 | 295248 | 301601 | 307863 | 9 |
| 52 | 248083 | 255159 | 262122 | 268975 | 275722 | 282365 | 288908 | 295354 | 301706 | 307966 | 8 |
| 53 | 248202 | 255276 | 262237 | 269089 | 275833 | 282475 | 289017 | 295461 | 301811 | 308070 | 7 |
| 54 | 248321 | 255393 | 262353 | 269202 | 275945 | 282585 | 289125 | 295568 | 301916 | 308173 | 6 |
| 55 | 248440 | 255510 | 262468 | 269315 | 276057 | 282695 | 289233 | 295674 | 302021 | 308277 | 5 |
| 56 | 248558 | 255627 | 262583 | 269428 | 276168 | 282805 | 289341 | 295781 | 302126 | 308380 | 4 |
| 57 | 248677 | 255744 | 262698 | 269542 | 276279 | 282914 | 289449 | 295887 | 302231 | 308484 | 3 |
| 58 | 248796 | 255861 | 262813 | 269655 | 276391 | 283024 | 289557 | 295994 | 302336 | 308587 | 2 |
| 59 | 248914 | 255978 | 262927 | 269768 | 276502 | 283134 | 289665 | 296100 | 302441 | 308691 | 1 |
| 60 | 249033 | 256094 | 263042 | 269881 | 276614 | 283243 | 289773 | 296207 | 302546 | 308794 | 0 |
| ″ | 88° 59′ | 88° 58′ | 88° 57′ | 88° 56′ | 88° 55′ | 88° 54′ | 88° 53′ | 88° 52′ | 88° 51′ | 88° 50′ | ″ |

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## LOG. SINES OF SMALL ARCS TO EACH SECOND

| ″ | 1° 10′ | 1° 11′ | 1° 12′ | 1° 13′ | 1° 14′ | 1° 15′ | 1° 16′ | 1° 17′ | 1° 18′ | 1° 19′ | ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 8· | 8· | 8· | 8· | 8· | 8· | 8· | 8· | 8· | 8· | |
| 0 | 308794 | 314954 | 321027 | 327016 | 332924 | 338753 | 344504 | 350181 | 355783 | 361315 | 60 |
| 1 | 308898 | 315056 | 321127 | 327115 | 333022 | 338849 | 344600 | 350275 | 355876 | 361407 | 59 |
| 2 | 309001 | 315157 | 321228 | 327215 | 333120 | 338946 | 344695 | 350368 | 355969 | 361498 | 58 |
| 3 | 309104 | 315259 | 321328 | 327314 | 333218 | 339042 | 344790 | 350462 | 356062 | 361590 | 57 |
| 4 | 309208 | 315361 | 321429 | 327413 | 333315 | 339139 | 344885 | 350556 | 356154 | 361681 | 56 |
| 5 | 309311 | 315463 | 321529 | 327512 | 333413 | 339235 | 344980 | 350650 | 356247 | 361773 | 55 |
| 6 | 309414 | 315565 | 321630 | 327611 | 333511 | 339332 | 345075 | 350744 | 356340 | 361864 | 54 |
| 7 | 309517 | 315667 | 321730 | 327710 | 333608 | 339428 | 345170 | 350838 | 356432 | 361956 | 53 |
| 8 | 309620 | 315768 | 321830 | 327809 | 333706 | 339524 | 345265 | 350932 | 356525 | 362047 | 52 |
| 9 | 309724 | 315870 | 321931 | 327908 | 333804 | 339621 | 345361 | 351026 | 356618 | 362139 | 51 |
| 10 | 309827 | 315972 | 322031 | 328007 | 333901 | 339717 | 345456 | 351119 | 356710 | 362230 | 50 |
| 11 | 309930 | 316073 | 322131 | 328106 | 333999 | 339813 | 345551 | 351213 | 356803 | 362321 | 49 |
| 12 | 310033 | 316175 | 322231 | 328204 | 334096 | 339909 | 345646 | 351307 | 356895 | 362413 | 48 |
| 13 | 310136 | 316277 | 322332 | 328303 | 334194 | 340006 | 345740 | 351401 | 356988 | 362504 | 47 |
| 14 | 310239 | 316378 | 322432 | 328402 | 334291 | 340102 | 345835 | 351494 | 357080 | 362596 | 46 |
| 15 | 310342 | 316480 | 322532 | 328501 | 334389 | 340198 | 345930 | 351588 | 357173 | 362687 | 45 |
| 16 | 310445 | 316581 | 322632 | 328600 | 334486 | 340294 | 346025 | 351682 | 357265 | 362778 | 44 |
| 17 | 310548 | 316683 | 322732 | 328698 | 334584 | 340390 | 346120 | 351775 | 357358 | 362870 | 43 |
| 18 | 310651 | 316785 | 322832 | 328797 | 334681 | 340486 | 346215 | 351869 | 357450 | 362961 | 42 |
| 19 | 310754 | 316886 | 322932 | 328896 | 334779 | 340582 | 346310 | 351963 | 357543 | 363052 | 41 |
| 20 | 310857 | 316987 | 323033 | 328995 | 334876 | 340679 | 346405 | 352056 | 357635 | 363143 | 40 |
| 21 | 310960 | 317089 | 323133 | 329093 | 334973 | 340775 | 346499 | 352150 | 357728 | 363234 | 39 |
| 22 | 311063 | 317190 | 323233 | 329192 | 335071 | 340871 | 346594 | 352243 | 357820 | 363326 | 38 |
| 23 | 311166 | 317292 | 323333 | 329291 | 335168 | 340967 | 346689 | 352337 | 357912 | 363417 | 37 |
| 24 | 311268 | 317393 | 323433 | 329389 | 335265 | 341063 | 346784 | 352430 | 358005 | 363508 | 36 |
| 25 | 311371 | 317494 | 323533 | 329488 | 335362 | 341159 | 346878 | 352524 | 358097 | 363599 | 35 |
| 26 | 311474 | 317596 | 323632 | 329586 | 335460 | 341255 | 346973 | 352617 | 358189 | 363690 | 34 |
| 27 | 311577 | 317697 | 323732 | 329685 | 335557 | 341350 | 347068 | 352711 | 358281 | 363781 | 33 |
| 28 | 311679 | 317798 | 323832 | 329783 | 335654 | 341446 | 347162 | 352804 | 358374 | 363872 | 32 |
| 29 | 311782 | 317900 | 323932 | 329882 | 335751 | 341542 | 347257 | 352898 | 358466 | 363963 | 31 |
| 30 | 311885 | 318001 | 324032 | 329980 | 335848 | 341638 | 347352 | 352991 | 358558 | 364055 | 30 |
| 31 | 311987 | 318102 | 324132 | 330079 | 335946 | 341734 | 347446 | 353084 | 358650 | 364146 | 29 |
| 32 | 312090 | 318203 | 324232 | 330177 | 336043 | 341830 | 347541 | 353178 | 358742 | 364237 | 28 |
| 33 | 312193 | 318304 | 324331 | 330276 | 336140 | 341926 | 347635 | 353271 | 358835 | 364328 | 27 |
| 34 | 312295 | 318406 | 324431 | 330374 | 336237 | 342021 | 347730 | 353364 | 358927 | 364419 | 26 |
| 35 | 312398 | 318507 | 324531 | 330472 | 336334 | 342117 | 347824 | 353458 | 359019 | 364509 | 25 |
| 36 | 312500 | 318608 | 324630 | 330571 | 336431 | 342213 | 347919 | 353551 | 359111 | 364600 | 24 |
| 37 | 312603 | 318709 | 324730 | 330669 | 336528 | 342309 | 348013 | 353644 | 359203 | 364691 | 23 |
| 38 | 312705 | 318810 | 324830 | 330767 | 336625 | 342404 | 348108 | 353737 | 359295 | 364782 | 22 |
| 39 | 312808 | 318911 | 324929 | 330866 | 336722 | 342500 | 348202 | 353831 | 359387 | 364873 | 21 |
| 40 | 312910 | 319012 | 325029 | 330964 | 336819 | 342596 | 348297 | 353924 | 359479 | 364964 | 20 |
| 41 | 313013 | 319113 | 325129 | 331062 | 336916 | 342691 | 348391 | 354017 | 359571 | 365055 | 19 |
| 42 | 313115 | 319214 | 325228 | 331160 | 337013 | 342787 | 348485 | 354110 | 359663 | 365146 | 18 |
| 43 | 313217 | 319315 | 325328 | 331259 | 337109 | 342882 | 348580 | 354203 | 359755 | 365236 | 17 |
| 44 | 313320 | 319416 | 325427 | 331357 | 337206 | 342978 | 348674 | 354296 | 359847 | 365327 | 16 |
| 45 | 313422 | 319516 | 325527 | 331455 | 337303 | 343074 | 348768 | 354389 | 359939 | 365418 | 15 |
| 46 | 313524 | 319617 | 325626 | 331553 | 337400 | 343169 | 348863 | 354483 | 360031 | 365509 | 14 |
| 47 | 313626 | 319718 | 325726 | 331651 | 337497 | 343265 | 348957 | 354576 | 360122 | 365599 | 13 |
| 48 | 313729 | 319819 | 325825 | 331749 | 337593 | 343360 | 349051 | 354669 | 360214 | 365690 | 12 |
| 49 | 313831 | 319920 | 325924 | 331847 | 337690 | 343456 | 349145 | 354762 | 360306 | 365781 | 11 |
| 50 | 313933 | 320021 | 326024 | 331945 | 337787 | 343551 | 349240 | 354855 | 360398 | 365871 | 10 |
| 51 | 314035 | 320121 | 326123 | 332043 | 337884 | 343646 | 349334 | 354948 | 360490 | 365962 | 9 |
| 52 | 314137 | 320222 | 326223 | 332141 | 337980 | 343742 | 349428 | 355041 | 360582 | 366053 | 8 |
| 53 | 314239 | 320323 | 326322 | 332239 | 338077 | 343837 | 349522 | 355133 | 360673 | 366143 | 7 |
| 54 | 314342 | 320423 | 326421 | 332337 | 338174 | 343933 | 349616 | 355226 | 360765 | 366234 | 6 |
| 55 | 314444 | 320524 | 326520 | 332435 | 338270 | 344028 | 349710 | 355319 | 360857 | 366324 | 5 |
| 56 | 314546 | 320625 | 326620 | 332533 | 338367 | 344123 | 349804 | 355412 | 360948 | 366415 | 4 |
| 57 | 314648 | 320725 | 326719 | 332631 | 338463 | 344219 | 349898 | 355505 | 361040 | 366505 | 3 |
| 58 | 314750 | 320826 | 326818 | 332729 | 338560 | 344314 | 349993 | 355598 | 361132 | 366596 | 2 |
| 59 | 314852 | 320926 | 326917 | 332826 | 338656 | 344409 | 350087 | 355691 | 361223 | 366686 | 1 |
| 60 | 314954 | 321027 | 327016 | 3[illegible]4924 | 338753 | 344504 | 350181 | 355783 | 361315 | 366777 | 0 |
| ″ | 88° 49′ | 88° 48′ | 88° 47′ | 88° 46′ | 88° 45′ | 88° 44′ | 88° 43′ | 88° 42′ | 88° 41′ | 88° 40′ | ″ |

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## LOG. SINES OF SMALL ARCS TO EACH SECOND

| ″ | 1° 20′ | 1° 21′ | 1° 22′ | 1° 23′ | 1° 24′ | 1° 25′ | 1° 26′ | 1° 27′ | 1° 28′ | 1° 29′ | ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 8· | 8· | 8· | 8· | 8· | 8· | 8· | 8· | 8· | 8· | |
| 0 | 366777 | 372171 | 377499 | 382762 | 387962 | 393101 | 398179 | 403199 | 408161 | 413068 | 60 |
| 1 | 366867 | 372260 | 377587 | 382849 | 388048 | 393186 | 398263 | 403282 | 408244 | 413149 | 59 |
| 2 | 366958 | 372350 | 377675 | 382936 | 388134 | 393271 | 398348 | 403365 | 408326 | 413230 | 58 |
| 3 | 367048 | 372439 | 377763 | 383024 | 388221 | 393356 | 398432 | 403448 | 408408 | 413311 | 57 |
| 4 | 367139 | 372528 | 377852 | 383111 | 388307 | 393441 | 398516 | 403532 | 408490 | 413393 | 56 |
| 5 | 367229 | 372617 | 377940 | 383198 | 388393 | 393526 | 398600 | 403615 | 408572 | 413474 | 55 |
| 6 | 367319 | 372707 | 378028 | 383285 | 388479 | 393611 | 398684 | 403698 | 408654 | 413555 | 54 |
| 7 | 367410 | 372796 | 378116 | 383372 | 388565 | 393696 | 398768 | 403781 | 408737 | 413636 | 53 |
| 8 | 367500 | 372885 | 378204 | 383459 | 388651 | 393781 | 398852 | 403864 | 408819 | 413718 | 52 |
| 9 | 367590 | 372974 | 378292 | 383546 | 388737 | 393866 | 398936 | 403947 | 408901 | 413799 | 51 |
| 10 | 367681 | 373063 | 378380 | 383633 | 388823 | 393951 | 399020 | 404030 | 408983 | 413880 | 50 |
| 11 | 367771 | 373153 | 378469 | 383720 | 388909 | 394036 | 399104 | 404113 | 409065 | 413961 | 49 |
| 12 | 367861 | 373242 | 378557 | 383807 | 388995 | 394121 | 399188 | 404196 | 409147 | 414042 | 48 |
| 13 | 367951 | 373331 | 378645 | 383894 | 389081 | 394206 | 399272 | 404279 | 409229 | 414123 | 47 |
| 14 | 368042 | 373420 | 378733 | 383981 | 389167 | 394291 | 399356 | 404362 | 409311 | 414204 | 46 |
| 15 | 368132 | 373509 | 378821 | 384068 | 389253 | 394376 | 399440 | 404445 | 409393 | 414286 | 45 |
| 16 | 368222 | 373598 | 378909 | 384155 | 389338 | 394461 | 399524 | 404528 | 409475 | 414367 | 44 |
| 17 | 368312 | 373687 | 378997 | 384242 | 389424 | 394546 | 399607 | 404611 | 409557 | 414448 | 43 |
| 18 | 368402 | 373776 | 379084 | 384329 | 389510 | 394631 | 399691 | 404694 | 409639 | 414529 | 42 |
| 19 | 368492 | 373865 | 379172 | 384415 | 389596 | 394715 | 399775 | 404777 | 409721 | 414610 | 41 |
| 20 | 368582 | 373954 | 379260 | 384502 | 389682 | 394800 | 399859 | 404859 | 409803 | 414691 | 40 |
| 21 | 368672 | 374043 | 379348 | 384589 | 389768 | 394885 | 399943 | 404942 | 409885 | 414772 | 39 |
| 22 | 368763 | 374132 | 379436 | 384676 | 389853 | 394970 | 400027 | 405025 | 409967 | 414853 | 38 |
| 23 | 368853 | 374221 | 379524 | 384763 | 389939 | 395055 | 400110 | 405108 | 410049 | 414934 | 37 |
| 24 | 368943 | 374310 | 379612 | 384850 | 390025 | 395139 | 400194 | 405191 | 410131 | 415015 | 36 |
| 25 | 369033 | 374399 | 379700 | 384936 | 390111 | 395224 | 400278 | 405274 | 410212 | 415096 | 35 |
| 26 | 369123 | 374488 | 379787 | 385023 | 390196 | 395309 | 400362 | 405356 | 410294 | 415177 | 34 |
| 27 | 369213 | 374577 | 379875 | 385110 | 390282 | 395393 | 400445 | 405439 | 410376 | 415257 | 33 |
| 28 | 369302 | 374665 | 379963 | 385197 | 390368 | 395478 | 400529 | 405522 | 410458 | 415338 | 32 |
| 29 | 369392 | 374754 | 380051 | 385283 | 390453 | 395563 | 400613 | 405605 | 410540 | 415419 | 31 |
| 30 | 369482 | 374843 | 380138 | 385370 | 390539 | 395647 | 400696 | 405687 | 410621 | 415500 | 30 |
| 31 | 369572 | 374932 | 380226 | 385457 | 390625 | 395732 | 400780 | 405770 | 410703 | 415581 | 29 |
| 32 | 369662 | 375021 | 380314 | 385543 | 390710 | 395817 | 400864 | 405853 | 410785 | 415662 | 28 |
| 33 | 369752 | 375109 | 380401 | 385630 | 390796 | 395901 | 400947 | 405935 | 410867 | 415743 | 27 |
| 34 | 369842 | 375198 | 380489 | 385716 | 390882 | 395986 | 401031 | 406018 | 410948 | 415823 | 26 |
| 35 | 369932 | 375287 | 380577 | 385803 | 390967 | 396070 | 401115 | 406101 | 411030 | 415904 | 25 |
| 36 | 370021 | 375375 | 380664 | 385890 | 391053 | 396155 | 401198 | 406183 | 411112 | 415985 | 24 |
| 37 | 370111 | 375464 | 380752 | 385976 | 391138 | 396240 | 401282 | 406266 | 411193 | 416066 | 23 |
| 38 | 370201 | 375553 | 380840 | 386063 | 391224 | 396324 | 401365 | 406348 | 411275 | 416146 | 22 |
| 39 | 370291 | 375641 | 380927 | 386149 | 391309 | 396409 | 401449 | 406431 | 411357 | 416227 | 21 |
| 40 | 370380 | 375730 | 381015 | 386236 | 391395 | 396493 | 401532 | 406514 | 411438 | 416308 | 20 |
| 41 | 370470 | 375819 | 381102 | 386322 | 391480 | 396578 | 401616 | 406596 | 411520 | 416389 | 19 |
| 42 | 370560 | 375907 | 381190 | 386409 | 391566 | 396662 | 401699 | 406679 | 411602 | 416469 | 18 |
| 43 | 370649 | 375996 | 381277 | 386495 | 391651 | 396746 | 401783 | 406761 | 411683 | 416550 | 17 |
| 44 | 370739 | 376084 | 381365 | 386582 | 391736 | 396831 | 401866 | 406844 | 411765 | 416631 | 16 |
| 45 | 370829 | 376173 | 381452 | 386668 | 391822 | 396915 | 401950 | 406926 | 411846 | 416711 | 15 |
| 46 | 370918 | 376261 | 381540 | 386754 | 391907 | 397000 | 402033 | 407009 | 411928 | 416792 | 14 |
| 47 | 371008 | 376350 | 381627 | 386841 | 391993 | 397084 | 402116 | 407091 | 412009 | 416872 | 13 |
| 48 | 371097 | 376438 | 381714 | 386927 | 392078 | 397168 | 402200 | 407173 | 412091 | 416953 | 12 |
| 49 | 371187 | 376527 | 381802 | 387013 | 392163 | 397253 | 402283 | 407256 | 412172 | 417034 | 11 |
| 50 | 371277 | 376615 | 381889 | 387100 | 392249 | 397337 | 402366 | 407338 | 412254 | 417114 | 10 |
| 51 | 371366 | 376704 | 381977 | 387186 | 392334 | 397421 | 402450 | 407421 | 412335 | 417195 | 9 |
| 52 | 371456 | 376792 | 382064 | 387272 | 392419 | 397506 | 402533 | 407503 | 412417 | 417275 | 8 |
| 53 | 371545 | 376881 | 382151 | 387359 | 392504 | 397590 | 402616 | 407585 | 412498 | 417356 | 7 |
| 54 | 371635 | 376969 | 382239 | 387445 | 392590 | 397674 | 402700 | 407668 | 412579 | 417436 | 6 |
| 55 | 371724 | 377057 | 382326 | 387531 | 392675 | 397758 | 402783 | 407750 | 412661 | 417517 | 5 |
| 56 | 371813 | 377146 | 382413 | 387617 | 392760 | 397843 | 402866 | 407832 | 412742 | 417597 | 4 |
| 57 | 371903 | 377234 | 382500 | 387704 | 392845 | 397927 | 402949 | 407915 | 412824 | 417678 | 3 |
| 58 | 371992 | 377322 | 382588 | 387790 | 392930 | 398011 | 403033 | 407997 | 412905 | 417758 | 2 |
| 59 | 372082 | 377411 | 382675 | 387876 | 393016 | 398095 | 403116 | 408079 | 412986 | 417839 | 1 |
| 60 | 372171 | 377499 | 382762 | 387962 | 393101 | 398179 | 403199 | 408161 | 413068 | 417919 | 0 |
| ″ | 88° 39′ | 88° 38′ | 88° 37′ | 88° 36′ | 88° 35′ | 88° 34′ | 88° 33′ | 88° 32′ | 88° 31′ | 88° 30′ | ″ |

Cosine

## LOG. SINES OF SMALL ARCS TO TEN SECONDS

| ° | ′ | 0″ | 10″ | 20″ | 30″ | 40″ | 50″ | 60″ | Parts | ° | ′ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 8· | 8· | 8· | 8· | 8· | 8· | 8· | | | |
| 1 | 30 | 417919 | 418722 | 419524 | 420325 | 421123 | 421921 | 422717 | 32′ 37′ | 88 | 29 |
| 1 | 31 | 422717 | 423511 | 424304 | 425096 | 425886 | 426675 | 427462 | 1″ 78 74 | 88 | 28 |
| 1 | 32 | 427462 | 428248 | 429032 | 429815 | 430597 | 431377 | 432156 | 2 156 148 | 88 | 27 |
| 1 | 33 | 432156 | 432934 | 433710 | 434484 | 435257 | 436029 | 436800 | 3 235 223 | 88 | 26 |
| 1 | 34 | 436800 | 437569 | 438337 | 439103 | 439868 | 440632 | 441394 | 4 313 297 | 88 | 25 |
| 1 | 35 | 441394 | 442156 | 442915 | 443674 | 444431 | 445186 | 445941 | 5 391 371 | 88 | 24 |
| 1 | 36 | 445941 | 446694 | 447446 | 448196 | 448946 | 449694 | 450440 | 6 469 445 | 88 | 23 |
| 1 | 37 | 450440 | 451186 | 451930 | 452673 | 453414 | 454154 | 454893 | 7 547 519 | 88 | 22 |
| 1 | 38 | 454893 | 455631 | 456368 | 457103 | 457837 | 458570 | 459301 | 8 626 594 | 88 | 21 |
| 1 | 39 | 459301 | 460032 | 460761 | 461489 | 462215 | 462941 | 463665 | 9 704 668 | 88 | 20 |
| 1 | 40 | 463665 | 464388 | 465110 | 465830 | 466550 | 467268 | 467985 | 42′ 47′ | 88 | 19 |
| 1 | 41 | 467985 | 468701 | 469416 | 470129 | 470841 | 471553 | 472263 | 1″ 71 67 | 88 | 18 |
| 1 | 42 | 472263 | 472971 | 473679 | 474386 | 475091 | 475795 | 476498 | 2 141 135 | 88 | 17 |
| 1 | 43 | 476498 | 477200 | 477901 | 478601 | 479299 | 479997 | 480693 | 3 212 202 | 88 | 16 |
| 1 | 44 | 480693 | 481388 | 482083 | 482776 | 483467 | 484158 | 484848 | 4 282 269 | 88 | 15 |
| 1 | 45 | 484848 | 485536 | 486224 | 486910 | 487596 | 488280 | 488963 | 5 353 336 | 88 | 14 |
| 1 | 46 | 488963 | 489645 | 490326 | 491006 | 491685 | 492363 | 493040 | 6 424 404 | 88 | 13 |
| 1 | 47 | 493040 | 493715 | 494390 | 495064 | 495736 | 496408 | 497078 | 7 494 471 | 88 | 12 |
| 1 | 48 | 497078 | 497748 | 498416 | 499084 | 499750 | 500416 | 501080 | 8 565 538 | 88 | 11 |
| 1 | 49 | 501080 | 501743 | 502405 | 503067 | 503727 | 504386 | 505045 | 9 635 606 | 88 | 10 |
| 1 | 50 | 505045 | 505702 | 506358 | 507014 | 507668 | 508321 | 508974 | 52′ 57′ | 88 | 9 |
| 1 | 51 | 508974 | 509625 | 510275 | 510925 | 511573 | 512221 | 512867 | 1″ 64 62 | 88 | 8 |
| 1 | 52 | 512867 | 513513 | 514157 | 514801 | 515444 | 516086 | 516726 | 2 129 123 | 88 | 7 |
| 1 | 53 | 516726 | 517366 | 518005 | 518643 | 519280 | 519916 | 520551 | 3 193 185 | 88 | 6 |
| 1 | 54 | 520551 | 521186 | 521819 | 522451 | 523083 | 523713 | 524343 | 4 257 246 | 88 | 5 |
| 1 | 55 | 524343 | 524972 | 525599 | 526226 | 526852 | 527477 | 528102 | 5 321 308 | 88 | 4 |
| 1 | 56 | 528102 | 528725 | 529347 | 529969 | 530590 | 531209 | 531828 | 6 386 370 | 88 | 3 |
| 1 | 57 | 531828 | 532446 | 533063 | 533679 | 534295 | 534909 | 535523 | 7 450 431 | 88 | 2 |
| 1 | 58 | 535523 | 536136 | 536747 | 537358 | 537969 | 538578 | 539186 | 8 514 493 | 88 | 1 |
| 1 | 59 | 539186 | 539794 | 540401 | 541007 | 541612 | 542216 | 542819 | 9 579 554 | 88 | 0 |
| 2 | 0 | 542819 | 543422 | 544023 | 544624 | 545224 | 545823 | 546422 | 2′ 7′ | 87 | 59 |
| 2 | 1 | 546422 | 547019 | 547616 | 548212 | 548807 | 549401 | 549995 | 1″ 59 57 | 87 | 58 |
| 2 | 2 | 549995 | 550587 | 551179 | 551770 | 552361 | 552950 | 553539 | 2 118 113 | 87 | 57 |
| 2 | 3 | 553539 | 554126 | 554713 | 555300 | 555885 | 556470 | 557054 | 3 177 170 | 87 | 56 |
| 2 | 4 | 557054 | 557637 | 558219 | 558801 | 559381 | 559961 | 560540 | 4 236 227 | 87 | 55 |
| 2 | 5 | 560540 | 561119 | 561696 | 562273 | 562849 | 563425 | 563999 | 5 295 284 | 87 | 54 |
| 2 | 6 | 563999 | 564573 | 565146 | 565719 | 566290 | 566861 | 567431 | 6 355 340 | 87 | 53 |
| 2 | 7 | 567431 | 568000 | 568569 | 569137 | 569704 | 570270 | 570836 | 7 414 397 | 87 | 52 |
| 2 | 8 | 570836 | 571401 | 571965 | 572528 | 573091 | 573653 | 574214 | 8 473 454 | 87 | 51 |
| 2 | 9 | 574214 | 574774 | 575334 | 575893 | 576451 | 577009 | 577566 | 9 532 510 | 87 | 50 |
| 2 | 10 | 577566 | 578122 | 578678 | 579232 | 579786 | 580340 | 580892 | 12′ 17′ | 87 | 49 |
| 2 | 11 | 580892 | 581444 | 581995 | 582546 | 583096 | 583645 | 584193 | 1″ 55 53 | 87 | 48 |
| 2 | 12 | 584193 | 584741 | 585288 | 585834 | 586380 | 586925 | 587469 | 2 109 105 | 87 | 47 |
| 2 | 13 | 587469 | 588013 | 588556 | 589098 | 589640 | 590181 | 590721 | 3 164 158 | 87 | 46 |
| 2 | 14 | 590721 | 591260 | 591799 | 592338 | 592875 | 593412 | 593948 | 4 218 210 | 87 | 45 |
| 2 | 15 | 593948 | 594484 | 595019 | 595553 | 596086 | 596619 | 597152 | 5 273 263 | 87 | 44 |
| 2 | 16 | 597152 | 597683 | 598214 | 598745 | 599274 | 599803 | 600332 | 6 328 316 | 87 | 43 |
| 2 | 17 | 600332 | 600859 | 601387 | 601913 | 602439 | 602964 | 603489 | 7 382 368 | 87 | 42 |
| 2 | 18 | 603489 | 604012 | 604536 | 605058 | 605580 | 606102 | 606623 | 8 437 421 | 87 | 41 |
| 2 | 19 | 606623 | 607143 | 607662 | 608181 | 608699 | 609217 | 609734 | 9 491 473 | 87 | 40 |
| 2 | 20 | 609734 | 610251 | 610766 | 611282 | 611796 | 612310 | 612823 | 22′ 27′ | 87 | 39 |
| 2 | 21 | 612823 | 613336 | 613848 | 614360 | 614871 | 615381 | 615891 | 1″ 51 49 | 87 | 38 |
| 2 | 22 | 615891 | 616400 | 616909 | 617417 | 617924 | 618431 | 618937 | 2 102 98 | 87 | 37 |
| 2 | 23 | 618937 | 619442 | 619947 | 620452 | 620956 | 621459 | 621962 | 3 152 147 | 87 | 36 |
| 2 | 24 | 621962 | 622464 | 622965 | 623466 | 623966 | 624466 | 624965 | 4 203 196 | 87 | 35 |
| 2 | 25 | 624965 | 625464 | 625962 | 626459 | 626956 | 627453 | 627948 | 5 254 245 | 87 | 34 |
| 2 | 26 | 627948 | 628444 | 628938 | 629432 | 629926 | 630419 | 630911 | 6 305 294 | 87 | 33 |
| 2 | 27 | 630911 | 631403 | 631894 | 632385 | 632875 | 633365 | 633854 | 7 356 343 | 87 | 32 |
| 2 | 28 | 633854 | 634342 | 634830 | 635317 | 635804 | 636291 | 636776 | 8 406 392 | 87 | 31 |
| 2 | 29 | 636776 | 637262 | 637746 | 638230 | 638714 | 639197 | 639680 | 9 457 441 | 87 | 30 |
| 2 | 30 | 639680 | 640162 | 640643 | 641124 | 641604 | 642084 | 642563 | | 87 | 29 |
| ° | ′ | 60″ | 50″ | 40″ | 30″ | 20″ | 10″ | 0″ | Parts | ° | ′ |

Cosine

## LOG. SINES OF SMALL ARCS TO TEN SECONDS

| ° ′ | 0″ | 10″ | 20″ | 30″ | 40″ | 50″ | 60″ | Parts | ° ′ |
|---|---|---|---|---|---|---|---|---|---|
| | 8· | 8· | 8· | 8· | 8· | 8· | 8· | | |
| 2 30 | 039680 | 640162 | 640643 | 641124 | 641604 | 642084 | 642563 | 32′ 37′ | 87 29 |
| 2 31 | 642563 | 643042 | 643520 | 643998 | 644475 | 644952 | 645428 | 1″ 47 46 | 87 28 |
| 2 32 | 645428 | 645904 | 646379 | 646854 | 647328 | 647801 | 648274 | 2 95 92 | 87 27 |
| 2 33 | 648274 | 648747 | 649219 | 649690 | 650161 | 650632 | 651102 | 3 142 138 | 87 26 |
| 2 34 | 651102 | 651571 | 652040 | 652508 | 652976 | 653444 | 653911 | 4 190 184 | 87 25 |
| 2 35 | 653911 | 654377 | 654843 | 655308 | 655773 | 656238 | 656702 | 5 237 229 | 87 24 |
| 2 36 | 656702 | 657165 | 657628 | 658090 | 658552 | 659014 | 659475 | 6 284 275 | 87 23 |
| 2 37 | 659475 | 659935 | 660395 | 660855 | 661314 | 661772 | 662230 | 7 332 321 | 87 22 |
| 2 38 | 662230 | 662688 | 663145 | 663602 | 664058 | 664513 | 664968 | 8 379 367 | 87 21 |
| 2 39 | 664968 | 665423 | 665877 | 666331 | 666784 | 667237 | 667689 | 9 427 413 | 87 20 |
| 2 40 | 667689 | 668141 | 668592 | 669043 | 669494 | 669944 | 670393 | 42′ 47′ | 87 19 |
| 2 41 | 670393 | 670842 | 671291 | 671739 | 672187 | 672634 | 673080 | 1″ 45 43 | 87 18 |
| 2 42 | 673080 | 673527 | 673972 | 674418 | 674863 | 675307 | 675751 | 2 89 86 | 87 17 |
| 2 43 | 675751 | 676194 | 676638 | 677080 | 677522 | 677964 | 678405 | 3 133 130 | 87 16 |
| 2 44 | 678405 | 678846 | 679286 | 679726 | 680166 | 680605 | 681043 | 4 178 173 | 87 15 |
| 2 45 | 681043 | 681481 | 681919 | 682356 | 682793 | 683230 | 683665 | 5 223 216 | 87 14 |
| 2 46 | 683665 | 684101 | 684536 | 684971 | 685405 | 685838 | 686272 | 6 267 259 | 87 13 |
| 2 47 | 686272 | 686705 | 687137 | 687569 | 688001 | 688432 | 688863 | 7 312 302 | 87 12 |
| 2 48 | 688863 | 689293 | 689723 | 690152 | 690581 | 691010 | 691438 | 8 356 346 | 87 11 |
| 2 49 | 691438 | 691866 | 692293 | 692720 | 693146 | 693572 | 693998 | 9 400 389 | 87 10 |
| 2 50 | 693998 | 694423 | 694848 | 695272 | 695696 | 696120 | 696543 | 52′ 57′ | 87 9 |
| 2 51 | 696543 | 696966 | 697388 | 697810 | 698232 | 698653 | 699073 | 1″ 42 41 | 87 8 |
| 2 52 | 699073 | 699494 | 699913 | 700333 | 700752 | 701171 | 701589 | 2 84 82 | 87 7 |
| 2 53 | 701589 | 702007 | 702424 | 702841 | 703258 | 703674 | 704090 | 3 126 122 | 87 6 |
| 2 54 | 704090 | 704505 | 704920 | 705335 | 705749 | 706163 | 706577 | 4 168 163 | 87 5 |
| 2 55 | 706577 | 706990 | 707402 | 707815 | 708226 | 708638 | 709049 | 5 209 204 | 87 4 |
| 2 56 | 709049 | 709460 | 709870 | 710280 | 710690 | 711099 | 711507 | 6 251 244 | 87 3 |
| 2 57 | 711507 | 711916 | 712324 | 712731 | 713139 | 713546 | 713952 | 7 293 285 | 87 2 |
| 2 58 | 713952 | 714358 | 714764 | 715169 | 715574 | 715979 | 716383 | 8 335 326 | 87 1 |
| 2 59 | 716383 | 716787 | 717190 | 717593 | 717996 | 718398 | 718800 | 9 377 366 | 87 0 |
| 3 0 | 718800 | 719202 | 719603 | 720004 | 720404 | 720804 | 721204 | 2′ 7′ | 86 59 |
| 3 1 | 721204 | 721603 | 722002 | 722401 | 722799 | 723197 | 723595 | 1″ 40 39 | 86 58 |
| 3 2 | 723595 | 723992 | 724389 | 724785 | 725181 | 725577 | 725972 | 2 79 77 | 86 57 |
| 3 3 | 725972 | 726367 | 726762 | 727156 | 727550 | 727943 | 728337 | 3 119 116 | 86 56 |
| 3 4 | 728337 | 728729 | 729122 | 729514 | 729906 | 730297 | 730688 | 4 158 154 | 86 55 |
| 3 5 | 730688 | 731079 | 731469 | 731859 | 732249 | 732638 | 733027 | 5 198 193 | 86 54 |
| 3 6 | 733027 | 733416 | 733804 | 734192 | 734579 | 734967 | 735354 | 6 238 232 | 86 53 |
| 3 7 | 735354 | 735740 | 736126 | 736512 | 736898 | 737283 | 737667 | 7 277 270 | 86 52 |
| 3 8 | 737667 | 738052 | 738436 | 738820 | 739203 | 739586 | 739969 | 8 317 309 | 86 51 |
| 3 9 | 739969 | 740352 | 740734 | 741115 | 741497 | 741878 | 742259 | 9 356 347 | 86 50 |
| 3 10 | 742259 | 742639 | 743019 | 743399 | 743778 | 744157 | 744536 | 12′ 17′ | 86 49 |
| 3 11 | 744536 | 744914 | 745293 | 745670 | 746048 | 746425 | 746802 | 1″ 38 37 | 86 48 |
| 3 12 | 746802 | 747178 | 747554 | 747930 | 748305 | 748680 | 749055 | 2 75 73 | 86 47 |
| 3 13 | 749055 | 749430 | 749804 | 750178 | 750551 | 750924 | 751297 | 3 113 110 | 86 46 |
| 3 14 | 751297 | 751670 | 752042 | 752414 | 752786 | 753157 | 753528 | 4 150 146 | 86 45 |
| 3 15 | 753528 | 753898 | 754269 | 754639 | 755008 | 755378 | 755747 | 5 188 183 | 86 44 |
| 3 16 | 755747 | 756116 | 756484 | 756852 | 757220 | 757587 | 757955 | 6 226 220 | 86 43 |
| 3 17 | 757955 | 758321 | 758688 | 759054 | 759420 | 759786 | 760151 | 7 263 256 | 86 42 |
| 3 18 | 760151 | 760516 | 760881 | 761245 | 761609 | 761973 | 762337 | 8 301 293 | 86 41 |
| 3 19 | 762337 | 762700 | 763063 | 763425 | 763787 | 764149 | 764511 | 9 338 329 | 86 40 |
| 3 20 | 764511 | 764872 | 765234 | 765594 | 765955 | 766315 | 766675 | 22′ 27′ | 86 39 |
| 3 21 | 766675 | 767034 | 767394 | 767752 | 768111 | 768469 | 768828 | 1″ 36 35 | 86 38 |
| 3 22 | 768828 | 769185 | 769543 | 769900 | 770257 | 770613 | 770970 | 2 71 70 | 86 37 |
| 3 23 | 770970 | 771326 | 771681 | 772037 | 772392 | 772747 | 773101 | 3 107 105 | 86 36 |
| 3 24 | 773101 | 773456 | 773810 | 774163 | 774517 | 774870 | 775223 | 4 143 139 | 86 35 |
| 3 25 | 775223 | 775575 | 775927 | 776279 | 776631 | 776982 | 777333 | 5 178 174 | 86 34 |
| 3 26 | 777333 | 777684 | 778035 | 778385 | 778735 | 779085 | 779434 | 6 214 209 | 86 33 |
| 3 27 | 779434 | 779783 | 780132 | 780480 | 780829 | 781177 | 781524 | 7 250 244 | 86 32 |
| 3 28 | 781524 | 781872 | 782219 | 782566 | 782912 | 783259 | 783605 | 8 286 278 | 86 31 |
| 3 29 | 783605 | 783951 | 784296 | 784641 | 784986 | 785331 | 785675 | 9 321 313 | 86 30 |
| 3 30 | 785675 | 786019 | 786363 | 786707 | 787050 | 787393 | 787736 | | 86 29 |
| ° ′ | 60″ | 50″ | 40″ | 30″ | 20″ | 10″ | 0″ | Parts | ° ′ |

COSINE

## LOG. SINES OF SMALL ARCS TO TEN SECONDS

| ° ′ | 0″ | 10″ | 20″ | 30″ | 40″ | 50″ | 60″ | Parts | ° ′ |
|---|---|---|---|---|---|---|---|---|---|
| | 8· | 8· | 8· | 8· | 8· | 8· | 8· | | |
| 3 30 | 785675 | 786019 | 786363 | 786707 | 787050 | 787393 | 787736 | 32 37′ | 86 29 |
| 3 31 | 787736 | 788078 | 788421 | 788762 | 789104 | 789446 | 789787 | 1″ 34 33 | 86 28 |
| 3 32 | 789787 | 790128 | 790468 | 790808 | 791149 | 791488 | 791828 | 2 68 66 | 86 27 |
| 3 33 | 791828 | 792167 | 792506 | 792845 | 793183 | 793521 | 793859 | 3 102 100 | 86 26 |
| 3 34 | 793859 | 794197 | 794534 | 794872 | 795208 | 795545 | 795881 | 4 136 133 | 86 25 |
| 3 35 | 795881 | 796218 | 796553 | 796889 | 797224 | 797559 | 797894 | 5 170 166 | 86 24 |
| 3 36 | 797894 | 798229 | 798563 | 798897 | 799231 | 799564 | 799897 | 6 204 199 | 86 23 |
| 3 37 | 799897 | 800230 | 800563 | 800896 | 801228 | 801560 | 801892 | 7 238 232 | 86 22 |
| 3 38 | 801892 | 802223 | 802554 | 802885 | 803216 | 803546 | 803876 | 8 272 266 | 86 21 |
| 3 39 | 803876 | 804206 | 804536 | 804866 | 805195 | 805524 | 805852 | 9 306 299 | 86 20 |
| 3 40 | 805852 | 806181 | 806509 | 806837 | 807165 | 807492 | 807819 | 42′ 47′ | 86 19 |
| 3 41 | 807819 | 808146 | 808473 | 808799 | 809126 | 809451 | 809777 | 1″ 32 32 | 86 18 |
| 3 42 | 809777 | 810103 | 810428 | 810753 | 811078 | 811402 | 811726 | 2 65 64 | 86 17 |
| 3 43 | 811726 | 812050 | 812374 | 812698 | 813021 | 813344 | 813667 | 3 97 95 | 86 16 |
| 3 44 | 813667 | 813989 | 814312 | 814634 | 814956 | 815277 | 815599 | 4 130 127 | 86 15 |
| 3 45 | 815599 | 815920 | 816241 | 816561 | 816882 | 817202 | 817522 | 5 162 159 | 86 14 |
| 3 46 | 817522 | 817841 | 818161 | 818480 | 818799 | 819118 | 819436 | 6 195 191 | 86 13 |
| 3 47 | 819436 | 819755 | 820073 | 820390 | 820708 | 821025 | 821343 | 7 228 223 | 86 12 |
| 3 48 | 821343 | 821659 | 821976 | 822292 | 822609 | 822925 | 823240 | 8 261 254 | 86 11 |
| 3 49 | 823240 | 823556 | 823871 | 824186 | 824501 | 824816 | 825130 | 9 293 286 | 86 10 |
| 3 50 | 825130 | 825444 | 825758 | 826072 | 826385 | 826698 | 827011 | 52′ 57′ | 86 9 |
| 3 51 | 827011 | 827324 | 827637 | 827949 | 828261 | 828573 | 828884 | 1″ 31 30 | 86 8 |
| 3 52 | 828884 | 829196 | 829507 | 829818 | 830129 | 830439 | 830749 | 2 62 61 | 86 7 |
| 3 53 | 830749 | 831060 | 831369 | 831679 | 831988 | 832298 | 832607 | 3 93 91 | 86 6 |
| 3 54 | 832607 | 832915 | 833224 | 833532 | 833840 | 834148 | 834456 | 4 124 122 | 86 5 |
| 3 55 | 834456 | 834763 | 835070 | 835377 | 835684 | 835991 | 836297 | 5 155 152 | 86 4 |
| 3 56 | 836297 | 836603 | 836909 | 837215 | 837520 | 837825 | 838130 | 6 187 182 | 86 3 |
| 3 57 | 838130 | 838435 | 838740 | 839044 | 839348 | 839652 | 839956 | 7 218 213 | 86 2 |
| 3 58 | 839956 | 840260 | 840563 | 840866 | 841169 | 841472 | 841774 | 8 249 243 | 86 1 |
| 3 59 | 841774 | 842076 | 842378 | 842680 | 842982 | 843283 | 843585 | 9 280 274 | 86 0 |
| 4 0 | 843585 | 843886 | 844186 | 844487 | 844787 | 845087 | 845387 | 2′ 7′ | 85 59 |
| 4 1 | 845387 | 845687 | 845987 | 846286 | 846585 | 846884 | 847183 | 1″ 30 29 | 85 58 |
| 4 2 | 847183 | 847481 | 847780 | 848078 | 848376 | 848673 | 848971 | 2 60 58 | 85 57 |
| 4 3 | 848971 | 849268 | 849565 | 849862 | 850159 | 850455 | 850751 | 3 89 88 | 85 56 |
| 4 4 | 850751 | 851047 | 851343 | 851639 | 851934 | 852229 | 852525 | 4 119 117 | 85 55 |
| 4 5 | 852525 | 852819 | 853114 | 853408 | 853703 | 853997 | 854291 | 5 149 146 | 85 54 |
| 4 6 | 854291 | 854584 | 854878 | 855171 | 855464 | 855757 | 856049 | 6 179 175 | 85 53 |
| 4 7 | 856049 | 856342 | 856634 | 856926 | 857218 | 857510 | 857801 | 7 209 204 | 85 52 |
| 4 8 | 857801 | 858092 | 858383 | 858674 | 858965 | 859255 | 859546 | 8 238 234 | 85 51 |
| 4 9 | 859546 | 859836 | 860126 | 860415 | 860705 | 860994 | 861283 | 9 268 263 | 85 50 |
| 4 10 | 861283 | 861572 | 861861 | 862149 | 862438 | 862726 | 863014 | 12′ 17′ | 85 49 |
| 4 11 | 863014 | 863302 | 863589 | 863877 | 864164 | 864451 | 864738 | 1″ 30 28 | 85 48 |
| 4 12 | 864738 | 865024 | 865311 | 865597 | 865883 | 866169 | 866455 | 2 57 56 | 85 47 |
| 4 13 | 866455 | 866740 | 867025 | 867310 | 867595 | 867880 | 868165 | 3 86 84 | 85 46 |
| 4 14 | 868165 | 868449 | 868733 | 869017 | 869301 | 869585 | 869868 | 4 114 112 | 85 45 |
| 4 15 | 869868 | 870151 | 870434 | 870717 | 871000 | 871282 | 871565 | 5 143 140 | 85 44 |
| 4 16 | 871565 | 871847 | 872129 | 872410 | 872692 | 872973 | 873255 | 6 172 169 | 85 43 |
| 4 17 | 873255 | 873536 | 873817 | 874097 | 874378 | 874658 | 874938 | 7 200 197 | 85 42 |
| 4 18 | 874938 | 875218 | 875498 | 875777 | 876057 | 876336 | 876615 | 8 229 225 | 85 41 |
| 4 19 | 876615 | 876894 | 877172 | 877451 | 877729 | 878007 | 878285 | 9 257 253 | 85 40 |
| 4 20 | 878285 | 878563 | 878841 | 879118 | 879395 | 879672 | 879949 | 22′ 27′ | 85 39 |
| 4 21 | 879949 | 880226 | 880503 | 880779 | 381055 | 881331 | 881607 | 1″ 28 27 | 85 38 |
| 4 22 | 881607 | 881883 | 882158 | 882433 | 882708 | 882983 | 883258 | 2 55 54 | 85 37 |
| 4 23 | 883258 | 883533 | 883807 | 884081 | 884355 | 884629 | 884903 | 3 82 81 | 85 36 |
| 4 24 | 884903 | 885177 | 885450 | 885723 | 885996 | 886269 | 886542 | 4 110 108 | 85 35 |
| 4 25 | 886542 | 886814 | 887087 | 887359 | 887631 | 887903 | 888174 | 5 137 135 | 85 34 |
| 4 26 | 888174 | 888446 | 888717 | 888988 | 889259 | 889530 | 889801 | 6 165 162 | 85 33 |
| 4 27 | 889801 | 890071 | 890341 | 890612 | 890882 | 891151 | 891421 | 7 192 189 | 85 32 |
| 4 28 | 891421 | 891690 | 891960 | 892229 | 892498 | 892767 | 893035 | 8 220 216 | 85 31 |
| 4 29 | 893035 | 893304 | 893572 | 893840 | 894108 | 894376 | 894643 | 9 247 243 | 85 30 |
| 4 30 | 894643 | 894011 | 895178 | 895445 | 895712 | 895979 | 896246 | | 85 29 |
| ° ′ | 60″ | 50″ | 40″ | 30″ | 20″ | 10″ | 0″ | Parts | ° ′ |

COSINE

## LOG. SINES OF SMALL ARCS TO TEN SECONDS

| ° | ′ | 0″ | 10″ | 20″ | 30″ | 40″ | 50″ | 60″ | Parts | ° | ′ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 8· | 8· | 8· | 8· | 8· | 8· | 8· | | | |
| 2 | 30 | 039680 | 640162 | 640643 | 641124 | 641604 | 642084 | 642563 | 32′ 37′ | 87 | 29 |
| 2 | 31 | 642563 | 643042 | 643520 | 643998 | 644475 | 644952 | 645428 | 1″ 47 46 | 87 | 28 |
| 2 | 32 | 645428 | 645904 | 646379 | 646854 | 647328 | 647801 | 648274 | 2 95 92 | 87 | 27 |
| 2 | 33 | 648274 | 648747 | 649219 | 649690 | 650161 | 650632 | 651102 | 3 142 138 | 87 | 26 |
| 2 | 34 | 651102 | 651571 | 652040 | 652508 | 652976 | 653444 | 653911 | 4 190 184 | 87 | 25 |
| 2 | 35 | 653911 | 654377 | 654843 | 655308 | 655773 | 656238 | 656702 | 5 237 229 | 87 | 24 |
| 2 | 36 | 656702 | 657165 | 657628 | 658090 | 658552 | 659014 | 659475 | 6 284 275 | 87 | 23 |
| 2 | 37 | 659475 | 659935 | 660395 | 660855 | 661314 | 661772 | 662230 | 7 332 321 | 87 | 22 |
| 2 | 38 | 662230 | 662688 | 663145 | 663602 | 664058 | 664513 | 664968 | 8 379 367 | 87 | 21 |
| 2 | 39 | 664968 | 665423 | 665877 | 666331 | 666784 | 667237 | 667689 | 9 427 413 | 87 | 20 |
| 2 | 40 | 667689 | 668141 | 668592 | 669043 | 669494 | 669944 | 670393 | 42′ 47′ | 87 | 19 |
| 2 | 41 | 670393 | 670842 | 671291 | 671739 | 672187 | 672634 | 673080 | 1″ 45 43 | 87 | 18 |
| 2 | 42 | 673080 | 673527 | 673972 | 674418 | 674863 | 675307 | 675751 | 2 89 86 | 87 | 17 |
| 2 | 43 | 675751 | 676194 | 676638 | 677080 | 677522 | 677964 | 678405 | 3 133 130 | 87 | 16 |
| 2 | 44 | 678405 | 678846 | 679286 | 679726 | 680166 | 680605 | 681043 | 4 178 173 | 87 | 15 |
| 2 | 45 | 681043 | 681481 | 681919 | 682356 | 682793 | 683230 | 683665 | 5 223 216 | 87 | 14 |
| 2 | 46 | 683665 | 684101 | 684536 | 684971 | 685405 | 685838 | 686272 | 6 267 259 | 87 | 13 |
| 2 | 47 | 686272 | 686705 | 687137 | 687569 | 688001 | 688432 | 688863 | 7 312 302 | 87 | 12 |
| 2 | 48 | 688863 | 689293 | 689723 | 690152 | 690581 | 691010 | 691438 | 8 356 346 | 87 | 11 |
| 2 | 49 | 691438 | 691866 | 692293 | 692720 | 693146 | 693572 | 693998 | 9 400 389 | 87 | 10 |
| 2 | 50 | 693998 | 694423 | 694848 | 695272 | 695696 | 696120 | 696543 | 52′ 57′ | 87 | 9 |
| 2 | 51 | 696543 | 696966 | 697388 | 697810 | 698232 | 698653 | 699073 | 1″ 42 41 | 87 | 8 |
| 2 | 52 | 699073 | 699494 | 699913 | 700333 | 700752 | 701171 | 701589 | 2 84 82 | 87 | 7 |
| 2 | 53 | 701589 | 702007 | 702424 | 702841 | 703258 | 703674 | 704090 | 3 126 122 | 87 | 6 |
| 2 | 54 | 704090 | 704505 | 704920 | 705335 | 705749 | 706163 | 706577 | 4 168 163 | 87 | 5 |
| 2 | 55 | 706577 | 706990 | 707402 | 707815 | 708226 | 708638 | 709049 | 5 209 204 | 87 | 4 |
| 2 | 56 | 709049 | 709460 | 709870 | 710280 | 710690 | 711099 | 711507 | 6 251 244 | 87 | 3 |
| 2 | 57 | 711507 | 711916 | 712324 | 712731 | 713139 | 713546 | 713952 | 7 293 285 | 87 | 2 |
| 2 | 58 | 713952 | 714358 | 714764 | 715169 | 715574 | 715979 | 716383 | 8 335 326 | 87 | 1 |
| 2 | 59 | 716383 | 716787 | 717190 | 717593 | 717996 | 718398 | 718800 | 9 377 366 | 87 | 0 |
| 3 | 0 | 718800 | 719202 | 719603 | 720004 | 720404 | 720804 | 721204 | 2′ 7′ | 86 | 59 |
| 3 | 1 | 721204 | 721603 | 722002 | 722401 | 722799 | 723197 | 723595 | 1″ 40 39 | 86 | 58 |
| 3 | 2 | 723595 | 723992 | 724389 | 724785 | 725181 | 725577 | 725972 | 2 79 77 | 86 | 57 |
| 3 | 3 | 725972 | 726367 | 726762 | 727156 | 727550 | 727943 | 728337 | 3 119 116 | 86 | 56 |
| 3 | 4 | 728337 | 728729 | 729122 | 729514 | 729906 | 730297 | 730688 | 4 158 154 | 86 | 55 |
| 3 | 5 | 730688 | 731079 | 731469 | 731859 | 732249 | 732638 | 733027 | 5 198 193 | 86 | 54 |
| 3 | 6 | 733027 | 733416 | 733804 | 734192 | 734579 | 734967 | 735354 | 6 238 232 | 86 | 53 |
| 3 | 7 | 735354 | 735740 | 736126 | 736512 | 736898 | 737283 | 737667 | 7 277 270 | 86 | 52 |
| 3 | 8 | 737667 | 738052 | 738436 | 738820 | 739203 | 739586 | 739969 | 8 317 309 | 86 | 51 |
| 3 | 9 | 739969 | 740352 | 740734 | 741115 | 741497 | 741878 | 742259 | 9 356 347 | 86 | 50 |
| 3 | 10 | 742259 | 742639 | 743019 | 743399 | 743778 | 744157 | 744536 | 12′ 17′ | 86 | 49 |
| 3 | 11 | 744536 | 744914 | 745293 | 745670 | 746048 | 746425 | 746802 | 1″ 38 37 | 86 | 48 |
| 3 | 12 | 746802 | 747178 | 747554 | 747930 | 748305 | 748680 | 749055 | 2 75 73 | 86 | 47 |
| 3 | 13 | 749055 | 749430 | 749804 | 750178 | 750551 | 750924 | 751297 | 3 113 110 | 86 | 46 |
| 3 | 14 | 751297 | 751670 | 752042 | 752414 | 752786 | 753157 | 753528 | 4 150 146 | 86 | 45 |
| 3 | 15 | 753528 | 753898 | 754269 | 754639 | 755008 | 755378 | 755747 | 5 188 183 | 86 | 44 |
| 3 | 16 | 755747 | 756116 | 756484 | 756852 | 757220 | 757587 | 757955 | 6 226 220 | 86 | 43 |
| 3 | 17 | 757955 | 758321 | 758688 | 759054 | 759420 | 759786 | 760151 | 7 263 256 | 86 | 42 |
| 3 | 18 | 760151 | 760516 | 760881 | 761245 | 761609 | 761973 | 762337 | 8 301 293 | 86 | 41 |
| 3 | 19 | 762337 | 762700 | 763063 | 763425 | 763787 | 764149 | 764511 | 9 338 329 | 86 | 40 |
| 3 | 20 | 764511 | 764872 | 765234 | 765594 | 765955 | 766315 | 766675 | 22′ 27′ | 86 | 39 |
| 3 | 21 | 766675 | 767034 | 767394 | 767752 | 768111 | 768469 | 768828 | 1″ 36 35 | 86 | 38 |
| 3 | 22 | 768828 | 769185 | 769543 | 769900 | 770257 | 770613 | 770970 | 2 71 70 | 86 | 37 |
| 3 | 23 | 770970 | 771326 | 771681 | 772037 | 772392 | 772747 | 773101 | 3 107 105 | 86 | 36 |
| 3 | 24 | 773101 | 773456 | 773810 | 774163 | 774517 | 774870 | 775223 | 4 143 139 | 86 | 35 |
| 3 | 25 | 775223 | 775575 | 775927 | 776279 | 776631 | 776982 | 777333 | 5 178 174 | 86 | 34 |
| 3 | 26 | 777333 | 777684 | 778035 | 778385 | 778735 | 779085 | 779434 | 6 214 209 | 86 | 33 |
| 3 | 27 | 779434 | 779783 | 780132 | 780480 | 780829 | 781177 | 781524 | 7 250 244 | 86 | 32 |
| 3 | 28 | 781524 | 781872 | 782219 | 782566 | 782912 | 783259 | 783605 | 8 286 278 | 86 | 31 |
| 3 | 29 | 783605 | 783951 | 784296 | 784641 | 784986 | 785331 | 785675 | 9 321 313 | 86 | 30 |
| 3 | 30 | 785675 | 786019 | 786363 | 786707 | 787050 | 787393 | 787736 | | 86 | 29 |
| ° | ′ | 60″ | 50″ | 40″ | 30″ | 20″ | 10″ | 0″ | Parts | ° | ′ |

COSINE

## LOG. SINES OF SMALL ARCS TO TEN SECONDS

| ° ′ | 0″ | 10″ | 20″ | 30″ | 40″ | 50″ | 60″ | Parts | ° ′ |
|---|---|---|---|---|---|---|---|---|---|
| | 8· | 8· | 8· | 8· | 8· | 8· | 8· | | |
| 3 30 | 785675 | 786019 | 786363 | 786707 | 787050 | 787393 | 787736 | 32′ 37′ | 86 29 |
| 3 31 | 787736 | 788078 | 788421 | 788762 | 789104 | 789446 | 789787 | 1″ 34 33 | 86 28 |
| 3 32 | 789787 | 790128 | 790468 | 790808 | 791149 | 791488 | 791828 | 2 68 66 | 86 27 |
| 3 33 | 791828 | 792167 | 792506 | 792845 | 793183 | 793521 | 793859 | 3 102 100 | 86 26 |
| 3 34 | 793859 | 794197 | 794534 | 794872 | 795208 | 795545 | 795881 | 4 136 133 | 86 25 |
| 3 35 | 795881 | 796218 | 796553 | 796889 | 797224 | 797559 | 797894 | 5 170 166 | 86 24 |
| 3 36 | 797894 | 798229 | 798563 | 798897 | 799231 | 799564 | 799897 | 6 204 199 | 86 23 |
| 3 37 | 799897 | 800230 | 800563 | 800896 | 801228 | 801560 | 801892 | 7 238 232 | 86 22 |
| 3 38 | 801892 | 802223 | 802554 | 802885 | 803216 | 803546 | 803876 | 8 272 266 | 86 21 |
| 3 39 | 803876 | 804206 | 804536 | 804866 | 805195 | 805524 | 805852 | 9 306 299 | 86 20 |
| 3 40 | 805852 | 806181 | 806509 | 806837 | 807165 | 807492 | 807819 | 42′ 47′ | 86 19 |
| 3 41 | 807819 | 808146 | 808473 | 808799 | 809126 | 809451 | 809777 | 1″ 32 32 | 86 18 |
| 3 42 | 809777 | 810103 | 810428 | 810753 | 811078 | 811402 | 811726 | 2 65 64 | 86 17 |
| 3 43 | 811726 | 812050 | 812374 | 812698 | 813021 | 813344 | 813667 | 3 97 95 | 86 16 |
| 3 44 | 813667 | 813989 | 814312 | 814634 | 814956 | 815277 | 815599 | 4 130 127 | 86 15 |
| 3 45 | 815599 | 815920 | 816241 | 816561 | 816882 | 817202 | 817522 | 5 162 159 | 86 14 |
| 3 46 | 817522 | 817841 | 818161 | 818480 | 818799 | 819118 | 819436 | 6 195 191 | 86 13 |
| 3 47 | 819436 | 819755 | 820073 | 820390 | 820708 | 821025 | 821343 | 7 228 223 | 86 12 |
| 3 48 | 821343 | 821659 | 821976 | 822292 | 822609 | 822925 | 823240 | 8 261 254 | 86 11 |
| 3 49 | 823240 | 823556 | 823871 | 824186 | 824501 | 824816 | 825130 | 9 293 286 | 86 10 |
| 3 50 | 825130 | 825444 | 825758 | 826072 | 826385 | 826698 | 827011 | 52′ 57′ | 86 9 |
| 3 51 | 827011 | 827324 | 827637 | 827949 | 828261 | 828573 | 828884 | 1″ 31 30 | 86 8 |
| 3 52 | 828884 | 829196 | 829507 | 829818 | 830129 | 830439 | 830749 | 2 62 61 | 86 7 |
| 3 53 | 830749 | 831060 | 831369 | 831679 | 831988 | 832298 | 832607 | 3 93 91 | 86 6 |
| 3 54 | 832607 | 832915 | 833224 | 833532 | 833840 | 834148 | 834456 | 4 124 122 | 86 5 |
| 3 55 | 834456 | 834763 | 835070 | 835377 | 835684 | 835991 | 836297 | 5 155 152 | 86 4 |
| 3 56 | 836297 | 836603 | 836909 | 837215 | 837520 | 837825 | 838130 | 6 187 182 | 86 3 |
| 3 57 | 838130 | 838435 | 838740 | 839044 | 839348 | 839652 | 839956 | 7 218 213 | 86 2 |
| 3 58 | 839956 | 840260 | 840563 | 840866 | 841169 | 841472 | 841774 | 8 249 243 | 86 1 |
| 3 59 | 841774 | 842076 | 842378 | 842680 | 842982 | 843283 | 843585 | 9 280 274 | 86 0 |
| 4 0 | 843585 | 843886 | 844186 | 844487 | 844787 | 845087 | 845387 | 2′ 7′ | 85 59 |
| 4 1 | 845387 | 845687 | 845987 | 846286 | 846585 | 846884 | 847183 | 1″ 30 29 | 85 58 |
| 4 2 | 847183 | 847481 | 847780 | 848078 | 848376 | 848673 | 848971 | 2 60 58 | 85 57 |
| 4 3 | 848971 | 849268 | 849565 | 849862 | 850159 | 850455 | 850751 | 3 89 88 | 85 56 |
| 4 4 | 850751 | 851047 | 851343 | 851639 | 851934 | 852229 | 852525 | 4 119 117 | 85 55 |
| 4 5 | 852525 | 852819 | 853114 | 853408 | 853703 | 853997 | 854291 | 5 149 146 | 85 54 |
| 4 6 | 854291 | 854584 | 854878 | 855171 | 855464 | 855757 | 856049 | 6 179 175 | 85 53 |
| 4 7 | 856049 | 856342 | 856634 | 856926 | 857218 | 857510 | 857801 | 7 209 204 | 85 52 |
| 4 8 | 857801 | 858092 | 858383 | 858674 | 858965 | 859255 | 859546 | 8 238 234 | 85 51 |
| 4 9 | 859546 | 859836 | 860126 | 860415 | 860705 | 860994 | 861283 | 9 268 263 | 85 50 |
| 4 10 | 861283 | 861572 | 861861 | 862149 | 862438 | 862726 | 863014 | 12′ 17′ | 85 49 |
| 4 11 | 863014 | 863302 | 863589 | 863877 | 864164 | 864451 | 864738 | 1″ 30 28 | 85 48 |
| 4 12 | 864738 | 865024 | 865311 | 865597 | 865883 | 866169 | 866455 | 2 57 56 | 85 47 |
| 4 13 | 866455 | 866740 | 867025 | 867310 | 867595 | 867880 | 868165 | 3 86 84 | 85 46 |
| 4 14 | 868165 | 868449 | 868733 | 869017 | 869301 | 869585 | 869868 | 4 114 112 | 85 45 |
| 4 15 | 869868 | 870151 | 870434 | 870717 | 871000 | 871282 | 871565 | 5 143 140 | 85 44 |
| 4 16 | 871565 | 871847 | 872129 | 872410 | 872692 | 872973 | 873255 | 6 172 169 | 85 43 |
| 4 17 | 873255 | 873536 | 873817 | 874097 | 874378 | 874658 | 874938 | 7 200 197 | 85 42 |
| 4 18 | 874938 | 875218 | 875498 | 875777 | 876057 | 876336 | 876615 | 8 229 225 | 85 41 |
| 4 19 | 876615 | 876894 | 877172 | 877451 | 877729 | 878007 | 878285 | 9 257 253 | 85 40 |
| 4 20 | 878285 | 878563 | 878841 | 879118 | 879395 | 879672 | 879949 | 22′ 27′ | 85 39 |
| 4 21 | 879949 | 880226 | 880503 | 880779 | 381055 | 881331 | 881607 | 1″ 28 27 | 85 38 |
| 4 22 | 881607 | 881883 | 882158 | 882433 | 882708 | 882983 | 883258 | 2 55 54 | 85 37 |
| 4 23 | 883258 | 883533 | 883807 | 884081 | 884355 | 884629 | 884903 | 3 82 81 | 85 36 |
| 4 24 | 884903 | 885177 | 885450 | 885723 | 885996 | 886269 | 886542 | 4 110 108 | 85 35 |
| 4 25 | 886542 | 886814 | 887087 | 887359 | 887631 | 887903 | 888174 | 5 137 135 | 85 34 |
| 4 26 | 888174 | 888446 | 888717 | 888988 | 889259 | 889530 | 889801 | 6 165 162 | 85 33 |
| 4 27 | 889801 | 890071 | 890341 | 890612 | 890882 | 891151 | 891421 | 7 192 189 | 85 32 |
| 4 28 | 891421 | 891690 | 891960 | 892229 | 892498 | 892767 | 893035 | 8 220 216 | 85 31 |
| 4 29 | 893035 | 893304 | 893572 | 893840 | 894108 | 894376 | 894643 | 9 247 243 | 85 30 |
| 4 30 | 894643 | 894911 | 895178 | 895445 | 895712 | 895979 | 896246 | | 85 29 |
| ° ′ | 60″ | 50″ | 40″ | 30″ | 20″ | 10″ | 0″ | Parts | ° ′ |

Cosine

## LOG. SINES, COSINES, &c.

$0^h\ 0^m$ — 0°

| ′ ″ | m. s. | Sine | D. | Cosec. | Tangent | D. | Cotang. | Secant | D. | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | — ∞ | | ∞ | — ∞ | | ∞ | 10·000000 | 0 | 10·000000 | 60 | 60 |
| 30 | 2 | 6·162696 | 477121 | 13·837394 | 6·162696 | 477121 | 13·837304 | 10·000000 | 0 | 10·000000 | 58 | 30 |
| 1 | 4 | 6·463726 | 221849 | 13·536274 | 6·463726 | 221849 | 13·536274 | 10·000000 | 0 | 10·000000 | 56 | 59 |
| 30 | 6 | 6·639817 | 146128 | 13·360183 | 6·639817 | 146128 | 13·360183 | 10·000000 | 0 | 10·000000 | 54 | 30 |
| 2 | 8 | 6·764756 | 109145 | 13·235244 | 6·764756 | 109145 | 13·235244 | 10·000000 | 0 | 10·000000 | 52 | 58 |
| 30 | 10 | 6·861666 | 87150 | 13·138334 | 6·861666 | 87150 | 13·138334 | 10·000000 | 0 | 10·000000 | 50 | 30 |
| 3 | 12 | 6·940847 | 72550 | 13·059153 | 6·940847 | 72551 | 13·059153 | 10·000000 | 0 | 10·000000 | 48 | 57 |
| 30 | 14 | 7·007794 | 62148 | 12·992206 | 7·007794 | 62148 | 12·992206 | 10·000000 | 0 | 10·000000 | 46 | 30 |
| 4 | 16 | 7·065786 | 54358 | 12·934214 | 7·065786 | 54357 | 12·934214 | 10·000000 | 0 | 10·000000 | 44 | 56 |
| 30 | 18 | 7·116939 | 48305 | 12·883061 | 7·116939 | 48305 | 12·883061 | 10·000000 | 0 | 10·000000 | 42 | 30 |
| 5 | 20 | 7·162696 | 43465 | 12·837304 | 7·162696 | 43466 | 12·837304 | 10·000000 | 0 | 10·000000 | 40 | 55 |
| 30 | 22 | 7·204089 | 39509 | 12·795911 | 7·204089 | 39508 | 12·795911 | 10·000001 | 0 | 9·999999 | 38 | 30 |
| 6 | 24 | 7·241877 | 36212 | 12·758123 | 7·241878 | 36213 | 12·758122 | 10·000001 | 0 | 9·999999 | 36 | 54 |
| 30 | 26 | 7·276639 | 33424 | 12·723361 | 7·276640 | 33423 | 12·723360 | 10·000001 | 0 | 9·999999 | 34 | 30 |
| 7 | 28 | 7·308824 | 31034 | 12·691176 | 7·308825 | 31035 | 12·691175 | 10·000001 | 0 | 9·999999 | 32 | 53 |
| 30 | 30 | 7·338787 | 28963 | 12·661213 | 7·338788 | 28964 | 12·661212 | 10·000001 | 0 | 9·999999 | 30 | 30 |
| 8 | 32 | 7·366816 | 27153 | 12·633184 | 7·366817 | 27152 | 12·633183 | 10·000001 | 0 | 9·999999 | 28 | 52 |
| 30 | 34 | 7·393145 | 25554 | 12·606855 | 7·393146 | 25554 | 12·606854 | 10·000001 | 0 | 9·999999 | 26 | 30 |
| 9 | 36 | 7·417968 | 24133 | 12·582032 | 7·417970 | 24134 | 12·582030 | 10·000001 | 0 | 9·999999 | 24 | 51 |
| 30 | 38 | 7·441449 | 22863 | 12·558551 | 7·441451 | 22863 | 12·558549 | 10·000002 | 0 | 9·999998 | 22 | 30 |
| 10 | 40 | 7·463726 | 21719 | 12·536274 | 7·463727 | 21719 | 12·536273 | 10·000002 | 0 | 9·999998 | 20 | 50 |
| 30 | 42 | 7·484915 | 20685 | 12·515085 | 7·484917 | 20685 | 12·515083 | 10·000002 | 0 | 9·999998 | 18 | 30 |
| 11 | 44 | 7·505118 | 19744 | 12·494882 | 7·505120 | 19744 | 12·494880 | 10·000002 | 0 | 9·999998 | 16 | 49 |
| 30 | 46 | 7·524423 | 18885 | 12·475577 | 7·524426 | 18886 | 12·475574 | 10·000002 | 0 | 9·999998 | 14 | 30 |
| 12 | 48 | 7·542906 | 18098 | 12·457094 | 7·542909 | 18098 | 12·457091 | 10·000003 | 0 | 9·999997 | 12 | 48 |
| 30 | 50 | 7·560635 | 17374 | 12·439365 | 7·560638 | 17374 | 12·439362 | 10·000003 | 0 | 9·999997 | 10 | 30 |
| 13 | 52 | 7·577668 | 16706 | 12·422332 | 7·577672 | 16706 | 12·422328 | 10·000003 | 0 | 9·999997 | 8 | 47 |
| 30 | 54 | 7·594059 | 16087 | 12·405941 | 7·594062 | 16087 | 12·405938 | 10·000003 | 0 | 9·999997 | 6 | 30 |
| 14 | 56 | 7·609853 | 15512 | 12·390147 | 7·609857 | 15512 | 12·390143 | 10·000004 | 0 | 9·999996 | 4 | 46 |
| 30 | 58 | 7·625093 | 14977 | 12·374907 | 7·625097 | 14978 | 12·374903 | 10·000004 | 0 | 9·999996 | 2 | 30 |
| 15 | 1 | 7·639816 | 14478 | 12·360184 | 7·639820 | 14478 | 12·360180 | 10·000004 | 0 | 9·999996 | 59 | 45 |
| 30 | 2 | 7·654056 | 14010 | 12·345944 | 7·654061 | 14011 | 12·345939 | 10·000004 | 0 | 9·999996 | 58 | 30 |
| 16 | 4 | 7·667845 | 13573 | 12·332155 | 7·667849 | 13573 | 12·332151 | 10·000005 | 0 | 9·999995 | 56 | 44 |
| 30 | 6 | 7·681208 | 13161 | 12·318792 | 7·681213 | 13161 | 12·318787 | 10·000005 | 0 | 9·999995 | 54 | 30 |
| 17 | 8 | 7·694173 | 12774 | 12·305827 | 7·694179 | 12775 | 12·305821 | 10·000005 | 0 | 9·999995 | 52 | 43 |
| 30 | 10 | 7·706762 | 12410 | 12·293238 | 7·706768 | 12409 | 12·293232 | 10·000006 | 0 | 9·999994 | 50 | 30 |
| 18 | 12 | 7·718997 | 12064 | 12·281003 | 7·719003 | 12065 | 12·280997 | 10·000006 | 0 | 9·999994 | 48 | 42 |
| 30 | 14 | 7·730896 | 11738 | 12·269104 | 7·730902 | 11739 | 12·269098 | 10·000006 | 0 | 9·999994 | 46 | 30 |
| 19 | 16 | 7·742478 | 11430 | 12·257522 | 7·742484 | 11429 | 12·257516 | 10·000007 | 0 | 9·999993 | 44 | 41 |
| 30 | 18 | 7·753758 | 11136 | 12·246242 | 7·753765 | 11137 | 12·246235 | 10·000007 | 0 | 9·999993 | 42 | 30 |
| 20 | 20 | 7·764754 | 10858 | 12·235246 | 7·764761 | 10858 | 12·235239 | 10·000007 | 0 | 9·999993 | 40 | 40 |
| 30 | 22 | 7·775477 | 10593 | 12·224523 | 7·775485 | 10593 | 12·224515 | 10·000008 | 0 | 9·999992 | 38 | 30 |
| 21 | 24 | 7·785943 | 10340 | 12·214057 | 7·785951 | 10342 | 12·214049 | 10·000008 | 0 | 9·999992 | 36 | 39 |
| 30 | 26 | 7·796162 | 10100 | 12·203838 | 7·796170 | 10100 | 12·203830 | 10·000009 | 0 | 9·999991 | 34 | 30 |
| 22 | 28 | 7·806146 | 9871 | 12·193854 | 7·806155 | 9871 | 12·193845 | 10·000009 | 0 | 9·999991 | 32 | 38 |
| 30 | 30 | 7·815906 | 9651 | 12·184094 | 7·815915 | 9652 | 12·184085 | 10·000009 | 0 | 9·999991 | 30 | 30 |
| 23 | 32 | 7·825451 | 9442 | 12·174549 | 7·825460 | 9442 | 12·174540 | 10·000010 | 0 | 9·999990 | 28 | 37 |
| 30 | 34 | 7·834791 | 9240 | 12·165209 | 7·834801 | 9241 | 12·165199 | 10·000010 | 0 | 9·999990 | 26 | 30 |
| 24 | 36 | 7·843934 | 9048 | 12·156066 | 7·843944 | 9048 | 12·156056 | 10·000011 | 0 | 9·999989 | 24 | 36 |
| 30 | 38 | 7·852889 | 8864 | 12·147111 | 7·852900 | 8864 | 12·147100 | 10·000011 | 0 | 9·999989 | 22 | 30 |
| 25 | 40 | 7·861662 | 8686 | 12·138338 | 7·861674 | 8686 | 12·138326 | 10·000011 | 0 | 9·999989 | 20 | 35 |
| 30 | 42 | 7·870262 | 8515 | 12·129738 | 7·870274 | 8516 | 12·129726 | 10·000012 | 0 | 9·999988 | 18 | 30 |
| 26 | 44 | 7·878695 | 8352 | 12·121305 | 7·878708 | 8353 | 12·121292 | 10·000012 | 0 | 9·999988 | 16 | 34 |
| 30 | 46 | 7·886963 | 8195 | 12·113032 | 7·886981 | 8195 | 12·113019 | 10·000013 | 0 | 9·999987 | 14 | 30 |
| 27 | 48 | 7·895085 | 8042 | 12·104915 | 7·895099 | 8043 | 12·104901 | 10·000013 | 0 | 9·999987 | 12 | 33 |
| 30 | 50 | 7·903054 | 7896 | 12·096946 | 7·903068 | 7897 | 12·096932 | 10·000014 | 0 | 9·999986 | 10 | 30 |
| 28 | 52 | 7·910879 | 7756 | 12·089121 | 7·910894 | 7755 | 12·089106 | 10·000014 | 1 | 9·999986 | 8 | 32 |
| 30 | 54 | 7·918566 | 7619 | 12·081434 | 7·918581 | 7620 | 12·081419 | 10·000015 | 1 | 9·999985 | 6 | 30 |
| 29 | 56 | 7·926119 | 7488 | 12·073881 | 7·926134 | 7488 | 12·073866 | 10·000015 | 1 | 9·999985 | 4 | 31 |
| 30 | 58 | 7·933543 | 7361 | 12·066457 | 7·933559 | 7362 | 12·066441 | 10·000016 | 1 | 9·999984 | 2 | 30 |
| 30 | 2 | 7·940842 | 7238 | 12·059158 | 7·940858 | 7239 | 12·059142 | 10·000017 | 1 | 9·999983 | 58 | 30 |
| ′ ″ | m. s. | Cosine | D. | Secant | Cotang. | D. | Tangent | Cosec. | D. | Sine | m. s. | ′ ″ |

89° — $5^h\ 58^m$

## LOG. SINES. COSINES, &c.

0h 2m 0°

| ′ ″ | m. s. | Sine | D. | Cosec. | Tangent | D. | Cotang. | Secant | D. | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 7·940842 | 7238 | 12·059158 | 7·940858 | 7239 | 12·059142 | 10·000017 | | 9·999983 | 58 | 30 |
| 30 | 2 | 7·948020 | 7119 | 12·051980 | 7·948037 | 7120 | 12·051963 | 10·000017 | 1 | 9·999983 | 58 | 30 |
| 31 | 4 | 7·955082 | 7005 | 12·044918 | 7·955100 | 7005 | 12·044900 | 10·000018 | 1 | 9·999982 | 56 | 29 |
| 30 | 6 | 7·962031 | 6894 | 12·037969 | 7·962049 | 6894 | 12·037951 | 10·000018 | 1 | 9·999982 | 54 | 30 |
| 32 | 8 | 7·968870 | 6785 | 12·031130 | 7·968889 | 6787 | 12·031111 | 10·000019 | 1 | 9·999981 | 52 | 28 |
| 30 | 10 | 7·975603 | 6682 | 12·024397 | 7·975622 | 6682 | 12·024378 | 10·000019 | 1 | 9·999981 | 50 | 30 |
| 33 | 12 | 7·982233 | 6580 | 12·017767 | 7·982253 | 6580 | 12·017747 | 10·000020 | 1 | 9·999980 | 48 | 27 |
| 30 | 14 | 7·988764 | 6482 | 12·011236 | 7·988785 | 6483 | 12·011215 | 10·000021 | 1 | 9·999979 | 46 | 30 |
| 34 | 16 | 7·995198 | 6387 | 12·004802 | 7·995219 | 6387 | 12·004781 | 10·000021 | 1 | 9·999979 | 44 | 26 |
| 30 | 18 | 8·001538 | 6294 | 11·998462 | 8·001560 | 6295 | 11·998440 | 10·000022 | 1 | 9·999978 | 42 | 30 |
| 35 | 20 | 8·007787 | 6204 | 11·992213 | 8·007809 | 6204 | 11·992191 | 10·000023 | 1 | 9·999977 | 40 | 25 |
| 30 | 22 | 8·013947 | 6116 | 11·986053 | 8·013970 | 6118 | 11·986030 | 10·000023 | 1 | 9·999977 | 38 | 30 |
| 36 | 24 | 8·020021 | 6032 | 11·979979 | 8·020045 | 6032 | 11·979956 | 10·000024 | 1 | 9·999976 | 36 | 24 |
| 30 | 26 | 8·026011 | 5949 | 11·973989 | 8·026035 | 5950 | 11·973965 | 10·000024 | 1 | 9·999976 | 34 | 30 |
| 37 | 28 | 8·031919 | 5869 | 11·968081 | 8·031945 | 5869 | 11·968055 | 10·000025 | 1 | 9·999975 | 32 | 23 |
| 30 | 30 | 8·037749 | 5790 | 11·962251 | 8·037775 | 5792 | 11·962225 | 10·000026 | 1 | 9·999974 | 30 | 30 |
| 38 | 32 | 8·043501 | 5715 | 11·956499 | 8·043527 | 5714 | 11·956473 | 10·000027 | 1 | 9·999973 | 28 | 22 |
| 30 | 34 | 8·049178 | 5640 | 11·950822 | 8·049205 | 5641 | 11·950795 | 10·000027 | 1 | 9·999973 | 26 | 30 |
| 39 | 36 | 8·054781 | 5567 | 11·945219 | 8·054809 | 5569 | 11·945191 | 10·000028 | 1 | 9·999972 | 24 | 21 |
| 30 | 38 | 8·060314 | 5498 | 11·939686 | 8·060342 | 5498 | 11·939658 | 10·000029 | 1 | 9·999971 | 22 | 30 |
| 40 | 40 | 8·065776 | 5428 | 11·934224 | 8·065806 | 5429 | 11·934194 | 10·000029 | 1 | 9·999971 | 20 | 20 |
| 30 | 42 | 8·071171 | 5362 | 11·928829 | 8·071201 | 5362 | 11·928799 | 10·000030 | 1 | 9·999970 | 18 | 30 |
| 41 | 44 | 8·076500 | 5296 | 11·923500 | 8·076531 | 5297 | 11·923469 | 10·000031 | 1 | 9·999969 | 16 | 19 |
| 30 | 46 | 8·081764 | 5232 | 11·918236 | 8·081795 | 5233 | 11·918205 | 10·000032 | 1 | 9·999968 | 14 | 30 |
| 42 | 48 | 8·086965 | 5170 | 11·913035 | 8·086997 | 5171 | 11·913003 | 10·000032 | 1 | 9·999968 | 12 | 18 |
| 30 | 50 | 8·092104 | 5109 | 11·907896 | 8·092137 | 5110 | 11·907863 | 10·000033 | 1 | 9·999967 | 10 | 30 |
| 43 | 52 | 8·097183 | 5050 | 11·902817 | 8·097217 | 5050 | 11·902783 | 10·000034 | 1 | 9·999966 | 8 | 17 |
| 30 | 54 | 8·102204 | 4991 | 11·897796 | 8·102239 | 4993 | 11·897761 | 10·000035 | 1 | 9·999965 | 6 | 30 |
| 44 | 56 | 8·107167 | 4935 | 11·892833 | 8·107203 | 4935 | 11·892797 | 10·000036 | 1 | 9·999964 | 4 | 16 |
| 30 | 58 | 8·112074 | 4880 | 11·887926 | 8·112110 | 4881 | 11·887890 | 10·000036 | 1 | 9·999964 | 2 | 30 |
| 45 | 3 | 8·116926 | 4825 | 11·883074 | 8·116963 | 4826 | 11·883037 | 10·000037 | 1 | 9·999963 | 57 | 15 |
| 30 | 2 | 8·121725 | 4772 | 11·878275 | 8·121763 | 4773 | 11·878237 | 10·000038 | 1 | 9·999962 | 58 | 30 |
| 46 | 4 | 8·126471 | 4721 | 11·873529 | 8·126510 | 4721 | 11·873490 | 10·000039 | 1 | 9·999961 | 56 | 14 |
| 30 | 6 | 8·131166 | 4669 | 11·868834 | 8·131206 | 4671 | 11·868794 | 10·000040 | 1 | 9·999960 | 54 | 30 |
| 47 | 8 | 8·135810 | 4620 | 11·864190 | 8·135851 | 4620 | 11·864149 | 10·000041 | 1 | 9·999959 | 52 | 13 |
| 30 | 10 | 8·140406 | 4572 | 11·859594 | 8·140447 | 4572 | 11·859553 | 10·000041 | 1 | 9·999959 | 50 | 30 |
| 48 | 12 | 8·144953 | 4523 | 11·855047 | 8·144996 | 4525 | 11·855004 | 10·000042 | 1 | 9·999958 | 48 | 12 |
| 30 | 14 | 8·149453 | 4477 | 11·850547 | 8·149497 | 4478 | 11·850503 | 10·000043 | 1 | 9·999957 | 46 | 30 |
| 49 | 16 | 8·153907 | 4431 | 11·846093 | 8·153952 | 4432 | 11·846048 | 10·000044 | 1 | 9·999956 | 44 | 11 |
| 30 | 18 | 8·158316 | 4387 | 11·841684 | 8·158361 | 4388 | 11·841639 | 10·000045 | 1 | 9·999955 | 42 | 30 |
| 50 | 20 | 8·162681 | 4343 | 11·837319 | 8·162727 | 4343 | 11·837273 | 10·000046 | 1 | 9·999954 | 40 | 10 |
| 30 | 22 | 8·167002 | 4299 | 11·832998 | 8·167049 | 4301 | 11·832951 | 10·000047 | 1 | 9·999953 | 38 | 30 |
| 51 | 24 | 8·171280 | 4258 | 11·828720 | 8·171328 | 4258 | 11·828672 | 10·000048 | 1 | 9·999952 | 36 | 9 |
| 30 | 26 | 8·175517 | 4216 | 11·824483 | 8·175566 | 4217 | 11·824434 | 10·000049 | 1 | 9·999951 | 34 | 30 |
| 52 | 28 | 8·179713 | 4176 | 11·820287 | 8·179763 | 4177 | 11·820237 | 10·000050 | 1 | 9·999950 | 32 | 8 |
| 30 | 30 | 8·183869 | 4136 | 11·816131 | 8·183919 | 4137 | 11·816081 | 10·000051 | 1 | 9·999949 | 30 | 30 |
| 53 | 32 | 8·187985 | 4096 | 11·812015 | 8·188036 | 4097 | 11·811964 | 10·000052 | 1 | 9·999948 | 28 | 7 |
| 30 | 34 | 8·192062 | 4059 | 11·807938 | 8·192115 | 4060 | 11·807885 | 10·000053 | 1 | 9·999947 | 26 | 30 |
| 54 | 36 | 8·196102 | 4021 | 11·803898 | 8·196156 | 4022 | 11·803844 | 10·000054 | 1 | 9·999946 | 24 | 6 |
| 30 | 38 | 8·200104 | 3984 | 11·799896 | 8·200159 | 3985 | 11·799841 | 10·000055 | 1 | 9·999945 | 22 | 30 |
| 55 | 40 | 8·204070 | 3948 | 11·795930 | 8·204126 | 3949 | 11·795874 | 10·000056 | 1 | 9·999944 | 20 | 5 |
| 30 | 42 | 8·208000 | 3912 | 11·792000 | 8·208057 | 3913 | 11·791943 | 10·000057 | 1 | 9·999943 | 18 | 30 |
| 56 | 44 | 8·211895 | 3877 | 11·788105 | 8·211953 | 3878 | 11·788047 | 10·000058 | 1 | 9·999942 | 16 | 4 |
| 30 | 46 | 8·215755 | 3843 | 11·784245 | 8·215814 | 3844 | 11·784186 | 10·000059 | 1 | 9·999941 | 14 | 30 |
| 57 | 48 | 8·219581 | 3810 | 11·780419 | 8·219641 | 3811 | 11·780359 | 10·000060 | 1 | 9·999940 | 12 | 3 |
| 30 | 50 | 8·223374 | 3776 | 11·776626 | 8·223434 | 3777 | 11·776566 | 10·000061 | 1 | 9·999939 | 10 | 30 |
| 58 | 52 | 8·227134 | 3743 | 11·772866 | 8·227195 | 3745 | 11·772805 | 10·000062 | 1 | 9·999938 | 8 | 2 |
| 30 | 54 | 8·230861 | 3712 | 11·769139 | 8·230924 | 3712 | 11·769076 | 10·000063 | 1 | 9·999937 | 6 | 30 |
| 59 | 56 | 8·234557 | 3680 | 11·765443 | 8·234621 | 3681 | 11·765379 | 10·000064 | 1 | 9·999936 | 4 | 1 |
| 30 | 58 | 8·238221 | 3649 | 11·761779 | 8·238286 | 3651 | 11·761714 | 10·000065 | 1 | 9·999935 | 2 | 30 |
| 60 | 4 | 8·241855 | 3619 | 11·758145 | 8·241921 | 3620 | 11·758079 | 10·000066 | 1 | 9·999934 | 0 | 0 |
| ′ ″ | m. s. | Cosine | D. | Secant | Cotang. | D. | Tangent | Cosec. | D. | Sine | m. s. | ′ ″ |

89° 5h 56m

## LOG. SINES, COSINES, &c.

0h 4m — 1°

| ′ ″ | m. s. | Sine | D. | Cosec. | Tangent | D. | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 8·241855 | 3619 | 11·758145 | 8·241921 | 3620 | 11·758079 | 10·000066 | | 9·999934 | 56 | 60 |
| 30 | 2 | 8·245459 | 3589 | 11·754541 | 8·245526 | 3590 | 11·754474 | 10·000067 | 1″ 0 | 9·999933 | 58 | 30 |
| 1 | 4 | 8·249033 | 3559 | 11·750967 | 8·249102 | 3560 | 11·750898 | 10·000068 | 2 0 | 9·999932 | 56 | 59 |
| 30 | 6 | 8·252578 | 3531 | 11·747422 | 8·252648 | 3532 | 11·747352 | 10·000069 | 3 0 | 9·999931 | 54 | 30 |
| 2 | 8 | 8·256094 | 3502 | 11·743906 | 8·256165 | 3503 | 11·743835 | 10·000071 | 4 0 | 9·999929 | 52 | 58 |
| 30 | 10 | 8·259582 | 3474 | 11·740418 | 8·259654 | 3475 | 11·740346 | 10·000072 | 5 0 | 9·999928 | 50 | 30 |
| 3 | 12 | 8·263042 | 3446 | 11·736958 | 8·263115 | 3448 | 11·736885 | 10·000073 | 6 0 | 9·999927 | 48 | 57 |
| 30 | 14 | 8·266475 | 3419 | 11·733525 | 8·266549 | 3420 | 11·733451 | 10·000074 | 7 0 | 9·999926 | 46 | 30 |
| 4 | 16 | 8·269881 | 3393 | 11·730119 | 8·269956 | 3394 | 11·730044 | 10·000075 | 8 0 | 9·999925 | 44 | 56 |
| 30 | 18 | 8·273260 | 3366 | 11·726740 | 8·273337 | 3367 | 11·726663 | 10·000076 | 9 0 | 9·999924 | 42 | 30 |
| 5 | 20 | 8·276614 | 3341 | 11·723386 | 8·276691 | 3342 | 11·723309 | 10·000078 | 10 0 | 9·999922 | 40 | 55 |
| 30 | 22 | 8·279941 | 3314 | 11·7200[illegible] | 8·280020 | 3316 | 11·719980 | 10·000079 | 11 0 | 9·999921 | 38 | 30 |
| 6 | 24 | 8·283243 | 3290 | 11·716757 | 8·283323 | 3291 | 11·716677 | 10·000080 | 12 0 | 9·999920 | 36 | 54 |
| 30 | 26 | 8·286521 | 3265 | 11·713479 | 8·286602 | 3266 | 11·713398 | 10·000081 | 13 1 | 9·999919 | 34 | 30 |
| 7 | 28 | 8·289773 | 3241 | 11·710227 | 8·289856 | 3242 | 11·710144 | 10·000082 | 14 1 | 9·999918 | 32 | 53 |
| 30 | 30 | 8·293002 | 3216 | 11·706998 | 8·293086 | 3218 | 11·706914 | 10·000084 | 15 1 | 9·999916 | 30 | 30 |
| 8 | 32 | 8·296207 | 3193 | 11·703793 | 8·296292 | 3194 | 11·703708 | 10·000085 | 16 1 | 9·999915 | 28 | 52 |
| 30 | 34 | 8·299388 | 3170 | 11·700612 | 8·299474 | 3171 | 11·700526 | 10·000086 | 17 1 | 9·999914 | 26 | 30 |
| 9 | 36 | 8·302546 | 3147 | 11·697454 | 8·302634 | 3148 | 11·697366 | 10·000087 | 18 1 | 9·999913 | 24 | 51 |
| 30 | 38 | 8·305681 | 3124 | 11·694319 | 8·305770 | 3125 | 11·694230 | 10·000089 | 19 1 | 9·999911 | 22 | 30 |
| 10 | 40 | 8·308794 | 3102 | 11·691206 | 8·308884 | 3103 | 11·691116 | 10·000090 | 20 1 | 9·999910 | 20 | 50 |
| 30 | 42 | 8·311885 | 3080 | 11·688115 | 8·311976 | 3081 | 11·688024 | 10·000091 | 21 1 | 9·999909 | 18 | 30 |
| 11 | 44 | 8·314954 | 3058 | 11·685046 | 8·315046 | 3059 | 11·684954 | 10·000093 | 22 1 | 9·999907 | 16 | 49 |
| 30 | 46 | 8·318001 | 3036 | 11·681999 | 8·318095 | 3038 | 11·681905 | 10·000094 | 23 1 | 9·999906 | 14 | 30 |
| 12 | 48 | 8·321027 | 3016 | 11·678973 | 8·321122 | 3017 | 11·678878 | 10·000095 | 24 1 | 9·999905 | 12 | 48 |
| 30 | 50 | 8·324032 | 2995 | 11·675968 | 8·324129 | 2996 | 11·675871 | 10·000097 | 25 1 | 9·999903 | 10 | 30 |
| 13 | 52 | 8·327016 | 2974 | 11·672984 | 8·327114 | 2975 | 11·672886 | 10·000098 | 26 1 | 9·999902 | 8 | 47 |
| 30 | 54 | 8·329980 | 2954 | 11·670020 | 8·330080 | 2956 | 11·669920 | 10·000099 | 27 1 | 9·999901 | 6 | 30 |
| 14 | 56 | 8·332924 | 2934 | 11·667076 | 8·333025 | 2935 | 11·666975 | 10·000101 | 28 1 | 9·999899 | 4 | 46 |
| 30 | 58 | 8·335848 | 2914 | 11·664152 | 8·335950 | 2916 | 11·664050 | 10·000102 | 29 1 | 9·999898 | 2 | 30 |
| 15 | 5 | 8·338753 | 2895 | 11·661247 | 8·338856 | 2896 | 11·661144 | 10·000103 | 30 1 | 9·999897 | 55 | 45 |
| 30 | 2 | 8·341638 | 2876 | 11·658362 | 8·341743 | 2877 | 11·658257 | 10·000105 | 1 0 | 9·999895 | 58 | 30 |
| 16 | 4 | 8·344504 | 2856 | 11·655496 | 8·344610 | 2858 | 11·655390 | 10·000106 | 2 0 | 9·999894 | 56 | 44 |
| 30 | 6 | 8·347352 | 2838 | 11·652648 | 8·347459 | 2840 | 11·652541 | 10·000108 | 3 0 | 9·999892 | 54 | 30 |
| 17 | 8 | 8·350181 | 2820 | 11·649819 | 8·350289 | 2821 | 11·649711 | 10·000109 | 4 0 | 9·999891 | 52 | 43 |
| 30 | 10 | 8·352991 | 2801 | 11·647009 | 8·353101 | 2803 | 11·646899 | 10·000110 | 5 0 | 9·999890 | 50 | 30 |
| 18 | 12 | 8·355783 | 2784 | 11·644217 | 8·355895 | 2784 | 11·644105 | 10·000112 | 6 0 | 9·999888 | 48 | 42 |
| 30 | 14 | 8·358558 | 2766 | 11·641442 | 8·358671 | 2768 | 11·641329 | 10·000[illegible]3 | 7 0 | 9·999887 | 46 | 30 |
| 19 | 16 | 8·361315 | 2748 | 11·638685 | 8·361430 | 2749 | 11·638570 | 10·000115 | 8 0 | 9·999885 | 44 | 41 |
| 30 | 18 | 8·364055 | 2731 | 11·635945 | 8·364171 | 2733 | 11·635829 | 10·000116 | 9 0 | 9·999884 | 42 | 30 |
| 20 | 20 | 8·366777 | 2714 | 11·633223 | 8·366895 | 2715 | 11·633105 | 10·000118 | 10 1 | 9·999882 | 40 | 40 |
| 30 | 22 | 8·369482 | 2697 | 11·630518 | 8·369601 | 2699 | 11·630399 | 10·000119 | 11 1 | 9·999881 | 38 | 30 |
| 21 | 24 | 8·372171 | 2680 | 11·627829 | 8·372292 | 2681 | 11·627708 | 10·000121 | 12 1 | 9·999879 | 36 | 39 |
| 30 | 26 | 8·374843 | 2664 | 11·625157 | 8·374965 | 2666 | 11·625035 | 10·000122 | 13 1 | 9·999878 | 34 | 30 |
| 22 | 28 | 8·377499 | 2648 | 11·622501 | 8·377622 | 2649 | 11·622378 | 10·000124 | 14 1 | 9·999876 | 32 | 38 |
| 30 | 30 | 8·380138 | 2631 | 11·619862 | 8·380263 | 2633 | 11·619737 | 10·000125 | 15 1 | 9·999875 | 30 | 30 |
| 23 | 32 | 8·382762 | 2616 | 11·617238 | 8·382889 | 2617 | 11·617111 | 10·000127 | 16 1 | 9·999873 | 28 | 37 |
| 30 | 34 | 8·385370 | 2600 | 11·614630 | 8·385498 | 2602 | 11·614502 | 10·000128 | 17 1 | 9·999872 | 26 | 30 |
| 24 | 36 | 8·387962 | 2585 | 11·612038 | 8·388092 | 2586 | 11·611908 | 10·000130 | 18 1 | 9·999870 | 24 | 36 |
| 30 | 38 | 8·390539 | 2569 | 11·609461 | 8·390670 | 2571 | 11·609330 | 10·000131 | 19 1 | 9·999869 | 22 | 30 |
| 25 | 40 | 8·393101 | 2554 | 11·606899 | 8·393234 | 2556 | 11·606766 | 10·000133 | 20 1 | 9·999867 | 20 | 35 |
| 30 | 42 | 8·395647 | 2539 | 11·604352 | 8·395782 | 2540 | 11·604218 | 10·000134 | 21 1 | 9·999866 | 18 | 30 |
| 26 | 44 | 8·398179 | 2525 | 11·601821 | 8·398315 | 2526 | 11·601685 | 10·000136 | 22 1 | 9·999864 | 16 | 34 |
| 30 | 46 | 8·400696 | 2510 | 11·599304 | 8·400834 | 2512 | 11·599166 | 10·000137 | 23 1 | 9·999863 | 14 | 30 |
| 27 | 48 | 8·403199 | 2495 | 11·596801 | 8·403338 | 2497 | 11·596662 | 10·000139 | 24 1 | 9·999861 | 12 | 33 |
| 30 | 50 | 8·405687 | 2481 | 11·594313 | 8·405828 | 2483 | 11·594172 | 10·000141 | 25 1 | 9·999859 | 10 | 30 |
| 28 | 52 | 8·408161 | 2467 | 11·591839 | 8·408304 | 2468 | 11·591696 | 10·000142 | 26 1 | 9·999858 | 8 | 32 |
| 30 | 54 | 8·410621 | 2453 | 11·589379 | 8·410765 | 2455 | 11·58923[illegible] | 10·000144 | 27 1 | 9·999856 | 6 | 30 |
| 29 | 56 | 8·413068 | 2440 | 11·586932 | 8·413213 | 2441 | 11·586787 | 10·000146 | 28 1 | 9·999854 | 4 | 31 |
| 30 | 58 | 8·415500 | 2425 | 11·584500 | 8·415647 | 2427 | 11·584353 | 10·000147 | 29 1 | 9·999853 | 2 | 30 |
| 30 | 6 | 8·417919 | 2412 | 11·582081 | 8·418068 | 2414 | 11·581932 | 10·000149 | 30 2 | 9·999851 | 0 | 30 |
| ′ ″ | m. s. | Cosine | D. | Secant | Cotang. | D. | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

88° — 5h 54m

## LOG. SINES, COSINES, &c.

$0^h\ 6^m$ — 1°

| ′ ″ | m. s. | Sine | D. | Cosec. | Tangent | D. | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 8·417919 | 2412 | 11·582081 | 8·418068 | 2414 | 11·581932 | 10·000149 | | 9·999851 | 54 | 30 |
| 30 | 2 | 8·420325 | 2399 | 11·579675 | 8·420475 | 2401 | 11·579525 | 10·000151 | 1″ 0 | 9·999849 | 58 | 30 |
| 31 | 4 | 8·422717 | 2386 | 11·577283 | 8·422869 | 2387 | 11·577131 | 10·000152 | 2 0 | 9·999848 | 56 | 29 |
| 30 | 6 | 8·425096 | 2373 | 11·574904 | 8·425250 | 2374 | 11·574750 | 10·000154 | 3 0 | 9·999846 | 54 | 30 |
| 32 | 8 | 8·427462 | 2359 | 11·572538 | 8·427618 | 2362 | 11·572382 | 10·000156 | 4 0 | 9·999844 | 52 | 28 |
| 30 | 10 | 8·429815 | 2347 | 11·570185 | 8·429973 | 2348 | 11·570027 | 10·000157 | 5 0 | 9·999843 | 50 | 30 |
| 33 | 12 | 8·432156 | 2335 | 11·567844 | 8·432315 | 2336 | 11·567685 | 10·000159 | 6 0 | 9·999841 | 48 | 27 |
| 30 | 14 | 8·434484 | 2322 | 11·565516 | 8·434645 | 2324 | 11·565355 | 10·000161 | 7 0 | 9·999839 | 46 | 30 |
| 34 | 16 | 8·436800 | 2309 | 11·563200 | 8·436962 | 2311 | 11·563038 | 10·000162 | 8 0 | 9·999838 | | 26 |
| 30 | 18 | 8·439103 | 2297 | 11·560897 | 8·439267 | 2299 | 11·560733 | 10·000164 | 9 0 | 9·999836 | 42 | 30 |
| 35 | 20 | 8·441394 | 2286 | 11·558606 | 8·441560 | 2287 | 11·558440 | 10·000166 | 10 1 | 9·999834 | 40 | 25 |
| 30 | 22 | 8·443674 | 2273 | 11·556326 | 8·443841 | 2275 | 11·556159 | 10·000168 | 11 1 | 9·999832 | 38 | 30 |
| 36 | 24 | 8·445941 | 2261 | 11·554059 | 8·446110 | 2263 | 11·553890 | 10·000169 | 12 1 | 9·999831 | 36 | 24 |
| 30 | 26 | 8·448196 | 2250 | 11·551804 | 8·448368 | 2252 | 11·551632 | 10·000171 | 13 1 | 9·999829 | 34 | 30 |
| 37 | 28 | 8·450440 | 2238 | 11·549560 | 8·450613 | 2240 | 11·549387 | 10·000173 | 14 1 | 9·999827 | 32 | 23 |
| 30 | 30 | 8·452673 | 2226 | 11·547327 | 8·452847 | 2228 | 11·547153 | 10·000175 | 15 1 | 9·999825 | 30 | 30 |
| 38 | 32 | 8·454893 | 2216 | 11·545107 | 8·455070 | 2217 | 11·544930 | 10·000176 | 16 1 | 9·999824 | 28 | 22 |
| 30 | 34 | 8·457103 | 2203 | 11·542897 | 8·457281 | 2206 | 11·542719 | 10·000178 | 17 1 | 9·999822 | 26 | 30 |
| 39 | 36 | 8·459301 | 2193 | 11·540699 | 8·459481 | 2194 | 11·540519 | 10·000180 | 18 1 | 9·999820 | 24 | 21 |
| 30 | 38 | 8·461489 | 2182 | 11·538511 | 8·461670 | 2184 | 11·538330 | 10·000182 | 19 1 | 9·999818 | 22 | 30 |
| 40 | 40 | 8·463665 | 2171 | 11·536335 | 8·463849 | 2173 | 11·536151 | 10·000184 | 20 1 | 9·999816 | 20 | 20 |
| 30 | 42 | 8·465830 | 2160 | 11·534170 | 8·466016 | 2162 | 11·533984 | 10·000186 | 21 1 | 9·999814 | 18 | 30 |
| 41 | 44 | 8·467985 | 2149 | 11·532015 | 8·468172 | 2151 | 11·531828 | 10·000187 | 22 1 | 9·999813 | 16 | 19 |
| 30 | 46 | 8·470129 | 2139 | 11·529871 | 8·470318 | 2140 | 11·529682 | 10·000189 | 23 1 | 9·999811 | 14 | 30 |
| 42 | 48 | 8·472263 | 2128 | 11·527737 | 8·472454 | 2131 | 11·527546 | 10·000191 | 24 1 | 9·999809 | 12 | 18 |
| 30 | 50 | 8·474386 | 2118 | 11·525614 | 8·474579 | 2119 | 11·525421 | 10·000193 | 25 2 | 9·999807 | 10 | 30 |
| 43 | 52 | 8·476498 | 2108 | 11·523502 | 8·476693 | 2110 | 11·523307 | 10·000195 | 26 2 | 9·999805 | 8 | 17 |
| 30 | 54 | 8·478601 | 2097 | 11·521399 | 8·478798 | 2095 | 11·521202 | 10·000197 | 27 2 | 9·999803 | 6 | 30 |
| 44 | 56 | 8·480693 | 2088 | 11·519307 | 8·480892 | 2089 | 11·519108 | 10·000199 | 28 2 | 9·999801 | 4 | 16 |
| 30 | 58 | 8·482776 | 2077 | 11·517224 | 8·482976 | 2080 | 11·517024 | 10·000201 | 29 2 | 9·999799 | 2 | 30 |
| 45 | 7 | 8·484848 | 2067 | 11·515152 | 8·485050 | 2069 | 11·514950 | 10·000203 | 30 2 | 9·999797 | 53 | 15 |
| 30 | 2 | 8·486910 | 2058 | 11·513090 | 8·487115 | 2060 | 11·512885 | 10·000205 | 1 0 | 9·999795 | 58 | 30 |
| 46 | 4 | 8·488963 | 2048 | 11·511037 | 8·489170 | 2049 | 11·510830 | 10·000206 | 2 0 | 9·999794 | 56 | 14 |
| 30 | 6 | 8·491006 | 2038 | 11·508994 | 8·491215 | 2041 | 11·508785 | 10·000208 | 3 0 | 9·999792 | 54 | 30 |
| 47 | 8 | 8·493040 | 2029 | 11·506960 | 8·493250 | 2030 | 11·506750 | 10·000210 | 4 0 | 9·999790 | 52 | 13 |
| 30 | 10 | 8·495064 | 2019 | 11·504936 | 8·495276 | 2022 | 11·504724 | 10·000212 | 5 0 | 9·999788 | 50 | 30 |
| 48 | 12 | 8·497078 | 2010 | 11·502922 | 8·497293 | 2012 | 11·502707 | 10·000214 | 6 0 | 9·999786 | 48 | 12 |
| 30 | 14 | 8·499084 | 2001 | 11·500916 | 8·499300 | 2002 | 11·500700 | 10·000216 | 7 0 | 9·999784 | 46 | 30 |
| 49 | 16 | 8·501080 | 1991 | 11·498920 | 8·501298 | 1994 | 11·498702 | 10·000218 | 8 1 | 9·999782 | 44 | 11 |
| 30 | 18 | 8·503067 | 1983 | 11·496933 | 8·503287 | 1984 | 11·496713 | 10·000220 | 9 1 | 9·999780 | 42 | 30 |
| 50 | 20 | 8·505045 | 1973 | 11·494955 | 8·505267 | 1976 | 11·494733 | 10·000222 | 10 1 | 9·999778 | 40 | 10 |
| 30 | 22 | 8·507014 | 1965 | 11·492986 | 8·507238 | 1966 | 11·492762 | 10·000224 | 11 1 | 9·999776 | 38 | 30 |
| 51 | 24 | 8·508974 | 1955 | 11·491026 | 8·509200 | 1958 | 11·490800 | 10·000226 | 12 1 | 9·999774 | 36 | 9 |
| 30 | 26 | 8·510925 | 1947 | 11·489075 | 8·511153 | 1949 | 11·488847 | 10·000228 | 13 1 | 9·999772 | 34 | 30 |
| 52 | 28 | 8·512867 | 1938 | 11·487133 | 8·513098 | 1940 | 11·486902 | 10·000231 | 14 1 | 9·999769 | 32 | 8 |
| 30 | 30 | 8·514801 | 1930 | 11·485199 | 8·515034 | 1931 | 11·484966 | 10·000233 | 15 1 | 9·999767 | 30 | 30 |
| 53 | 32 | 8·516726 | 1921 | 11·483274 | 8·516961 | 1923 | 11·483039 | 10·000235 | 16 1 | 9·999765 | 28 | 7 |
| 30 | 34 | 8·518643 | 1912 | 11·481357 | 8·518880 | 1915 | 11·481120 | 10·000237 | 17 1 | 9·999763 | 26 | 30 |
| 54 | 36 | 8·520551 | 1904 | 11·479449 | 8·520790 | 1906 | 11·479210 | 10·000239 | 18 1 | 9·999761 | 24 | 6 |
| 30 | 38 | 8·522451 | 1896 | 11·477549 | 8·522692 | 1898 | 11·477308 | 10·000241 | 19 1 | 9·999759 | 22 | 30 |
| 55 | 40 | 8·524343 | 1888 | 11·475657 | 8·524586 | 1890 | 11·475414 | 10·000243 | 20 1 | 9·999757 | 20 | 5 |
| 30 | 42 | 8·526226 | 1879 | 11·473774 | 8·526472 | 1881 | 11·473528 | 10·000245 | 21 1 | 9·999755 | 18 | 30 |
| 56 | 44 | 8·528102 | 1871 | 11·471898 | 8·528349 | 1874 | 11·471651 | 10·000247 | 22 2 | 9·999753 | 16 | 4 |
| 30 | 46 | 8·529969 | 1864 | 11·470031 | 8·530218 | 1865 | 11·469782 | 10·000249 | 23 2 | 9·999751 | 14 | 30 |
| 57 | 48 | 8·531828 | 1855 | 11·468172 | 8·532080 | 1857 | 11·467920 | 10·000252 | 24 2 | 9·999748 | 12 | 3 |
| 30 | 50 | 8·533679 | 1847 | 11·466321 | 8·533933 | 1850 | 11·466067 | 10·000254 | 25 2 | 9·999746 | 10 | 30 |
| 58 | 52 | 8·535523 | 1840 | 11·464477 | 8·535779 | 1842 | 11·464221 | 10·000256 | 26 2 | 9·999744 | 8 | 2 |
| 30 | 54 | 8·537358 | 1831 | 11·462642 | 8·537617 | 1834 | 11·462383 | 10·000258 | 27 2 | 9·999742 | 6 | 30 |
| 59 | 56 | 8·539186 | 1824 | 11·460814 | 8·539447 | 1826 | 11·460553 | 10·000260 | 28 2 | 9·999740 | 4 | 1 |
| 30 | 58 | 8·541007 | 1817 | 11·458993 | 8·541269 | 1818 | 11·458731 | 10·000262 | 29 2 | 9·999738 | 2 | 30 |
| 60 | 8 | 8·542819 | 1809 | 11·457181 | 8·543084 | 1811 | 11·456916 | 10·000265 | 30 2 | 9·999735 | 0 | 0 |
| ′ ″ | m. s. | Cosine | D. | Secant | Cotang. | D. | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

88° — $5^h\ 52^m$

## LOG. SINES, COSINES, &c.

$0^h$ $8^m$ 2°

| ′ ″ | m. | Sine | D. | Cosec. | Tangent | D. | Cotang. | Secant | Parts | Cosine | m. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 8·542819 | 1809 | 11·457181 | 8·543084 | 1811 | 11·456916 | 10·000265 | | 9·999735 | 52 | 60 |
| 30 | 2 | 8·544624 | 1801 | 11·455376 | 8·544891 | 1804 | 11·455109 | 10·000267 | 1″ 0 | 9·999733 | 58 | 30 |
| 1 | 4 | 8·546422 | 1794 | 11·453578 | 8·546691 | 1796 | 11·453309 | 10·000269 | 2 0 | 9·999731 | 56 | 59 |
| 30 | 6 | 8·548212 | 1786 | 11·451788 | 8·548483 | 1789 | 11·451517 | 10·000271 | 3 0 | 9·999729 | 54 | 30 |
| 2 | 8 | 8·549995 | 1779 | 11·450005 | 8·550268 | 1781 | 11·449732 | 10·000274 | 4 0 | 9·999726 | 52 | 58 |
| 30 | 10 | 8·551770 | 1772 | 11·448230 | 8·552046 | 1774 | 11·447954 | 10·000276 | 5 0 | 9·999724 | 50 | 30 |
| 3 | 12 | 8·553539 | 1765 | 11·446461 | 8·553817 | 1767 | 11·446183 | 10·000278 | 6 0 | 9·999722 | 48 | 57 |
| 30 | 14 | 8·555300 | 1758 | 11·444700 | 8·555580 | 1760 | 11·444420 | 10·000280 | 7 1 | 9·999720 | 46 | 30 |
| 4 | 16 | 8·557054 | 1750 | 11·442946 | 8·557336 | 1753 | 11·442664 | 10·000283 | 8 1 | 9·999717 | 44 | 56 |
| 30 | 18 | 8·558801 | 1743 | 11·441199 | 8·559085 | 1745 | 11·440915 | 10·000285 | 9 1 | 9·999715 | 42 | 30 |
| 5 | 20 | 8·560540 | 1737 | 11·439460 | 8·560828 | 1739 | 11·439172 | 10·000287 | 10 1 | 9·999713 | 40 | 55 |
| 30 | 22 | 8·562273 | 1729 | 11·437727 | 8·562563 | 1732 | 11·437437 | 10·000289 | 11 1 | 9·999711 | 38 | 30 |
| 6 | 24 | 8·563999 | 1723 | 11·436001 | 8·564291 | 1725 | 11·435709 | 10·000292 | 12 1 | 9·999708 | 36 | 54 |
| 30 | 26 | 8·565719 | 1716 | 11·434281 | 8·566013 | 1718 | 11·433987 | 10·000294 | 13 1 | 9·999706 | 34 | 30 |
| 7 | 28 | 8·567431 | 1709 | 11·432569 | 8·567727 | 1711 | 11·432273 | 10·000296 | 14 1 | 9·999704 | 32 | 53 |
| 30 | 30 | 8·569137 | 1702 | 11·430863 | 8·569435 | 1705 | 11·430565 | 10·000299 | 15 1 | 9·999701 | 30 | 30 |
| 8 | 32 | 8·570836 | 1696 | 11·429164 | 8·571137 | 1698 | 11·428863 | 10·000301 | 16 1 | 9·999699 | 28 | 52 |
| 30 | 34 | 8·572528 | 1689 | 11·427472 | 8·572832 | 1692 | 11·427168 | 10·000304 | 17 1 | 9·999696 | 26 | 30 |
| 9 | 36 | 8·574214 | 1682 | 11·425786 | 8·574520 | 1684 | 11·425480 | 10·000306 | 18 1 | 9·999694 | 24 | 51 |
| 30 | 38 | 8·575893 | 1676 | 11·424107 | 8·576201 | 1679 | 11·423799 | 10·000308 | 19 1 | 9·999692 | 22 | 30 |
| 10 | 40 | 8·577566 | 1670 | 11·422434 | 8·577877 | 1672 | 11·422123 | 10·000311 | 20 2 | 9·999689 | 20 | 50 |
| 30 | 42 | 8·579232 | 1663 | 11·420768 | 8·579545 | 1665 | 11·420455 | 10·000313 | 21 2 | 9·999687 | 18 | 30 |
| 11 | 44 | 8·580892 | 1657 | 11·419108 | 8·581208 | 1660 | 11·418792 | 10·000315 | 22 2 | 9·999685 | 16 | 49 |
| 30 | 46 | 8·582546 | 1650 | 11·417454 | 8·582864 | 1652 | 11·417136 | 10·000318 | 23 2 | 9·999682 | 14 | 30 |
| 12 | 48 | 8·584193 | 1645 | 11·415807 | 8·584514 | 1647 | 11·415486 | 10·000320 | 24 2 | 9·999680 | 12 | 48 |
| 30 | 50 | 8·585834 | 1638 | 11·414166 | 8·586157 | 1641 | 11·413843 | 10·000323 | 25 2 | 9·999677 | 10 | 30 |
| 13 | 52 | 8·587469 | 1632 | 11·412531 | 8·587795 | 1634 | 11·412205 | 10·000325 | 26 2 | 9·999675 | 8 | 47 |
| 30 | 54 | 8·589098 | 1625 | 11·410902 | 8·589426 | 1628 | 11·410574 | 10·000328 | 27 2 | 9·999672 | 6 | 30 |
| 14 | 56 | 8·590721 | 1620 | 11·409279 | 8·591051 | 1622 | 11·408949 | 10·000330 | 28 2 | 9·999670 | 4 | 46 |
| 30 | 58 | 8·592338 | 1614 | 11·407662 | 8·592670 | 1616 | 11·407330 | 10·000332 | 29 2 | 9·999668 | 2 | 30 |
| 15 | 9 | 8·593948 | 1607 | 11·406052 | 8·594283 | 1611 | 11·405717 | 10·000335 | 30 2 | 9·999665 | 51 | 45 |
| 30 | 2 | 8·595553 | 1602 | 11·404447 | 8·595890 | 1604 | 11·404110 | 10·000337 | 1 0 | 9·999663 | 58 | 30 |
| 16 | 4 | 8·597152 | 1596 | 11·402848 | 8·597492 | 1598 | 11·402508 | 10·000340 | 2 0 | 9·999660 | 56 | 44 |
| 30 | 6 | 8·598745 | 1590 | 11·401255 | 8·599087 | 1593 | 11·400913 | 10·000342 | 3 0 | 9·999658 | 54 | 30 |
| 17 | 8 | 8·600332 | 1584 | 11·399668 | 8·600677 | 1586 | 11·399323 | 10·000345 | 4 0 | 9·999655 | 52 | 43 |
| 30 | 10 | 8·601913 | 1579 | 11·398087 | 8·602260 | 1581 | 11·397740 | 10·000347 | 5 0 | 9·999653 | 50 | 30 |
| 18 | 12 | 8·603489 | 1572 | 11·396511 | 8·603839 | 1576 | 11·396161 | 10·000350 | 6 1 | 9·999650 | 48 | 42 |
| 30 | 14 | 8·605058 | 1567 | 11·394942 | 8·605411 | 1569 | 11·394589 | 10·000353 | 7 1 | 9·999647 | 46 | 30 |
| 19 | 16 | 8·606623 | 1562 | 11·393377 | 8·606978 | 1564 | 11·393022 | 10·000355 | 8 1 | 9·999645 | 44 | 41 |
| 30 | 18 | 8·608181 | 1555 | 11·391819 | 8·608539 | 1558 | 11·391461 | 10·000358 | 9 1 | 9·999642 | 42 | 30 |
| 20 | 20 | 8·609734 | 1551 | 11·390266 | 8·610094 | 1553 | 11·389906 | 10·000360 | 10 1 | 9·999640 | 40 | 40 |
| 30 | 22 | 8·611282 | 1544 | 11·388718 | 8·611644 | 1547 | 11·388356 | 10·000363 | 11 1 | 9·999637 | 38 | 30 |
| 21 | 24 | 8·612823 | 1539 | 11·387177 | 8·613189 | 1542 | 11·386811 | 10·000365 | 12 1 | 9·999635 | 36 | 39 |
| 30 | 26 | 8·614360 | 1534 | 11·385640 | 8·614728 | 1536 | 11·385272 | 10·000368 | 13 1 | 9·999632 | 34 | 30 |
| 22 | 28 | 8·615891 | 1529 | 11·384109 | 8·616262 | 1531 | 11·383738 | 10·000371 | 14 1 | 9·999629 | 32 | 38 |
| 30 | 30 | 8·617417 | 1522 | 11·382583 | 8·617790 | 1526 | 11·382210 | 10·000373 | 15 1 | 9·999627 | 30 | 30 |
| 23 | 32 | 8·618937 | 1518 | 11·381063 | 8·619313 | 1520 | 11·380687 | 10·000376 | 16 1 | 9·999624 | 28 | 37 |
| 30 | 34 | 8·620452 | 1512 | 11·379548 | 8·620830 | 1515 | 11·379170 | 10·000378 | 17 2 | 9·999622 | 26 | 30 |
| 24 | 36 | 8·621962 | 1508 | 11·378038 | 8·622343 | 1510 | 11·377657 | 10·000381 | 18 2 | 9·999619 | 24 | 36 |
| 30 | 38 | 8·623466 | 1501 | 11·376534 | 8·623850 | 1505 | 11·376150 | 10·000384 | 19 2 | 9·999616 | 22 | 30 |
| 25 | 40 | 8·624965 | 1497 | 11·375035 | 8·625352 | 1499 | 11·374648 | 10·000386 | 20 2 | 9·999614 | 20 | 35 |
| 30 | 42 | 8·626459 | 1492 | 11·373541 | 8·626849 | 1494 | 11·373151 | 10·000389 | 21 2 | 9·999611 | 18 | 30 |
| 26 | 44 | 8·627948 | 1486 | 11·372052 | 8·628340 | 1489 | 11·371660 | 10·000392 | 22 2 | 9·999608 | 16 | 34 |
| 30 | 46 | 8·629432 | 1481 | 11·370568 | 8·629827 | 1484 | 11·370173 | 10·000394 | 23 2 | 9·999606 | 14 | 30 |
| 27 | 48 | 8·630911 | 1477 | 11·369089 | 8·631308 | 1479 | 11·368692 | 10·000397 | 24 2 | 9·999603 | 12 | 33 |
| 30 | 50 | 8·632385 | 1471 | 11·367615 | 8·632785 | 1474 | 11·367215 | 10·000400 | 25 2 | 9·999600 | 10 | 30 |
| 28 | 52 | 8·633854 | 1466 | 11·366146 | 8·634256 | 1469 | 11·365744 | 10·000403 | 26 2 | 9·999597 | 8 | 32 |
| 30 | 54 | 8·635317 | 1462 | 11·364683 | 8·635723 | 1464 | 11·364277 | 10·000405 | 27 2 | 9·999595 | 6 | 30 |
| 29 | 56 | 8·636776 | 1456 | 11·363224 | 8·637184 | 1459 | 11·362816 | 10·000408 | 28 3 | 9·999592 | 4 | 31 |
| 30 | 58 | 8·638230 | 1452 | 11·361770 | 8·638641 | 1455 | 11·361359 | 10·000411 | 29 3 | 9·999589 | 2 | 30 |
| 30 | 10 | 8·639680 | 1446 | 11·360320 | 8·640093 | 1449 | 11·359907 | 10·000414 | 30 3 | 9·999586 | 0 | 30 |
| ′ ″ | m. | Cosine | D. | Secant | Cotang. | D. | Tangent | Cosec. | Parts | Sine | m. | ′ ″ |

87° $5^h$ $50^m$

## LOG. SINES, COSINES, &c.

0ʰ 10ᵐ 2°

| ′ ″ | m. s. | Sine | D. | Cosec. | Tangent | D. | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 8·639680 | 1446 | 11·360320 | 8·640093 | 1449 | 11·359907 | 10·000414 | | 9·999586 | 50 | 30 |
| 30 | 2 | 8·641124 | 1442 | 11·358876 | 8·641540 | 1445 | 11·358460 | 10·000416 | 1″ 0 | 9·999584 | 58 | 30 |
| 31 | 4 | 8·642563 | 1437 | 11·357437 | 8·642982 | 1440 | 11·357018 | 10·000419 | 2 0 | 9·999581 | 56 | 29 |
| 30 | 6 | 8·643998 | 1433 | 11·356002 | 8·644420 | 1435 | 11·355580 | 10·000422 | 3 0 | 9·999578 | 54 | 30 |
| 32 | 8 | 8·645428 | 1427 | 11·354572 | 8·645853 | 1431 | 11·354147 | 10·000425 | 4 0 | 9·999575 | 52 | 28 |
| 30 | 10 | 8·646854 | 1423 | 11·353146 | 8·647281 | 1425 | 11·352719 | 10·000427 | 5 0 | 9·999573 | 50 | 30 |
| 33 | 12 | 8·648274 | 1419 | 11·351726 | 8·648704 | 1421 | 11·351296 | 10·000430 | 6 1 | 9·999570 | 48 | 27 |
| 30 | 14 | 8·649690 | 1413 | 11·350310 | 8·650123 | 1417 | 11·349877 | 10·000433 | 7 1 | 9·999567 | 46 | 30 |
| 34 | 16 | 8·651102 | 1410 | 11·348898 | 8·651537 | 1412 | 11·348463 | 10·000436 | 8 1 | 9·999564 | 44 | 26 |
| 30 | 18 | 8·652508 | 1404 | 11·347492 | 8·652947 | 1407 | 11·347053 | 10·000439 | 9 1 | 9·999561 | 42 | 30 |
| 35 | 20 | 8·653911 | 1400 | 11·346089 | 8·654352 | 1403 | 11·345648 | 10·000442 | 10 1 | 9·999558 | 40 | 25 |
| 30 | 22 | 8·655308 | 1396 | 11·344692 | 8·655753 | 1399 | 11·344247 | 10·000444 | 11 1 | 9·999556 | 38 | 30 |
| 36 | 24 | 8·656702 | 1391 | 11·343298 | 8·657149 | 1393 | 11·342851 | 10·000447 | 12 1 | 9·999553 | 36 | 24 |
| 30 | 26 | 8·658090 | 1386 | 11·341910 | 8·658541 | 1390 | 11·341459 | 10·000450 | 13 1 | 9·999550 | 34 | 30 |
| 37 | 28 | 8·659475 | 1382 | 11·340525 | 8·659928 | 1385 | 11·340072 | 10·000453 | 14 1 | 9·999547 | 32 | 23 |
| 30 | 30 | 8·660855 | 1378 | 11·339145 | 8·661311 | 1381 | 11·338689 | 10·000456 | 15 1 | 9·999544 | 30 | 30 |
| 38 | 32 | 8·662230 | 1373 | 11·337770 | 8·662689 | 1376 | 11·337311 | 10·000459 | 16 2 | 9·999541 | 28 | 22 |
| 30 | 34 | 8·663602 | 1370 | 11·336398 | 8·664063 | 1372 | 11·335937 | 10·000462 | 17 2 | 9·999538 | 26 | 30 |
| 39 | 36 | 8·664968 | 1364 | 11·335032 | 8·665433 | 1367 | 11·334567 | 10·000465 | 18 2 | 9·999535 | 24 | 21 |
| 30 | 38 | 8·666331 | 1361 | 11·333669 | 8·666799 | 1364 | 11·333201 | 10·000468 | 19 2 | 9·999532 | 22 | 30 |
| 40 | 40 | 8·667689 | 1356 | 11·332311 | 8·668160 | 1359 | 11·331840 | 10·000471 | 20 2 | 9·999529 | 20 | 20 |
| 30 | 42 | 8·669043 | 1352 | 11·330957 | 8·669517 | 1355 | 11·330483 | 10·000473 | 21 2 | 9·999527 | 18 | 30 |
| 41 | 44 | 8·670393 | 1348 | 11·329607 | 8·670870 | 1351 | 11·329130 | 10·000476 | 22 2 | 9·999524 | 16 | 19 |
| 30 | 46 | 8·671739 | 1343 | 11·328261 | 8·672218 | 1346 | 11·327782 | 10·000479 | 23 2 | 9·999521 | 14 | 30 |
| 42 | 48 | 8·673080 | 1340 | 11·326920 | 8·673563 | 1343 | 11·326437 | 10·000482 | 24 2 | 9·999518 | 12 | 18 |
| 30 | 50 | 8·674418 | 1335 | 11·325582 | 8·674903 | 1338 | 11·325097 | 10·000485 | 25 2 | 9·999515 | 10 | 30 |
| 43 | 52 | 8·675751 | 1331 | 11·324249 | 8·676239 | 1334 | 11·323761 | 10·000488 | 26 3 | 9·999512 | 8 | 17 |
| 30 | 54 | 8·677080 | 1327 | 11·322920 | 8·677572 | 1330 | 11·322428 | 10·000491 | 27 3 | 9·999509 | 6 | 30 |
| 44 | 56 | 8·678405 | 1323 | 11·321595 | 8·678900 | 1326 | 11·321100 | 10·000494 | 28 3 | 9·999506 | 4 | 6 |
| 30 | 58 | 8·679726 | 1319 | 11·320274 | 8·680224 | 1322 | 11·319776 | 10·000497 | 29 3 | 9·999503 | 2 | 30 |
| 45 | 11 | 8·681043 | 1315 | 11·318957 | 8·681544 | 1318 | 11·318456 | 10·000500 | 30 3 | 9·999500 | 49 | 15 |
| 30 | 2 | 8·682356 | 1311 | 11·317644 | 8·682860 | 1314 | 11·317140 | 10·000503 | 1 0 | 9·999497 | 58 | 30 |
| 46 | 4 | 8·683665 | 1308 | 11·316335 | 8·684172 | 1311 | 11·315828 | 10·000507 | 2 0 | 9·999493 | 56 | 14 |
| 30 | 6 | 8·684971 | 1303 | 11·315029 | 8·685480 | 1306 | 11·314520 | 10·000510 | 3 0 | 9·999490 | 54 | 30 |
| 47 | 8 | 8·686272 | 1299 | 11·313728 | 8·686784 | 1302 | 11·313216 | 10·000513 | 4 0 | 9·999487 | 52 | 13 |
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| 30 | 18 | 8·692720 | 1280 | 11·307280 | 8·693248 | 1283 | 11·306752 | 10·000528 | 9 1 | 9·999472 | 42 | 30 |
| 50 | 20 | 8·693998 | 1277 | 11·306002 | 8·694529 | 1280 | 11·305471 | 10·000531 | 10 1 | 9·999469 | 40 | 10 |
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| 51 | 24 | 8·696543 | 1269 | 11·303457 | 8·697081 | 1272 | 11·302919 | 10·000537 | 12 1 | 9·999463 | 36 | 9 |
| 30 | 26 | 8·697810 | 1265 | 11·302190 | 8·698351 | 1268 | 11·301649 | 10·000541 | 13 1 | 9·999459 | 34 | 30 |
| 52 | 28 | 8·699073 | 1262 | 11·300927 | 8·699617 | 1265 | 11·300383 | 10·000544 | 14 1 | 9·999456 | 32 | 8 |
| 30 | 30 | 8·700333 | 1257 | 11·299667 | 8·700880 | 1261 | 11·299120 | 10·000547 | 15 2 | 9·999453 | 30 | 30 |
| 53 | 32 | 8·701589 | 1255 | 11·298411 | 8·702139 | 1257 | 11·297861 | 10·000550 | 16 2 | 9·999450 | 28 | 7 |
| 30 | 34 | 8·702841 | 1250 | 11·297159 | 8·703395 | 1254 | 11·296605 | 10·000553 | 17 2 | 9·999447 | 26 | 30 |
| 54 | 36 | 8·704090 | 1247 | 11·295910 | 8·704646 | 1250 | 11·295354 | 10·000557 | 18 2 | 9·999443 | 24 | 6 |
| 30 | 38 | 8·705335 | 1243 | 11·294665 | 8·705895 | 1247 | 11·294105 | 10·000560 | 19 2 | 9·999440 | 22 | 30 |
| 55 | 40 | 8·706577 | 1240 | 11·293423 | 8·707140 | 1243 | 11·292860 | 10·000563 | 20 2 | 9·999437 | 20 | 5 |
| 30 | 42 | 8·707815 | 1236 | 11·292185 | 8·708381 | 1239 | 11·291619 | 10·000566 | 21 2 | 9·999434 | 18 | 30 |
| 56 | 44 | 8·709049 | 1233 | 11·290951 | 8·709618 | 1236 | 11·290382 | 10·000569 | 22 2 | 9·999431 | 16 | 4 |
| 30 | 46 | 8·710280 | 1229 | 11·289720 | 8·710853 | 1233 | 11·289147 | 10·000573 | 23 2 | 9·999427 | 14 | 30 |
| 57 | 48 | 8·711507 | 1226 | 11·288493 | 8·712083 | 1228 | 11·287917 | 10·000576 | 24 2 | 9·999424 | 12 | 3 |
| 30 | 50 | 8·712731 | 1222 | 11·287268 | 8·713311 | 1226 | 11·286689 | 10·000579 | 25 3 | 9·999421 | 10 | 30 |
| 58 | 52 | 8·713952 | 1219 | 11·286048 | 8·714534 | 1222 | 11·285466 | 10·000582 | 26 3 | 9·999418 | 8 | 2 |
| 30 | 54 | 8·715169 | 1216 | 11·284831 | 8·715755 | 1219 | 11·284245 | 10·000586 | 27 3 | 9·999414 | 6 | 30 |
| 59 | 56 | 8·716383 | 1212 | 11·283617 | 8·716972 | 1215 | 11·283028 | 10·000589 | 28 3 | 9·999411 | 4 | 1 |
| 30 | 58 | 8·717593 | 1208 | 11·282406 | 8·718186 | 1212 | 11·281814 | 10·000592 | 29 3 | 9·999408 | 2 | 30 |
| 60 | 12 | 8·718800 | 1205 | 11·281200 | 8·719396 | 1209 | 11·280604 | 10·000596 | 30 3 | 9·999404 | 0 | 0 |
| ′ ″ | m. s. | Cosine | D. | Secant | Cotang. | D. | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

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## LOG. SINES, COSINES, &c.

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| ′ ″ | m. s. | Sine | D. | Cosec. | Tangent | D. | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 8·718800 | 1205 | 11·281200 | 8·719396 | 1209 | 11·280604 | 10·000596 | | 9·999404 | 48 | 60 |
| 30 | 2 | 8·720004 | 1202 | 11·279996 | 8·720603 | 1205 | 11·279397 | 10·000599 | 1″ 0 | 9·999401 | 58 | 30 |
| 1 | 4 | 8·721204 | 1199 | 11·278796 | 8·721806 | 1202 | 11·278194 | 10·000602 | 2 0 | 9·999398 | 56 | 59 |
| 30 | 6 | 8·722401 | 1195 | 11·277599 | 8·723007 | 1198 | 11·276993 | 10·000606 | 3 0 | 9·999394 | 54 | 30 |
| 2 | 8 | 8·723595 | 1192 | 11·276405 | 8·724204 | 1196 | 11·275796 | 10·000609 | 4 0 | 9·999391 | 52 | 58 |
| 30 | 10 | 8·724785 | 1189 | 11·275215 | 8·725397 | 1192 | 11·274603 | 10·000612 | 5 1 | 9·999388 | 50 | 30 |
| 3 | 12 | 8·725972 | 1185 | 11·274028 | 8·726588 | 1189 | 11·273412 | 10·000616 | 6 1 | 9·999384 | 48 | 57 |
| 30 | 14 | 8·727156 | 1183 | 11·272844 | 8·727775 | 1185 | 11·272225 | 10·000619 | 7 1 | 9·999381 | 46 | 30 |
| 4 | 16 | 8·728337 | 1179 | 11·271663 | 8·728959 | 1183 | 11·271041 | 10·000622 | 8 1 | 9·999378 | 44 | 56 |
| 30 | 18 | 8·729514 | 1176 | 11·270486 | 8·730140 | 1179 | 11·269860 | 10·000626 | 9 1 | 9·999374 | 42 | 30 |
| 5 | 20 | 8·730688 | 1172 | 11·269312 | 8·731317 | 1176 | 11·268683 | 10·000629 | 10 1 | 9·999371 | 40 | 55 |
| 30 | 22 | 8·731859 | 1170 | 11·268141 | 8·732492 | 1173 | 11·267508 | 10·000633 | 11 1 | 9·999367 | 38 | 30 |
| 6 | 24 | 8·733027 | 1166 | 11·266973 | 8·733663 | 1170 | 11·266337 | 10·000636 | 12 1 | 9·999364 | 36 | 54 |
| 30 | 26 | 8·734192 | 1163 | 11·265808 | 8·734831 | 1166 | 11·265169 | 10·000639 | 13 1 | 9·999361 | 34 | 30 |
| 7 | 28 | 8·735354 | 1160 | 11·264646 | 8·735996 | 1164 | 11·264004 | 10·000643 | 14 2 | 9·999357 | 32 | 53 |
| 30 | 30 | 8·736512 | 1157 | 11·263488 | 8·737158 | 1160 | 11·262842 | 10·000646 | 15 2 | 9·999354 | 30 | 30 |
| 8 | 32 | 8·737667 | 1154 | 11·262333 | 8·738317 | 1158 | 11·261683 | 10·000650 | 16 2 | 9·999350 | 28 | 52 |
| 30 | 34 | 8·738820 | 1151 | 11·261180 | 8·739473 | 1154 | 11·260527 | 10·000653 | 17 2 | 9·999347 | 26 | 30 |
| 9 | 36 | 8·739969 | 1148 | 11·260031 | 8·740626 | 1151 | 11·259374 | 10·000657 | 18 2 | 9·999343 | 24 | 51 |
| 30 | 38 | 8·741115 | 1144 | 11·258885 | 8·741776 | 1148 | 11·258224 | 10·000660 | 19 2 | 9·999340 | 22 | 30 |
| 10 | 40 | 8·742259 | 1142 | 11·257741 | 8·742922 | 1146 | 11·257078 | 10·000664 | 20 2 | 9·999336 | 20 | 50 |
| 30 | 42 | 8·743399 | 1139 | 11·256601 | 8·744066 | 1142 | 11·255934 | 10·000667 | 21 2 | 9·999333 | 18 | 30 |
| 11 | 44 | 8·744536 | 1136 | 11·255464 | 8·745207 | 1139 | 11·254793 | 10·000671 | 22 3 | 9·999329 | 16 | 49 |
| 30 | 46 | 8·745670 | 1132 | 11·254330 | 8·746344 | 1136 | 11·253656 | 10·000674 | 23 3 | 9·999326 | 14 | 30 |
| 12 | 48 | 8·746802 | 1130 | 11·253198 | 8·747479 | 1134 | 11·252521 | 10·000678 | 24 3 | 9·999322 | 12 | 48 |
| 30 | 50 | 8·747930 | 1127 | 11·252070 | 8·748611 | 1130 | 11·251389 | 10·000681 | 25 3 | 9·999319 | 10 | 30 |
| 13 | 52 | 8·749055 | 1124 | 11·250945 | 8·749740 | 1127 | 11·250260 | 10·000685 | 26 3 | 9·999315 | 8 | 47 |
| 30 | 54 | 8·750178 | 1121 | 11·249822 | 8·750866 | 1125 | 11·249134 | 10·000688 | 27 3 | 9·999312 | 6 | 30 |
| 14 | 56 | 8·751297 | 1118 | 11·248703 | 8·751989 | 1122 | 11·248011 | 10·000692 | 28 3 | 9·999308 | 4 | 46 |
| 30 | 58 | 8·752414 | 1115 | 11·247586 | 8·753109 | 1119 | 11·246891 | 10·000695 | 29 3 | 9·999305 | 2 | 30 |
| 15 | 13 | 8·753528 | 1113 | 11·246472 | 8·754227 | 1116 | 11·245773 | 10·000699 | 30 3 | 9·999301 | 47 | 45 |
| 30 | 2 | 8·754639 | 1109 | 11·245361 | 8·755341 | 1113 | 11·244659 | 10·000703 | 1 0 | 9·999297 | 58 | 30 |
| 16 | 4 | 8·755747 | 1107 | 11·244253 | 8·756453 | 1110 | 11·243547 | 10·000706 | 2 0 | 9·999294 | 56 | 44 |
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| 30 | 10 | 8·759054 | 1098 | 11·240946 | 8·759771 | 1102 | 11·240229 | 10·000717 | 5 1 | 9·999283 | 50 | 30 |
| 18 | 12 | 8·760151 | 1096 | 11·239849 | 8·760872 | 1099 | 11·239128 | 10·000721 | 6 1 | 9·999279 | 48 | 42 |
| 30 | 14 | 8·761245 | 1092 | 11·238755 | 8·761970 | 1097 | 11·238030 | 10·000724 | 7 1 | 9·999276 | 46 | 30 |
| 19 | 16 | 8·762337 | 1090 | 11·237663 | 8·763065 | 1093 | 11·236935 | 10·000728 | 8 1 | 9·999272 | 44 | 41 |
| 30 | 18 | 8·763425 | 1088 | 11·236575 | 8·764157 | 1091 | 11·235843 | 10·000732 | 9 1 | 9·999268 | 42 | 30 |
| 20 | 20 | 8·764511 | 1084 | 11·235489 | 8·765246 | 1088 | 11·234754 | 10·000735 | 10 1 | 9·999265 | 40 | 40 |
| 30 | 22 | 8·765594 | 1082 | 11·234406 | 8·766333 | 1086 | 11·233667 | 10·000739 | 11 1 | 9·999261 | 38 | 30 |
| 21 | 24 | 8·766675 | 1079 | 11·233325 | 8·767417 | 1083 | 11·232583 | 10·000743 | 12 1 | 9·999257 | 36 | 39 |
| 30 | 26 | 8·767752 | 1076 | 11·232248 | 8·768499 | 1080 | 11·231501 | 10·000746 | 13 2 | 9·999254 | 34 | 30 |
| 22 | 28 | 8·768828 | 1074 | 11·231172 | 8·769578 | 1077 | 11·230422 | 10·000750 | 14 2 | 9·999250 | 32 | 38 |
| 30 | 30 | 8·769900 | 1071 | 11·230100 | 8·770654 | 1075 | 11·229346 | 10·000754 | 15 2 | 9·999246 | 30 | 30 |
| 23 | 32 | 8·770970 | 1069 | 11·229030 | 8·771727 | 1072 | 11·228273 | 10·000758 | 16 2 | 9·999242 | 28 | 37 |
| 30 | 34 | 8·772037 | 1065 | 11·227963 | 8·772798 | 1070 | 11·227202 | 10·000761 | 17 2 | 9·999239 | 26 | 30 |
| 24 | 36 | 8·773101 | 1064 | 11·226899 | 8·773866 | 1067 | 11·226134 | 10·000765 | 18 2 | 9·999235 | 24 | 36 |
| 30 | 38 | 8·774163 | 1060 | 11·225837 | 8·774932 | 1064 | 11·225068 | 10·000769 | 19 2 | 9·999231 | 22 | 30 |
| 25 | 40 | 8·775223 | 1058 | 11·224777 | 8·775995 | 1062 | 11·224005 | 10·000773 | 20 2 | 9·999227 | 20 | 35 |
| 30 | 42 | 8·776279 | 1056 | 11·223721 | 8·777056 | 1059 | 11·222944 | 10·000776 | 21 3 | 9·999224 | 18 | 30 |
| 26 | 44 | 8·777333 | 1053 | 11·222667 | 8·778114 | 1057 | 11·221886 | 10·000780 | 22 3 | 9·999220 | 16 | 34 |
| 30 | 46 | 8·778385 | 1050 | 11·221615 | 8·779169 | 1054 | 11·220831 | 10·000784 | 23 3 | 9·999216 | 14 | 30 |
| 27 | 48 | 8·779434 | 1048 | 11·220566 | 8·780222 | 1051 | 11·219778 | 10·000788 | 24 3 | 9·999212 | 12 | 33 |
| 30 | 50 | 8·780480 | 1045 | 11·219520 | 8·781272 | 1049 | 11·218728 | 10·000792 | 25 3 | 9·999208 | 10 | 30 |
| 28 | 52 | 8·781524 | 1043 | 11·218476 | 8·782320 | 1047 | 11·217680 | 10·000795 | 26 3 | 9·999205 | 8 | 32 |
| 30 | 54 | 8·782566 | 1040 | 11·217434 | 8·783365 | 1044 | 11·216635 | 10·000799 | 27 3 | 9·999201 | 6 | 30 |
| 29 | 56 | 8·783605 | 1037 | 11·216395 | 8·784408 | 1041 | 11·215592 | 10·000803 | 28 3 | 9·999197 | 4 | 31 |
| 30 | 58 | 8·784641 | 1036 | 11·215359 | 8·785448 | 1040 | 11·214552 | 10·000807 | 29 4 | 9·999193 | 2 | 30 |
| 30 | 14 | 8·785675 | 1032 | 11·214325 | 8·786486 | 1036 | 11·213514 | 10·000811 | 30 4 | 9·999189 | 0 | 30 |
| ′ ″ | m. s. | Cosine | D. | Secant | Cotang. | D. | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

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## LOG. SINES, COSINES, &c.

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| ′ ″ | m. s. | Sine | D. | Cosec. | Tangent | D. | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 8·785675 | 1032 | 11·214325 | 8·786486 | 1036 | 11·213514 | 10·000811 | | 9·999189 | 46 | 30 |
| 30 | 2 | 8·786707 | 1031 | 11·213293 | 8·787521 | 1034 | 11·212479 | 10·000815 | 1″ 0 | 9·999185 | 58 | 30 |
| 31 | 4 | 8·787736 | 1028 | 11·212264 | 8·788554 | 1032 | 11·211446 | 10·000819 | 2 0 | 9·999181 | 56 | 29 |
| 30 | 6 | 8·788762 | 1025 | 11·211238 | 8·789585 | 1029 | 11·210415 | 10·000822 | 3 0 | 9·999178 | 54 | 30 |
| 32 | 8 | 8·789787 | 1023 | 11·210213 | 8·790613 | 1027 | 11·209387 | 10·000826 | 4 1 | 9·999174 | 52 | 28 |
| 30 | 10 | 8·790808 | 1020 | 11·209192 | 8·791639 | 1025 | 11·208361 | 10·000830 | 5 1 | 9·999170 | 50 | 30 |
| 33 | 12 | 8·791828 | 1019 | 11·208172 | 8·792662 | 1022 | 11·207338 | 10·000834 | 6 1 | 9·999166 | 48 | 27 |
| 30 | 14 | 8·792845 | 1015 | 11·207155 | 8·793683 | 1019 | 11·206317 | 10·000838 | 7 1 | 9·999162 | 46 | 30 |
| 34 | 16 | 8·793859 | 1014 | 11·206141 | 8·794701 | 1018 | 11·205299 | 10·000842 | 8 1 | 9·999158 | 44 | 26 |
| 30 | 18 | 8·794872 | 1011 | 11·205128 | 8·795718 | 1015 | 11·204282 | 10·000846 | 9 1 | 9·999154 | 42 | 30 |
| 35 | 20 | 8·795881 | 1009 | 11·204119 | 8·796731 | 1012 | 11·203269 | 10·000850 | 10 1 | 9·999150 | 40 | 25 |
| 30 | 22 | 8·796889 | 1006 | 11·203111 | 8·797743 | 1011 | 11·202257 | 10·000854 | 11 1 | 9·999146 | 38 | 30 |
| 36 | 24 | 8·797894 | 1004 | 11·202106 | 8·798752 | 1008 | 11·201248 | 10·000858 | 12 2 | 9·999142 | 36 | 24 |
| 30 | 26 | 8·798897 | 1001 | 11·201103 | 8·799759 | 1005 | 11·200241 | 10·000862 | 13 2 | 9·999138 | 34 | 30 |
| 37 | 28 | 8·799897 | 1000 | 11·200103 | 8·800763 | 1004 | 11·199237 | 10·000866 | 14 2 | 9·999134 | 32 | 23 |
| 30 | 30 | 8·800896 | 997 | 11·199104 | 8·801765 | 1001 | 11·198235 | 10·000870 | 15 2 | 9·999130 | 30 | 30 |
| 38 | 32 | 8·801892 | 995 | 11·198108 | 8·802765 | 998 | 11·197235 | 10·000874 | 16 2 | 9·999126 | 28 | 22 |
| 30 | 34 | 8·802885 | 992 | 11·197115 | 8·803763 | 997 | 11·196237 | 10·000878 | 17 2 | 9·999122 | 26 | 30 |
| 39 | 36 | 8·803876 | 990 | 11·196124 | 8·804758 | 994 | 11·195242 | 10·000882 | 18 2 | 9·999118 | 24 | 21 |
| 30 | 38 | 8·804866 | 988 | 11·195134 | 8·805751 | 992 | 11·194249 | 10·000886 | 19 3 | 9·999114 | 22 | 30 |
| 40 | 40 | 8·805852 | 986 | 11·194148 | 8·806742 | 990 | 11·193258 | 10·000890 | 20 3 | 9·999110 | 20 | 20 |
| 30 | 42 | 8·806837 | 983 | 11·193163 | 8·807731 | 987 | 11·192269 | 10·000894 | 21 3 | 9·999106 | 18 | 30 |
| 41 | 44 | 8·807819 | 982 | 11·192181 | 8·808717 | 986 | 11·191283 | 10·000898 | 22 3 | 9·999102 | 16 | 19 |
| 30 | 46 | 8·808799 | 979 | 11·191201 | 8·809701 | 983 | 11·190299 | 10·000902 | 23 3 | 9·999098 | 14 | 30 |
| 42 | 48 | 8·809777 | 976 | 11·190223 | 8·810683 | 981 | 11·189317 | 10·000906 | 24 3 | 9·999094 | 12 | 18 |
| 30 | 50 | 8·810753 | 975 | 11·189247 | 8·811663 | 978 | 11·188337 | 10·000910 | 25 3 | 9·999090 | 10 | 30 |
| 43 | 52 | 8·811726 | 972 | 11·188274 | 8·812641 | 977 | 11·187359 | 10·000914 | 26 3 | 9·999086 | 8 | 17 |
| 30 | 54 | 8·812698 | 971 | 11·187302 | 8·813616 | 974 | 11·186384 | 10·000918 | 27 4 | 9·999082 | 6 | 30 |
| 44 | 56 | 8·813667 | 968 | 11·186333 | 8·814589 | 972 | 11·185411 | 10·000923 | 28 4 | 9·999077 | 4 | 16 |
| 30 | 58 | 8·814634 | 965 | 11·185366 | 8·815560 | 970 | 11·184440 | 10·000927 | 29 4 | 9·999073 | 2 | 30 |
| 45 | 15 | 8·815599 | 964 | 11·184401 | 8·816529 | 968 | 11·183471 | 10·000931 | 30 4 | 9·999069 | 45 | 15 |
| 30 | 2 | 8·816561 | 962 | 11·183439 | 8·817496 | 966 | 11·182504 | 10·000935 | 1 0 | 9·999065 | 58 | 30 |
| 46 | 4 | 8·817522 | 959 | 11·182478 | 8·818461 | 963 | 11·181539 | 10·000939 | 2 0 | 9·999061 | 56 | 14 |
| 30 | 6 | 8·818480 | 958 | 11·181520 | 8·819423 | 962 | 11·180577 | 10·000943 | 3 0 | 9·999057 | 54 | 30 |
| 47 | 8 | 8·819436 | 955 | 11·180564 | 8·820384 | 959 | 11·179616 | 10·000947 | 4 1 | 9·999053 | 52 | 13 |
| 30 | 10 | 8·820390 | 953 | 11·179610 | 8·821342 | 958 | 11·178658 | 10·000952 | 5 1 | 9·999048 | 50 | 30 |
| 48 | 12 | 8·821343 | 951 | 11·178657 | 8·822298 | 955 | 11·177702 | 10·000956 | 6 1 | 9·999044 | 48 | 12 |
| 30 | 14 | 8·822292 | 949 | 11·177708 | 8·823253 | 953 | 11·176747 | 10·000960 | 7 1 | 9·999040 | 46 | 30 |
| 49 | 16 | 8·823240 | 947 | 11·176760 | 8·824205 | 951 | 11·175795 | 10·000964 | 8 1 | 9·999036 | 44 | 11 |
| 30 | 18 | 8·824186 | 944 | 11·175814 | 8·825155 | 949 | 11·174845 | 10·000968 | 9 1 | 9·999032 | 42 | 30 |
| 50 | 20 | 8·825130 | 943 | 11·174870 | 8·826103 | 947 | 11·173897 | 10·000973 | 10 1 | 9·999027 | 40 | 10 |
| 30 | 22 | 8·826072 | 941 | 11·173928 | 8·827049 | 945 | 11·172951 | 10·000977 | 11 2 | 9·999023 | 38 | 30 |
| 51 | 24 | 8·827011 | 938 | 11·172989 | 8·827992 | 943 | 11·172008 | 10·000981 | 12 2 | 9·999019 | 36 | 9 |
| 30 | 26 | 8·827949 | 937 | 11·172051 | 8·828934 | 941 | 11·171066 | 10·000985 | 13 2 | 9·999015 | 34 | 30 |
| 52 | 28 | 8·828884 | 934 | 11·171116 | 8·829874 | 938 | 11·170126 | 10·000990 | 14 2 | 9·999010 | 32 | 8 |
| 30 | 30 | 8·829818 | 933 | 11·170182 | 8·830812 | 937 | 11·169188 | 10·000994 | 15 2 | 9·999006 | 30 | 30 |
| 53 | 32 | 8·830749 | 931 | 11·169251 | 8·831748 | 935 | 11·168252 | 10·000998 | 16 2 | 9·999002 | 28 | 7 |
| 30 | 34 | 8·831679 | 928 | 11·168321 | 8·832682 | 933 | 11·167318 | 10·001003 | 17 2 | 9·998997 | 26 | 30 |
| 54 | 36 | 8·832607 | 927 | 11·167393 | 8·833613 | 931 | 11·166387 | 10·001007 | 18 3 | 9·998993 | 24 | 6 |
| 30 | 38 | 8·833532 | 924 | 11·166468 | 8·834543 | 929 | 11·165457 | 10·001011 | 19 3 | 9·998989 | 22 | 30 |
| 55 | 40 | 8·834456 | 923 | 11·165544 | 8·835471 | 926 | 11·164529 | 10·001016 | 20 3 | 9·998984 | 20 | 5 |
| 30 | 42 | 8·835377 | 920 | 11·164623 | 8·836397 | 925 | 11·163603 | 10·001020 | 21 3 | 9·998980 | 18 | 30 |
| 56 | 44 | 8·836297 | 919 | 11·163703 | 8·837321 | 923 | 11·162679 | 10·001024 | 22 3 | 9·998976 | 16 | 4 |
| 30 | 46 | 8·837215 | 917 | 11·162785 | 8·838243 | 922 | 11·161757 | 10·001029 | 23 3 | 9·998971 | 14 | 30 |
| 57 | 48 | 8·838130 | 915 | 11·161870 | 8·839163 | 919 | 11·160837 | 10·001033 | 24 3 | 9·998967 | 12 | 3 |
| 30 | 50 | 8·839044 | 912 | 11·160956 | 8·840081 | 917 | 11·159919 | 10·001037 | 25 4 | 9·998903 | 10 | 30 |
| 58 | 52 | 8·839956 | 911 | 11·160044 | 8·840998 | 915 | 11·159002 | 10·001042 | 26 4 | 9·998958 | 8 | 2 |
| 30 | 54 | 8·840866 | 909 | 11·159134 | 8·841912 | 914 | 11·158088 | 10·001046 | 27 4 | 9·998954 | 6 | 30 |
| 59 | 56 | 8·841774 | 907 | 11·158226 | 8·842825 | 911 | 11·157175 | 10·001050 | 28 4 | 9·998950 | 4 | 1 |
| 30 | 58 | 8·842680 | 906 | 11·157320 | 8·843735 | 910 | 11·156265 | 10·001055 | 29 4 | 9·998945 | 2 | 30 |
| 60 | 16 | 8·843585 | 903 | 11·156415 | 8·844644 | 907 | 11·155356 | 10·001059 | 30 4 | 9·998941 | 0 | 0 |
| ′ ″ | m. s. | Cosine | D. | Secant | Cotang. | D. | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

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## LOG. SINES, COSINES, &c.

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| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 8·843585 | | 11·156415 | 8·844644 | | 11·155356 | 10·001059 | | 9·998941 | 44 | 60 |
| 30 | 2 | 8·844487 | 1″ 30 | 11·155513 | 8·845551 | 1″ 30 | 11·154449 | 10·001064 | 1″ 0 | 9·998936 | 58 | 30 |
| 1 | 4 | 8·845387 | 2 60 | 11·154613 | 8·846455 | 2 60 | 11·153545 | 10·001068 | 2 0 | 9·998932 | 56 | 59 |
| 30 | 6 | 8·846286 | 3 89 | 11·153714 | 8·847358 | 3 90 | 11·152642 | 10·001073 | 3 0 | 9·998927 | 54 | 30 |
| 2 | 8 | 8·847183 | 4 119 | 11·152817 | 8·848260 | 4 120 | 11·151740 | 10·001077 | 4 1 | 9·998923 | 52 | 58 |
| 30 | 10 | 8·848078 | 5 149 | 11·151922 | 8·849159 | 5 150 | 11·150841 | 10·001081 | 5 1 | 9·998919 | 50 | 30 |
| 3 | 12 | 8·848971 | 6 179 | 11·151029 | 8·850057 | 6 180 | 11·149943 | 10·001086 | 6 1 | 9·998914 | 48 | 57 |
| 30 | 14 | 8·849862 | 7 208 | 11·150138 | 8·850952 | 7 210 | 11·149048 | 10·001090 | 7 1 | 9·998910 | 46 | 30 |
| 4 | 16 | 8·850751 | 8 238 | 11·149249 | 8·851846 | 8 239 | 11·148154 | 10·001095 | 8 1 | 9·998905 | 44 | 56 |
| 30 | 18 | 8·851639 | 9 268 | 11·148361 | 8·852738 | 9 269 | 11·147262 | 10·001099 | 9 1 | 9·998901 | 42 | 30 |
| 5 | 20 | 8·852525 | 10 298 | 11·147475 | 8·853628 | 10 299 | 11·146372 | 10·001104 | 10 2 | 9·998896 | 40 | 55 |
| 30 | 22 | 8·853408 | 1 29 | 11·146592 | 8·854517 | 1 29 | 11·145483 | 10·001108 | 11 2 | 9·998892 | 38 | 30 |
| 6 | 24 | 8·854291 | 2 58 | 11·145709 | 8·855403 | 2 59 | 11·144597 | 10·001113 | 12 2 | 9·998887 | 36 | 54 |
| 30 | 26 | 8·855171 | 3 88 | 11·144829 | 8·856288 | 3 88 | 11·143712 | 10·001117 | 13 2 | 9·998883 | 34 | 30 |
| 7 | 28 | 8·856049 | 4 117 | 11·143951 | 8·857171 | 4 117 | 11·142829 | 10·001122 | 14 2 | 9·998878 | 32 | 53 |
| 30 | 30 | 8·856926 | 5 146 | 11·143074 | 8·858053 | 5 146 | 11·141947 | 10·001127 | 15 2 | 9·998873 | 30 | 30 |
| 8 | 32 | 8·857801 | 6 175 | 11·142199 | 8·858932 | 6 176 | 11·141068 | 10·001131 | 16 2 | 9·998869 | 28 | 52 |
| 30 | 34 | 8·858674 | 7 204 | 11·141326 | 8·859810 | 7 205 | 11·140190 | 10·001136 | 17 3 | 9·998864 | 26 | 30 |
| 9 | 36 | 8·859546 | 8 233 | 11·140454 | 8·860686 | 8 234 | 11·139314 | 10·001140 | 18 3 | 9·998860 | 24 | 51 |
| 30 | 38 | 8·860415 | 9 263 | 11·139585 | 8·861560 | 9 264 | 11·138440 | 10·001145 | 19 3 | 9·998855 | 22 | 30 |
| 10 | 40 | 8·861283 | 10 292 | 11·138717 | 8·862433 | 10 293 | 11·137567 | 10·001149 | 20 3 | 9·998851 | 20 | 50 |
| 30 | 42 | 8·862149 | 1 29 | 11·137851 | 8·863303 | 1 29 | 11·136697 | 10·001154 | 21 3 | 9·998846 | 18 | 30 |
| 11 | 44 | 8·863014 | 2 57 | 11·136986 | 8·864173 | 2 58 | 11·135827 | 10·001159 | 22 3 | 9·998841 | 16 | 49 |
| 30 | 46 | 8·863877 | 3 86 | 11·136123 | 8·865040 | 3 86 | 11·134960 | 10·001163 | 23 3 | 9·998837 | 14 | 30 |
| 12 | 48 | 8·864738 | 4 114 | 11·135262 | 8·865906 | 4 115 | 11·134094 | 10·001168 | 24 4 | 9·998832 | 12 | 48 |
| 30 | 50 | 8·865597 | 5 143 | 11·134403 | 8·866769 | 5 144 | 11·133231 | 10·001173 | 25 4 | 9·998827 | 10 | 30 |
| 13 | 52 | 8·866455 | 6 172 | 11·133545 | 8·867632 | 6 173 | 11·132368 | 10·001177 | 26 4 | 9·998823 | 8 | 47 |
| 30 | 54 | 8·867310 | 7 200 | 11·132690 | 8·868492 | 7 201 | 11·131508 | 10·001182 | 27 4 | 9·998818 | 6 | 30 |
| 14 | 56 | 8·868165 | 8 229 | 11·131835 | 8·869351 | 8 230 | 11·130649 | 10·001187 | 28 4 | 9·998813 | 4 | 46 |
| 30 | 58 | 8·869017 | 9 257 | 11·130983 | 8·870208 | 9 259 | 11·129792 | 10·001191 | 29 4 | 9·998809 | 2 | 30 |
| 15 | 17 | 8·869868 | 10 286 | 11·130132 | 8·871064 | 10 288 | 11·128936 | 10·001196 | 30 5 | 9·998804 | 43 | 45 |
| 30 | 2 | 8·870717 | 1 28 | 11·129283 | 8·871918 | 1 28 | 11·128082 | 10·001201 | 1 0 | 9·998799 | 58 | 30 |
| 16 | 4 | 8·871565 | 2 56 | 11·128435 | 8·872770 | 2 56 | 11·127230 | 10·001205 | 2 0 | 9·998795 | 56 | 44 |
| 30 | 6 | 8·872410 | 3 84 | 11·127590 | 8·873620 | 3 85 | 11·126380 | 10·001210 | 3 0 | 9·998790 | 54 | 30 |
| 17 | 8 | 8·873255 | 4 112 | 11·126745 | 8·874469 | 4 113 | 11·125531 | 10·001215 | 4 1 | 9·998785 | 52 | 43 |
| 30 | 10 | 8·874097 | 5 140 | 11·125903 | 8·875317 | 5 141 | 11·124683 | 10·001219 | 5 1 | 9·998781 | 50 | 30 |
| 18 | 12 | 8·874938 | 6 168 | 11·125062 | 8·876162 | 6 169 | 11·123838 | 10·001224 | 6 1 | 9·998776 | 48 | 42 |
| 30 | 14 | 8·875777 | 7 196 | 11·124223 | 8·877006 | 7 197 | 11·122994 | 10·001229 | 7 1 | 9·998771 | 46 | 30 |
| 19 | 16 | 8·876615 | 8 224 | 11·123385 | 8·877849 | 8 225 | 11·122151 | 10·001234 | 8 1 | 9·998766 | 44 | 41 |
| 30 | 18 | 8·877451 | 9 252 | 11·122549 | 8·878689 | 9 254 | 11·121311 | 10·001238 | 9 1 | 9·998762 | 42 | 30 |
| 20 | 20 | 8·878285 | 10 280 | 11·121715 | 8·879529 | 10 282 | 11·120471 | 10·001243 | 10 2 | 9·998757 | 40 | 40 |
| 30 | 22 | 8·879118 | 1 27 | 11·120882 | 8·880366 | 1 28 | 11·119634 | 10·001248 | 11 2 | 9·998752 | 38 | 30 |
| 21 | 24 | 8·879949 | 2 55 | 11·120051 | 8·881202 | 2 55 | 11·118798 | 10·001253 | 12 2 | 9·998747 | 36 | 39 |
| 30 | 26 | 8·880779 | 3 82 | 11·119221 | 8·882037 | 3 83 | 11·117963 | 10·001258 | 13 2 | 9·998742 | 34 | 30 |
| 22 | 28 | 8·881607 | 4 110 | 11·118393 | 8·882869 | 4 111 | 11·117131 | 10·001262 | 14 2 | 9·998738 | 32 | 38 |
| 30 | 30 | 8·882433 | 5 137 | 11·117567 | 8·883701 | 5 138 | 11·116299 | 10·001267 | 15 2 | 9·998733 | 30 | 30 |
| 23 | 32 | 8·883258 | 6 165 | 11·116742 | 8·884530 | 6 166 | 11·115470 | 10·001272 | 16 3 | 9·998728 | 28 | 37 |
| 30 | 34 | 8·884081 | 7 192 | 11·115919 | 8·885358 | 7 193 | 11·114642 | 10·001277 | 17 3 | 9·998723 | 26 | 30 |
| 24 | 36 | 8·884903 | 8 220 | 11·115097 | 8·886185 | 8 221 | 11·113815 | 10·001282 | 18 3 | 9·998718 | 24 | 36 |
| 30 | 38 | 8·885723 | 9 247 | 11·114277 | 8·887010 | 9 249 | 11·112990 | 10·001287 | 19 3 | 9·998713 | 22 | 30 |
| 25 | 40 | 8·886542 | 10 275 | 11·113458 | 8·887833 | 10 276 | 11·112167 | 10·001292 | 20 3 | 9·998708 | 20 | 35 |
| 30 | 42 | 8·887359 | 1 27 | 11·112641 | 8·888655 | 1 27 | 11·111345 | 10·001296 | 21 3 | 9·998704 | 18 | 30 |
| 26 | 44 | 8·888174 | 2 54 | 11·111826 | 8·889476 | 2 54 | 11·110524 | 10·001301 | 22 4 | 9·998699 | 16 | 34 |
| 30 | 46 | 8·888988 | 3 81 | 11·111012 | 8·890295 | 3 81 | 11·109705 | 10·001306 | 23 4 | 9·998694 | 14 | 30 |
| 27 | 48 | 8·889801 | 4 108 | 11·110199 | 8·891112 | 4 109 | 11·108888 | 10·001311 | 24 4 | 9·998689 | 12 | 33 |
| 30 | 50 | 8·890612 | 5 135 | 11·109388 | 8·891928 | 5 136 | 11·108072 | 10·001316 | 25 4 | 9·998684 | 10 | 30 |
| 28 | 52 | 8·891421 | 6 162 | 11·108579 | 8·892742 | 6 163 | 11·107258 | 10·001321 | 26 4 | 9·998679 | 8 | 32 |
| 30 | 54 | 8·892229 | 7 189 | 11·107771 | 8·893555 | 7 190 | 11·106445 | 10·001326 | 27 4 | 9·998674 | 6 | 30 |
| 29 | 56 | 8·893035 | 8 216 | 11·106965 | 8·894366 | 8 217 | 11·105634 | 10·001331 | 28 5 | 9·998669 | 4 | 31 |
| 30 | 58 | 8·893840 | 9 243 | 11·106160 | 8·895176 | 9 244 | 11·104824 | 10·001336 | 29 5 | 9·998664 | 2 | 30 |
| 30 | 18 | 8·894643 | 10 270 | 11·105357 | 8·895984 | 10 271 | 11·104016 | 10·001341 | 30 5 | 9·998659 | 0 | 30 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

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## LOG. SINES, COSINES, &c.

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| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 8·894643 | | 11·105357 | 8·895984 | | 11·104016 | 10·001341 | | 9·998659 | 42 | 30 |
| 30 | 2 | 8·895445 | 1″ 26 | 11·104555 | 8·896791 | 1″ 27 | 11·103209 | 10·001346 | 1″ 0 | 9·998654 | 58 | 30 |
| 31 | 4 | 8·896246 | 2 53 | 11·103754 | 8·897596 | 2 53 | 11·102404 | 10·001351 | 2 0 | 9·998649 | 56 | 29 |
| 30 | 6 | 8·897044 | 3 79 | 11·102956 | 8·898400 | 3 80 | 11·101600 | 10·001356 | 3 1 | 9·998644 | 54 | 30 |
| 32 | 8 | 8·897842 | 4 106 | 11·102158 | 8·899203 | 4 107 | 11·100797 | 10·001361 | 4 1 | 9·998639 | 52 | 28 |
| 30 | 10 | 8·898638 | 5 132 | 11·101362 | 8·900004 | 5 133 | 11·099996 | 10·001366 | 5 1 | 9·998634 | 50 | 30 |
| 33 | 12 | 8·899432 | 6 159 | 11·100568 | 8·900803 | 6 160 | 11·099197 | 10·001371 | 6 1 | 9·998629 | 48 | 27 |
| 30 | 14 | 8·900225 | 7 185 | 11·099775 | 8·901601 | 7 186 | 11·098399 | 10·001376 | 7 1 | 9·998624 | 46 | 30 |
| 34 | 16 | 8·901017 | 8 212 | 11·098983 | 8·902398 | 8 213 | 11·097602 | 10·001381 | 8 1 | 9·998619 | 44 | 26 |
| 30 | 18 | 8·901807 | 9 238 | 11·098193 | 8·903193 | 9 240 | 11·096807 | 10·001386 | 9 2 | 9·998614 | 42 | 30 |
| 35 | 20 | 8·902596 | 10 265 | 11·097404 | 8·903987 | 10 266 | 11·096013 | 10·001391 | 10 2 | 9·998609 | 40 | 25 |
| 30 | 22 | 8·903383 | 1 26 | 11·096617 | 8·904779 | 1 26 | 11·095221 | 10·001396 | 11 2 | 9·998604 | 38 | 30 |
| 36 | 24 | 8·904169 | 2 52 | 11·095831 | 8·905570 | 2 52 | 11·094430 | 10·001401 | 12 2 | 9·998599 | 36 | 24 |
| 30 | 26 | 8·904953 | 3 78 | 11·095047 | 8·906359 | 3 79 | 11·093641 | 10·001406 | 13 2 | 9·998594 | 34 | 30 |
| 37 | 28 | 8·905736 | 4 104 | 11·094264 | 8·907147 | 4 105 | 11·092853 | 10·001411 | 14 2 | 9·998589 | 32 | 23 |
| 30 | 30 | 8·906517 | 5 130 | 11·093483 | 8·907934 | 5 131 | 11·092066 | 10·001416 | 15 3 | 9·998584 | 30 | 30 |
| 38 | 32 | 8·907297 | 6 156 | 11·092703 | 8·908719 | 6 157 | 11·091281 | 10·001422 | 16 3 | 9·998578 | 28 | 22 |
| 30 | 34 | 8·908076 | 7 182 | 11·091924 | 8·909503 | 7 183 | 11·090497 | 10·001427 | 17 3 | 9·998573 | 26 | 30 |
| 39 | 36 | 8·908853 | 8 208 | 11·091147 | 8·910285 | 8 209 | 11·089715 | 10·001432 | 18 3 | 9·998568 | 24 | 21 |
| 30 | 38 | 8·909629 | 9 234 | 11·090371 | 8·911066 | 9 236 | 11·088934 | 10·001437 | 19 3 | 9·998563 | 22 | 30 |
| 40 | 40 | 8·910404 | 10 260 | 11·089596 | 8·911846 | 10 262 | 11·088154 | 10·001442 | 20 3 | 9·998558 | 20 | 20 |
| 30 | 42 | 8·911177 | 1 26 | 11·088823 | 8·912624 | 1 26 | 11·087376 | 10·001447 | 21 4 | 9·998553 | 18 | 30 |
| 41 | 44 | 8·911949 | 2 51 | 11·088051 | 8·913401 | 2 51 | 11·086599 | 10·001452 | 22 4 | 9·998548 | 16 | 19 |
| 30 | 46 | 8·912719 | 3 77 | 11·087281 | 8·914177 | 3 77 | 11·085823 | 10·001458 | 23 4 | 9·998542 | 14 | 30 |
| 42 | 48 | 8·913488 | 4 102 | 11·086512 | 8·914951 | 4 103 | 11·085049 | 10·001463 | 24 4 | 9·998537 | 12 | 18 |
| 30 | 50 | 8·914256 | 5 128 | 11·085744 | 8·915724 | 5 129 | 11·084276 | 10·001468 | 25 4 | 9·998532 | 10 | 30 |
| 43 | 52 | 8·915022 | 6 153 | 11·084978 | 8·916495 | 6 154 | 11·083505 | 10·001473 | 26 4 | 9·998527 | 8 | 17 |
| 30 | 54 | 8·915787 | 7 179 | 11·084213 | 8·917265 | 7 180 | 11·082735 | 10·001478 | 27 5 | 9·998522 | 6 | 30 |
| 44 | 56 | 8·916550 | 8 204 | 11·083450 | 8·918034 | 8 206 | 11·081966 | 10·001484 | 28 5 | 9·998516 | 4 | 16 |
| 30 | 58 | 8·917313 | 9 230 | 11·082687 | 8·918801 | 9 231 | 11·081199 | 10·001489 | 29 5 | 9·998511 | 2 | 30 |
| 45 | 19 | 8·918073 | 10 255 | 11·081927 | 8·919568 | 10 257 | 11·080432 | 10·001494 | 30 5 | 9·998506 | 41 | 15 |
| 30 | 2 | 8·918833 | 1 25 | 11·081167 | 8·920332 | 1 25 | 11·079668 | 10·001499 | 1 0 | 9·998501 | 58 | 30 |
| 46 | 4 | 8·919591 | 2 50 | 11·080409 | 8·921096 | 2 51 | 11·078904 | 10·001505 | 2 0 | 9·998495 | 56 | 14 |
| 30 | 6 | 8·920348 | 3 75 | 11·079652 | 8·921858 | 3 76 | 11·078142 | 10·001510 | 3 1 | 9·998490 | 54 | 30 |
| 47 | 8 | 8·921103 | 4 100 | 11·078897 | 8·922619 | 4 101 | 11·077381 | 10·001515 | 4 1 | 9·998485 | 52 | 13 |
| 30 | 10 | 8·921858 | 5 125 | 11·078142 | 8·923378 | 5 126 | 11·076622 | 10·001521 | 5 1 | 9·998479 | 50 | 30 |
| 48 | 12 | 8·922610 | 6 150 | 11·077390 | 8·924136 | 6 152 | 11·075864 | 10·001526 | 6 1 | 9·998474 | 48 | 12 |
| 30 | 14 | 8·923362 | 7 175 | 11·076638 | 8·924893 | 7 177 | 11·075107 | 10·001531 | 7 1 | 9·998469 | 46 | 30 |
| 49 | 16 | 8·924112 | 8 201 | 11·075888 | 8·925649 | 8 202 | 11·074351 | 10·001536 | 8 1 | 9·998464 | 44 | 11 |
| 30 | 18 | 8·924861 | 9 226 | 11·075139 | 8·926403 | 9 227 | 11·073597 | 10·001542 | 9 2 | 9·998458 | 42 | 30 |
| 50 | 20 | 8·925609 | 10 251 | 11·074391 | 8·927156 | 10 253 | 11·072844 | 10·001547 | 10 2 | 9·998453 | 40 | 10 |
| 30 | 22 | 8·926355 | 1 25 | 11·073645 | 8·927908 | 1 25 | 11·072092 | 10·001552 | 11 2 | 9·998448 | 38 | 30 |
| 51 | 24 | 8·927100 | 2 49 | 11·072900 | 8·928658 | 2 50 | 11·071342 | 10·001558 | 12 2 | 9·998442 | 36 | 9 |
| 30 | 26 | 8·927844 | 3 74 | 11·072156 | 8·929407 | 3 74 | 11·070593 | 10·001563 | 13 2 | 9·998437 | 34 | 30 |
| 52 | 28 | 8·928587 | 4 99 | 11·071413 | 8·930155 | 4 99 | 11·069845 | 10·001569 | 14 3 | 9·998431 | 32 | 8 |
| 30 | 30 | 8·929328 | 5 123 | 11·070672 | 8·930902 | 5 124 | 11·069098 | 10·001574 | 15 3 | 9·998426 | 30 | 30 |
| 53 | 32 | 8·930068 | 6 148 | 11·069932 | 8·931647 | 6 149 | 11·068353 | 10·001579 | 16 3 | 9·998421 | 28 | 7 |
| 30 | 34 | 8·930806 | 7 173 | 11·069194 | 8·932391 | 7 174 | 11·067609 | 10·001585 | 17 3 | 9·998415 | 26 | 30 |
| 54 | 36 | 8·931544 | 8 197 | 11·068456 | 8·933134 | 8 199 | 11·066866 | 10·001590 | 18 3 | 9·998410 | 24 | 6 |
| 30 | 38 | 8·932280 | 9 222 | 11·067720 | 8·933876 | 9 223 | 11·066124 | 10·001596 | 19 3 | 9·998404 | 22 | 30 |
| 55 | 40 | 8·933015 | 10 247 | 11·066985 | 8·934616 | 10 248 | 11·065384 | 10·001601 | 20 4 | 9·998399 | 20 | 5 |
| 30 | 42 | 8·933749 | 1 24 | 11·066251 | 8·935355 | 1 24 | 11·064645 | 10·001606 | 21 4 | 9·998394 | 18 | 30 |
| 56 | 44 | 8·934481 | 2 48 | 11·065519 | 8·936093 | 2 49 | 11·063907 | 10·001612 | 22 4 | 9·998388 | 16 | 4 |
| 30 | 46 | 8·935212 | 3 73 | 11·064788 | 8·936830 | 3 73 | 11·063170 | 10·001617 | 23 4 | 9·998383 | 14 | 30 |
| 57 | 48 | 8·935942 | 4 97 | 11·064058 | 8·937565 | 4 98 | 11·062435 | 10·001623 | 24 4 | 9·998377 | 12 | 3 |
| 30 | 50 | 8·936671 | 5 121 | 11·063329 | 8·938299 | 5 122 | 11·061701 | 10·001628 | 25 4 | 9·998372 | 10 | 30 |
| 58 | 52 | 8·937398 | 6 145 | 11·062602 | 8·939032 | 6 147 | 11·060968 | 10·001634 | 26 5 | 9·998366 | 8 | 2 |
| 30 | 54 | 8·938125 | 7 170 | 11·061875 | 8·939764 | 7 171 | 11·060236 | 10·001639 | 27 5 | 9·998361 | 6 | 30 |
| 59 | 56 | 8·938850 | 8 194 | 11·061150 | 8·940494 | 8 195 | 11·059506 | 10·001645 | 28 5 | 9·998355 | 4 | 1 |
| 30 | 58 | 8·939573 | 9 218 | 11·060427 | 8·941224 | 9 220 | 11·058776 | 10·001650 | 29 5 | 9·998350 | 2 | 30 |
| 60 | 20 | 8·940296 | 10 242 | 11·059704 | 8·941952 | 10 244 | 11·058048 | 10·001656 | 30 5 | 9·998344 | 0 | 0 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

85° 5h 40m

## LOG. SINES, COSINES, &c.

0h 20m 5°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 8·940296 | | 11·059704 | 8·941952 | | 11·058048 | 10·001656 | | 9·998344 | 40 | 60 |
| 30 | 2 | 8·941017 | 1″ 24 | 11·058983 | 8·942679 | 1″ 24 | 11·057321 | 10·001660 | 1″ 0 | 9·998339 | 58 | 30 |
| 1 | 4 | 8·941738 | 2 48 | 11·058262 | 8·943404 | 2 48 | 11·056596 | 10·001667 | 2 0 | 9·998333 | 56 | 59 |
| 30 | 6 | 8·942457 | 3 71 | 11·057543 | 8·944129 | 3 72 | 11·055871 | 10·001672 | 3 1 | 9·998328 | 54 | 30 |
| 2 | 8 | 8·943174 | 4 95 | 11·056826 | 8·944852 | 4 96 | 11·055148 | 10·001678 | 4 1 | 9·998322 | 52 | 58 |
| 30 | 10 | 8·943891 | 5 119 | 11·056109 | 8·945574 | 5 120 | 11·054426 | 10·001684 | 5 1 | 9·998316 | 50 | 30 |
| 3 | 12 | 8·944606 | 6 143 | 11·055394 | 8·946295 | 6 144 | 11·053705 | 10·001689 | 6 1 | 9·998311 | 48 | 57 |
| 30 | 14 | 8·945321 | 7 167 | 11·054679 | 8·947015 | 7 168 | 11·052985 | 10·001695 | 7 1 | 9·998305 | 46 | 30 |
| 4 | 16 | 8·946034 | 8 191 | 11·053966 | 8·947734 | 8 192 | 11·052266 | 10·001700 | 8 2 | 9·998300 | 44 | 56 |
| 30 | 18 | 8·946745 | 9 214 | 11·053255 | 8·948451 | 9 216 | 11·051549 | 10·001706 | 9 2 | 9·998294 | 42 | 30 |
| 5 | 20 | 8·947456 | 10 238 | 11·052544 | 8·949168 | 10 240 | 11·050832 | 10·001711 | 10 2 | 9·998289 | 40 | 55 |
| 30 | 22 | 8·948166 | 1 23 | 11·051834 | 8·949883 | 1 24 | 11·050117 | 10·001717 | 11 2 | 9·998283 | 38 | 30 |
| 6 | 24 | 8·948874 | 2 47 | 11·051126 | 8·950597 | 2 47 | 11·049403 | 10·001723 | 12 2 | 9·998277 | 36 | 54 |
| 30 | 26 | 8·949581 | 3 70 | 11·050419 | 8·951309 | 3 71 | 11·048691 | 10·001728 | 13 2 | 9·998272 | 34 | 30 |
| 7 | 28 | 8·950287 | 4 94 | 11·049713 | 8·952021 | 4 95 | 11·047979 | 10·001734 | 14 3 | 9·998266 | 32 | 53 |
| 30 | 30 | 8·950992 | 5 117 | 11·049008 | 8·952732 | 5 118 | 11·047268 | 10·001740 | 15 3 | 9·998260 | 30 | 30 |
| 8 | 32 | 8·951696 | 6 141 | 11·048304 | 8·953441 | 6 142 | 11·046559 | 10·001745 | 16 3 | 9·998255 | 28 | 52 |
| 30 | 34 | 8·952398 | 7 164 | 11·047602 | 8·954149 | 7 165 | 11·045851 | 10·001751 | 17 3 | 9·998249 | 26 | 30 |
| 9 | 36 | 8·953100 | 8 188 | 11·046900 | 8·954856 | 8 189 | 11·045144 | 10·001757 | 18 3 | 9·998243 | 24 | 51 |
| 30 | 38 | 8·953800 | 9 211 | 11·046200 | 8·955562 | 9 213 | 11·044438 | 10·001762 | 19 4 | 9·998238 | 22 | 30 |
| 10 | 40 | 8·954499 | 10 235 | 11·045501 | 8·956267 | 10 236 | 11·043733 | 10·001768 | 20 4 | 9·998232 | 20 | 50 |
| 30 | 42 | 8·955197 | 1 23 | 11·044803 | 8·956971 | 1 23 | 11·043029 | 10·001774 | 21 4 | 9·998226 | 18 | 30 |
| 11 | 44 | 8·955894 | 2 46 | 11·044106 | 8·957674 | 2 47 | 11·042326 | 10·001780 | 22 4 | 9·998220 | 16 | 49 |
| 30 | 46 | 8·956590 | 3 69 | 11·043410 | 8·958375 | 3 70 | 11·041625 | 10·001785 | 23 4 | 9·998215 | 14 | 30 |
| 12 | 48 | 8·957284 | 4 92 | 11·042716 | 8·959075 | 4 93 | 11·040925 | 10·001791 | 24 5 | 9·998209 | 12 | 48 |
| 30 | 50 | 8·957978 | 5 115 | 11·042022 | 8·959775 | 5 116 | 11·040225 | 10·001797 | 25 5 | 9·998203 | 10 | 30 |
| 13 | 52 | 8·958670 | 6 138 | 11·041330 | 8·960473 | 6 140 | 11·039527 | 10·001803 | 26 5 | 9·998197 | 8 | 47 |
| 30 | 54 | 8·959362 | 7 161 | 11·040638 | 8·961170 | 7 163 | 11·038830 | 10·001808 | 27 5 | 9·998192 | 6 | 30 |
| 14 | 56 | 8·960052 | 8 185 | 11·039948 | 8·961866 | 8 186 | 11·038134 | 10·001814 | 28 5 | 9·998186 | 4 | 46 |
| 30 | 58 | 8·960741 | 9 208 | 11·039259 | 8·962561 | 9 209 | 11·037439 | 10·001820 | 29 6 | 9·998180 | 2 | 30 |
| 15 | 21 | 8·961429 | 10 231 | 11·038571 | 8·963255 | 10 233 | 11·036745 | 10·001826 | 30 6 | 9·998174 | 39 | 45 |
| 30 | 2 | 8·962116 | 1 23 | 11·037884 | 8·963947 | 1 23 | 11·036053 | 10·001832 | 1 0 | 9·998168 | 58 | 30 |
| 16 | 4 | 8·962801 | 2 45 | 11·037199 | 8·964639 | 2 46 | 11·035361 | 10·001837 | 2 0 | 9·998163 | 56 | 44 |
| 30 | 6 | 8·963486 | 3 68 | 11·036514 | 8·965329 | 3 69 | 11·034671 | 10·001843 | 3 1 | 9·998157 | 54 | 30 |
| 17 | 8 | 8·964170 | 4 91 | 11·035830 | 8·966019 | 4 92 | 11·033981 | 10·001849 | 4 1 | 9·998151 | 52 | 43 |
| 30 | 10 | 8·964852 | 5 114 | 11·035148 | 8·966707 | 5 115 | 11·033293 | 10·001855 | 5 1 | 9·998145 | 50 | 30 |
| 18 | 12 | 8·965534 | 6 136 | 11·034466 | 8·967394 | 6 137 | 11·032606 | 10·001861 | 6 1 | 9·998139 | 48 | 42 |
| 30 | 14 | 8·966214 | 7 159 | 11·033786 | 8·968081 | 7 160 | 11·031919 | 10·001867 | 7 1 | 9·998133 | 46 | 30 |
| 19 | 16 | 8·966893 | 8 182 | 11·033107 | 8·968766 | 8 183 | 11·031234 | 10·001872 | 8 2 | 9·998128 | 44 | 41 |
| 30 | 18 | 8·967572 | 9 205 | 11·032428 | 8·969450 | 9 206 | 11·030550 | 10·001878 | 9 2 | 9·998122 | 42 | 30 |
| 20 | 20 | 8·968249 | 10 227 | 11·031751 | 8·970133 | 10 229 | 11·029867 | 10·001884 | 10 2 | 9·998116 | 40 | 40 |
| 30 | 22 | 8·968925 | 1 22 | 11·031075 | 8·970815 | 1 23 | 11·029185 | 10·001890 | 11 2 | 9·998110 | 38 | 30 |
| 21 | 24 | 8·969600 | 2 45 | 11·030400 | 8·971496 | 2 45 | 11·028504 | 10·001896 | 12 2 | 9·998104 | 36 | 39 |
| 30 | 26 | 8·970274 | 3 67 | 11·029726 | 8·972176 | 3 68 | 11·027824 | 10·001902 | 13 3 | 9·998098 | 34 | 30 |
| 22 | 28 | 8·970947 | 4 89 | 11·029053 | 8·972855 | 4 90 | 11·027145 | 10·001908 | 14 3 | 9·998092 | 32 | 38 |
| 30 | 30 | 8·971619 | 5 112 | 11·028381 | 8·973532 | 5 113 | 11·026468 | 10·001914 | 15 3 | 9·998086 | 30 | 30 |
| 23 | 32 | 8·972289 | 6 134 | 11·027711 | 8·974209 | 6 135 | 11·025791 | 10·001920 | 16 3 | 9·998080 | 28 | 37 |
| 30 | 34 | 8·972959 | 7 156 | 11·027041 | 8·974885 | 7 158 | 11·025115 | 10·001926 | 17 3 | 9·998074 | 26 | 30 |
| 24 | 36 | 8·973628 | 8 179 | 11·026372 | 8·975560 | 8 180 | 11·024440 | 10·001932 | 18 4 | 9·998068 | 24 | 36 |
| 30 | 38 | 8·974296 | 9 201 | 11·025704 | 8·976233 | 9 203 | 11·023767 | 10·001938 | 19 4 | 9·998062 | 22 | 30 |
| 25 | 40 | 8·974962 | 10 223 | 11·025038 | 8·976906 | 10 226 | 11·023094 | 10·001944 | 20 4 | 9·998056 | 20 | 35 |
| 30 | 42 | 8·975628 | 1 22 | 11·024372 | 8·977578 | 1 22 | 11·022422 | 10·001950 | 21 4 | 9·998050 | 18 | 30 |
| 26 | 44 | 8·976293 | 2 44 | 11·023707 | 8·978248 | 2 44 | 11·021752 | 10·001956 | 22 5 | 9·998044 | 16 | 34 |
| 30 | 46 | 8·976956 | 3 66 | 11·023044 | 8·978918 | 3 67 | 11·021082 | 10·001962 | 23 5 | 9·998038 | 14 | 30 |
| 27 | 48 | 8·977619 | 4 88 | 11·022381 | 8·979586 | 4 89 | 11·020414 | 10·001968 | 24 5 | 9·998032 | 12 | 33 |
| 30 | 50 | 8·978280 | 5 110 | 11·021720 | 8·980254 | 5 111 | 11·019746 | 10·001974 | 25 5 | 9·998026 | 10 | 30 |
| 28 | 52 | 8·978941 | 6 132 | 11·021059 | 8·980921 | 6 133 | 11·019079 | 10·001980 | 26 5 | 9·998020 | 8 | 32 |
| 30 | 54 | 8·979600 | 7 154 | 11·020400 | 8·981586 | 7 156 | 11·018414 | 10·001986 | 27 5 | 9·998014 | 6 | 30 |
| 29 | 56 | 8·980259 | 8 176 | 11·019741 | 8·982251 | 8 178 | 11·017749 | 10·001992 | 28 6 | 9·998008 | 4 | 31 |
| 30 | 58 | 8·980916 | 9 198 | 11·019084 | 8·982914 | 9 200 | 11·017086 | 10·001998 | 29 6 | 9·998002 | 2 | 30 |
| 30 | 22 | 8·981573 | 10 220 | 11·018427 | 8·983577 | 10 222 | 11·016423 | 10·002004 | 30 6 | 9·997996 | 0 | 30 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

84° 5h 38m

## LOG. SINES, COSINES, &c.

0h 22m — 5°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 8·981573 | | 11·018427 | 8·983577 | | 11·016423 | 10·002004 | | 9·997996 | 38 | 30 |
| 30 | 2 | 8·982228 | 1″ 22 | 11·017772 | 8·984238 | 1″ 22 | 11·015762 | 10·002010 | 1″ 0 | 9·997990 | 58 | 30 |
| 31 | 4 | 8·982883 | 2 43 | 11·017117 | 8·984899 | 2 44 | 11·015101 | 10·002016 | 2 0 | 9·997984 | 56 | 29 |
| 30 | 6 | 8·983536 | 3 65 | 11·016464 | 8·985559 | 3 66 | 11·014441 | 10·002022 | 3 1 | 9·997978 | 54 | 30 |
| 32 | 8 | 8·984189 | 4 87 | 11·015811 | 8·986217 | 4 88 | 11·013783 | 10·002028 | 4 1 | 9·997972 | 52 | 28 |
| 30 | 10 | 8·984840 | 5 109 | 11·015160 | 8·986875 | 5 110 | 11·013125 | 10·002035 | 5 1 | 9·997965 | 50 | 30 |
| 33 | 12 | 8·985491 | 6 130 | 11·014509 | 8·987532 | 6 131 | 11·012468 | 10·002041 | 6 1 | 9·997959 | 48 | 27 |
| 30 | 14 | 8·986141 | 7 152 | 11·013859 | 8·988187 | 7 153 | 11·011813 | 10·002047 | 7 1 | 9·997953 | 46 | 30 |
| 34 | 16 | 8·986789 | 8 174 | 11·013211 | 8·988842 | 8 175 | 11·011158 | 10·002053 | 8 2 | 9·997947 | 44 | 26 |
| 30 | 18 | 8·987437 | 9 195 | 11·012563 | 8·989496 | 9 197 | 11·010504 | 10·002059 | 9 2 | 9·997941 | 42 | 30 |
| 35 | 20 | 8·988083 | 10 217 | 11·011917 | 8·990149 | 10 219 | 11·009851 | 10·002065 | 10 2 | 9·997935 | 40 | 25 |
| 30 | 22 | 8·988729 | 1 21 | 11·011271 | 8·990801 | 1 22 | 11·009199 | 10·002071 | 11 2 | 9·997929 | 38 | 30 |
| 36 | 24 | 8·989374 | 2 43 | 11·010626 | 8·991451 | 2 43 | 11·008549 | 10·002078 | 12 2 | 9·997922 | 36 | 24 |
| 30 | 26 | 8·990017 | 3 64 | 11·009983 | 8·992101 | 3 65 | 11·007899 | 10·002084 | 13 3 | 9·997916 | 34 | 30 |
| 37 | 28 | 8·990660 | 4 85 | 11·009340 | 8·992750 | 4 86 | 11·007250 | 10·002090 | 14 3 | 9·997910 | 32 | 23 |
| 30 | 30 | 8·991302 | 5 107 | 11·008698 | 8·993398 | 5 108 | 11·006602 | 10·002096 | 15 3 | 9·997904 | 30 | 30 |
| 38 | 32 | 8·991943 | 6 128 | 11·008057 | 8·994045 | 6 129 | 11·005955 | 10·002103 | 16 3 | 9·997897 | 28 | 22 |
| 30 | 34 | 8·992583 | 7 150 | 11·007417 | 8·994692 | 7 151 | 11·005308 | 10·002109 | 17 4 | 9·997891 | 26 | 30 |
| 39 | 36 | 8·993222 | 8 171 | 11·006778 | 8·995337 | 8 173 | 11·004663 | 10·002115 | 18 4 | 9·997885 | 24 | 21 |
| 30 | 38 | 8·993860 | 9 192 | 11·006140 | 8·995981 | 9 194 | 11·004019 | 10·002121 | 19 4 | 9·997879 | 22 | 30 |
| 40 | 40 | 8·994497 | 10 214 | 11·005503 | 8·996624 | 10 216 | 11·003376 | 10·002128 | 20 4 | 9·997872 | 20 | 20 |
| 30 | 42 | 8·995133 | 1 21 | 11·004867 | 8·997267 | 1 21 | 11·002733 | 10·002134 | 21 4 | 9·997866 | 18 | 30 |
| 41 | 44 | 8·995768 | 2 42 | 11·004232 | 8·997908 | 2 43 | 11·002092 | 10·002140 | 22 5 | 9·997860 | 16 | 19 |
| 30 | 46 | 8·996402 | 3 63 | 11·003598 | 8·998549 | 3 64 | 11·001451 | 10·002146 | 23 5 | 9·997854 | 14 | 30 |
| 42 | 48 | 8·997036 | 4 84 | 11·002964 | 8·999188 | 4 85 | 11·000812 | 10·002153 | 24 5 | 9·997847 | 12 | 18 |
| 30 | 50 | 8·997668 | 5 105 | 11·002332 | 8·999827 | 5 106 | 11·000173 | 10·002159 | 25 5 | 9·997841 | 10 | 30 |
| 43 | 52 | 8·998299 | 6 126 | 11·001701 | 9·000465 | 6 128 | 10·999535 | 10·002165 | 26 5 | 9·997835 | 8 | 17 |
| 30 | 54 | 8·998930 | 7 147 | 11·001070 | 9·001102 | 7 149 | 10·998898 | 10·002172 | 27 6 | 9·997828 | 6 | 30 |
| 44 | 56 | 8·999560 | 8 168 | 11·000440 | 9·001738 | 8 170 | 10·998262 | 10·002178 | 28 6 | 9·997822 | 4 | 16 |
| 30 | 58 | 9·000188 | 9 189 | 10·999812 | 9·002373 | 9 191 | 10·997627 | 10·002184 | 29 6 | 9·997816 | 2 | 30 |
| 45 | **23** | 9·000816 | 10 210 | 10·999184 | 9·003007 | 10 213 | 10·996993 | 10·002191 | 30 6 | 9·997809 | **37** | 15 |
| 30 | 2 | 9·001443 | 1 21 | 10·998557 | 9·003640 | 1 21 | 10·996360 | 10·002197 | 1 0 | 9·997803 | 58 | 30 |
| 46 | 4 | 9·002069 | 2 41 | 10·997931 | 9·004272 | 2 42 | 10·995728 | 10·002203 | 2 0 | 9·997797 | 56 | 14 |
| 30 | 6 | 9·002694 | 3 62 | 10·997306 | 9·004904 | 3 63 | 10·995096 | 10·002210 | 3 1 | 9·997790 | 54 | 30 |
| 47 | 8 | 9·003318 | 4 83 | 10·996682 | 9·005534 | 4 84 | 10·994466 | 10·002216 | 4 1 | 9·997784 | 52 | 13 |
| 30 | 10 | 9·003941 | 5 104 | 10·996059 | 9·006164 | 5 105 | 10·993836 | 10·002223 | 5 1 | 9·997777 | 50 | 30 |
| 48 | 12 | 9·004563 | 6 124 | 10·995437 | 9·006792 | 6 126 | 10·993208 | 10·002229 | 6 1 | 9·997771 | 48 | 12 |
| 30 | 14 | 9·005185 | 7 145 | 10·994815 | 9·007420 | 7 147 | 10·992580 | 10·002235 | 7 1 | 9·997765 | 46 | 30 |
| 49 | 16 | 9·005805 | 8 166 | 10·994195 | 9·008047 | 8 167 | 10·991953 | 10·002242 | 8 2 | 9·997758 | 44 | 11 |
| 30 | 18 | 9·006425 | 9 187 | 10·993575 | 9·008673 | 9 188 | 10·991327 | 10·002248 | 9 2 | 9·997752 | 42 | 30 |
| 50 | 20 | 9·007044 | 10 207 | 10·992956 | 9·009298 | 10 209 | 10·990702 | 10·002255 | 10 2 | 9·997745 | 40 | 10 |
| 30 | 22 | 9·007661 | 1 20 | 10·992339 | 9·009923 | 1 21 | 10·990077 | 10·002261 | 11 2 | 9·997739 | 38 | 30 |
| 51 | 24 | 9·008278 | 2 41 | 10·991722 | 9·010546 | 2 41 | 10·989454 | 10·002268 | 12 3 | 9·997732 | 36 | 9 |
| 30 | 26 | 9·008894 | 3 61 | 10·991106 | 9·011169 | 3 62 | 10·988831 | 10·002274 | 13 3 | 9·997726 | 34 | 30 |
| 52 | 28 | 9·009510 | 4 82 | 10·990490 | 9·011790 | 4 83 | 10·988210 | 10·002281 | 14 3 | 9·997719 | 32 | 8 |
| 30 | 30 | 9·010124 | 5 102 | 10·989876 | 9·012411 | 5 103 | 10·987589 | 10·002287 | 15 3 | 9·997713 | 30 | 30 |
| 53 | 32 | 9·010737 | 6 123 | 10·989263 | 9·013031 | 6 124 | 10·986969 | 10·002294 | 16 3 | 9·997706 | 28 | 7 |
| 30 | 34 | 9·011350 | 7 143 | 10·988650 | 9·013650 | 7 145 | 10·986350 | 10·002300 | 17 4 | 9·997700 | 26 | 30 |
| 54 | 36 | 9·011962 | 8 163 | 10·988038 | 9·014268 | 8 165 | 10·985732 | 10·002307 | 18 4 | 9·997693 | 24 | 6 |
| 30 | 38 | 9·012572 | 9 184 | 10·987428 | 9·014886 | 9 186 | 10·985114 | 10·002313 | 19 4 | 9·997687 | 22 | 30 |
| 55 | 40 | 9·013182 | 10 204 | 10·986818 | 9·015502 | 10 207 | 10·984498 | 10·002320 | 20 4 | 9·997680 | 20 | 5 |
| 30 | 42 | 9·013791 | 1 20 | 10·986209 | 9·016118 | 1 20 | 10·983882 | 10·002326 | 21 4 | 9·997674 | 18 | 30 |
| 56 | 44 | 9·014400 | 2 40 | 10·985600 | 9·016732 | 2 41 | 10·983268 | 10·002333 | 22 5 | 9·997667 | 16 | 4 |
| 30 | 46 | 9·015007 | 3 61 | 10·984993 | 9·017346 | 3 61 | 10·982654 | 10·002339 | 23 5 | 9·997661 | 14 | 30 |
| 57 | 48 | 9·015613 | 4 81 | 10·984387 | 9·017959 | 4 81 | 10·982041 | 10·002346 | 24 5 | 9·997654 | 12 | 3 |
| 30 | 50 | 9·016219 | 5 101 | 10·983781 | 9·018572 | 5 102 | 10·981428 | 10·002353 | 25 5 | 9·997647 | 10 | 30 |
| 58 | 52 | 9·016824 | 6 121 | 10·983176 | 9·019183 | 6 122 | 10·980817 | 10·002359 | 26 5 | 9·997641 | 8 | 2 |
| 30 | 54 | 9·017428 | 7 141 | 10·982572 | 9·019794 | 7 143 | 10·980206 | 10·002366 | 27 6 | 9·997634 | 6 | 30 |
| 59 | 56 | 9·018031 | 8 161 | 10·981969 | 9·020403 | 8 163 | 10·979597 | 10·002372 | 28 6 | 9·997628 | 4 | 1 |
| 30 | 58 | 9·018633 | 9 182 | 10·981367 | 9·021012 | 9 183 | 10·978988 | 10·002379 | 29 6 | 9·997621 | 2 | 30 |
| 60 | **24** | 9·019235 | 10 202 | 10·980765 | 9·021620 | 10 204 | 10·978380 | 10·002386 | 30 6 | 9·997614 | 0 | 0 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

84° — 5h 36m

## LOG. SINES, COSINES, &c.

$0^{h}\ 24^{m}$ — 6°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 9·019235 | | 10·980765 | 9·021620 | | 10·978380 | 10·002386 | | 9·997614 | 36 | 60 |
| 30 | 2 | 9·019835 | 1″ 20 | 10·980165 | 9·022227 | 1″ 20 | 10·977773 | 10·002392 | 1″ 0 | 9·997608 | 58 | 30 |
| 1 | 4 | 9·020435 | 2 40 | 10·979565 | 9·022834 | 2 40 | 10·977166 | 10·002399 | 2 0 | 9·997601 | 56 | 59 |
| 30 | 6 | 9·021034 | 3 60 | 10·978966 | 9·023439 | 3 60 | 10·976561 | 10·002406 | 3 1 | 9·997594 | 54 | 30 |
| 2 | 8 | 9·021632 | 4 79 | 10·978368 | 9·024044 | 4 80 | 10·975956 | 10·002412 | 4 1 | 9·997588 | 52 | 58 |
| 30 | 10 | 9·022229 | 5 99 | 10·977771 | 9·024648 | 5 101 | 10·975352 | 10·002419 | 5 1 | 9·997581 | 50 | 30 |
| 3 | 12 | 9·022825 | 6 119 | 10·977175 | 9·025251 | 6 121 | 10·974749 | 10·002426 | 6 1 | 9·997574 | 48 | 57 |
| 30 | 14 | 9·023421 | 7 139 | 10·976579 | 9·025853 | 7 141 | 10·974147 | 10·002432 | 7 2 | 9·997568 | 46 | 30 |
| 4 | 16 | 9·024016 | 8 159 | 10·975984 | 9·026455 | 8 161 | 10·973545 | 10·002439 | 8 2 | 9·997561 | 44 | 56 |
| 30 | 18 | 9·024610 | 9 179 | 10·975390 | 9·027055 | 9 181 | 10·972945 | 10·002446 | 9 2 | 9·997554 | 42 | 30 |
| 5 | 20 | 9·025203 | 10 199 | 10·974797 | 9·027655 | 10 201 | 10·972345 | 10·002453 | 10 2 | 9·997547 | 40 | 55 |
| 30 | 22 | 9·025795 | 1 20 | 10·974205 | 9·028254 | 1 20 | 10·971746 | 10·002459 | 11 2 | 9·997541 | 38 | 30 |
| 6 | 24 | 9·026386 | 2 39 | 10·973614 | 9·028852 | 2 40 | 10·971148 | 10·002466 | 12 3 | 9·997534 | 36 | 54 |
| 30 | 26 | 9·026977 | 3 59 | 10·973023 | 9·029450 | 3 59 | 10·970550 | 10·002473 | 13 3 | 9·997527 | 34 | 30 |
| 7 | 28 | 9·027567 | 4 78 | 10·972433 | 9·030046 | 4 79 | 10·969954 | 10·002480 | 14 3 | 9·997520 | 32 | 53 |
| 30 | 30 | 9·028156 | 5 98 | 10·971844 | 9·030642 | 5 99 | 10·969358 | 10·002486 | 15 3 | 9·997514 | 30 | 30 |
| 8 | 32 | 9·028744 | 6 118 | 10·971256 | 9·031237 | 6 119 | 10·968763 | 10·002493 | 16 4 | 9·997507 | 28 | 52 |
| 30 | 34 | 9·029332 | 7 137 | 10·970668 | 9·031831 | 7 139 | 10·968169 | 10·002500 | 17 4 | 9·997500 | 26 | 30 |
| 9 | 36 | 9·029918 | 8 157 | 10·970082 | 9·032425 | 8 159 | 10·967575 | 10·002507 | 18 4 | 9·997493 | 24 | 51 |
| 30 | 38 | 9·030504 | 9 176 | 10·969496 | 9·033017 | 9 178 | 10·966983 | 10·002513 | 19 4 | 9·997487 | 22 | 30 |
| 10 | 40 | 9·031089 | 10 196 | 10·968911 | 9·033609 | 10 198 | 10·966391 | 10·002520 | 20 5 | 9·997480 | 20 | 50 |
| 30 | 42 | 9·031673 | 1 19 | 10·968327 | 9·034200 | 1 20 | 10·965800 | 10·002527 | 21 5 | 9·997473 | 18 | 30 |
| 11 | 44 | 9·032257 | 2 39 | 10·967743 | 9·034791 | 2 39 | 10·965209 | 10·002534 | 22 5 | 9·997466 | 16 | 49 |
| 30 | 46 | 9·032839 | 3 58 | 10·967161 | 9·035380 | 3 59 | 10·964620 | 10·002541 | 23 5 | 9·997459 | 14 | 30 |
| 12 | 48 | 9·033421 | 4 77 | 10·966579 | 9·035969 | 4 78 | 10·964031 | 10·002548 | 24 5 | 9·997452 | 12 | 48 |
| 30 | 50 | 9·034002 | 5 97 | 10·965998 | 9·036557 | 5 98 | 10·963443 | 10·002555 | 25 6 | 9·997445 | 10 | 30 |
| 13 | 52 | 9·034582 | 6 116 | 10·965418 | 9·037144 | 6 117 | 10·962856 | 10·002561 | 26 6 | 9·997439 | 8 | 47 |
| 30 | 54 | 9·035162 | 7 135 | 10·964838 | 9·037730 | 7 137 | 10·962270 | 10·002568 | 27 6 | 9·997432 | 6 | 30 |
| 14 | 56 | 9·035741 | 8 155 | 10·964259 | 9·038316 | 8 157 | 10·961684 | 10·002575 | 28 6 | 9·997425 | 4 | 46 |
| 30 | 58 | 9·036319 | 9 174 | 10·963681 | 9·038901 | 9 176 | 10·961099 | 10·002582 | 29 7 | 9·997418 | 2 | 30 |
| 15 | 25 | 9·036896 | 10 193 | 10·963104 | 9·039485 | 10 196 | 10·960515 | 10·002589 | 30 7 | 9·997411 | 35 | 45 |
| 30 | 2 | 9·037472 | 1 19 | 10·962528 | 9·040068 | 1 19 | 10·959932 | 10·002596 | 1 0 | 9·997404 | 58 | 30 |
| 16 | 4 | 9·038048 | 2 38 | 10·961952 | 9·040651 | 2 39 | 10·959349 | 10·002603 | 2 0 | 9·997397 | 56 | 44 |
| 30 | 6 | 9·038623 | 3 57 | 10·961377 | 9·041232 | 3 58 | 10·958768 | 10·002610 | 3 1 | 9·997390 | 54 | 30 |
| 17 | 8 | 9·039197 | 4 76 | 10·960803 | 9·041813 | 4 77 | 10·958187 | 10·002617 | 4 1 | 9·997383 | 52 | 43 |
| 30 | 10 | 9·039770 | 5 95 | 10·960230 | 9·042394 | 5 97 | 10·957606 | 10·002624 | 5 1 | 9·997376 | 50 | 30 |
| 18 | 12 | 9·040342 | 6 114 | 10·959658 | 9·042973 | 6 116 | 10·957027 | 10·002631 | 6 1 | 9·997369 | 48 | 42 |
| 30 | 14 | 9·040914 | 7 133 | 10·959086 | 9·043552 | 7 135 | 10·956448 | 10·002638 | 7 2 | 9·997362 | 46 | 30 |
| 19 | 16 | 9·041485 | 8 153 | 10·958515 | 9·044130 | 8 154 | 10·955870 | 10·002645 | 8 2 | 9·997355 | 44 | 41 |
| 30 | 18 | 9·042055 | 9 172 | 10·957945 | 9·044707 | 9 174 | 10·955293 | 10·002652 | 9 2 | 9·997348 | 42 | 30 |
| 20 | 20 | 9·042625 | 10 191 | 10·957375 | 9·045284 | 10 193 | 10·954716 | 10·002659 | 10 2 | 9·997341 | 40 | 40 |
| 30 | 22 | 9·043194 | 1 19 | 10·956806 | 9·045859 | 1 19 | 10·954141 | 10·002666 | 11 3 | 9·997334 | 38 | 30 |
| 21 | 24 | 9·043762 | 2 38 | 10·956238 | 9·046434 | 2 38 | 10·953566 | 10·002673 | 12 3 | 9·997327 | 36 | 39 |
| 30 | 26 | 9·044329 | 3 56 | 10·955671 | 9·047009 | 3 57 | 10·952991 | 10·002680 | 13 3 | 9·997320 | 34 | 30 |
| 22 | 28 | 9·044895 | 4 75 | 10·955105 | 9·047582 | 4 76 | 10·952418 | 10·002687 | 14 3 | 9·997313 | 32 | 38 |
| 30 | 30 | 9·045461 | 5 94 | 10·954539 | 9·048155 | 5 95 | 10·951845 | 10·002694 | 15 4 | 9·997306 | 30 | 30 |
| 23 | 32 | 9·046026 | 6 113 | 10·953974 | 9·048727 | 6 114 | 10·951273 | 10·002701 | 16 4 | 9·997299 | 28 | 37 |
| 30 | 34 | 9·046590 | 7 132 | 10·953410 | 9·049298 | 7 133 | 10·950702 | 10·002708 | 17 4 | 9·997292 | 26 | 30 |
| 24 | 36 | 9·047154 | 8 151 | 10·952846 | 9·049869 | 8 153 | 10·950131 | 10·002715 | 18 4 | 9·997285 | 24 | 36 |
| 30 | 38 | 9·047717 | 9 169 | 10·952283 | 9·050439 | 9 172 | 10·949561 | 10·002722 | 19 4 | 9·997278 | 22 | 30 |
| 25 | 40 | 9·048279 | 10 188 | 10·951721 | 9·051008 | 10 191 | 10·948992 | 10·002729 | 20 5 | 9·997271 | 20 | 35 |
| 30 | 42 | 9·048840 | 1 19 | 10·951160 | 9·051576 | 1 19 | 10·948424 | 10·002736 | 21 5 | 9·997264 | 18 | 30 |
| 26 | 44 | 9·049400 | 2 37 | 10·950600 | 9·052144 | 2 38 | 10·947856 | 10·002743 | 22 5 | 9·997257 | 16 | 34 |
| 30 | 46 | 9·049960 | 3 56 | 10·950040 | 9·052711 | 3 56 | 10·947289 | 10·002751 | 23 5 | 9·997249 | 14 | 30 |
| 27 | 48 | 9·050519 | 4 74 | 10·949481 | 9·053277 | 4 75 | 10·946723 | 10·002758 | 24 6 | 9·997242 | 12 | 33 |
| 30 | 50 | 9·051078 | 5 93 | 10·948922 | 9·053843 | 5 94 | 10·946157 | 10·002765 | 25 5 | 9·997235 | 10 | 30 |
| 28 | 52 | 9·051635 | 6 111 | 10·948365 | 9·054407 | 6 113 | 10·945593 | 10·002772 | 26 6 | 9·997228 | 8 | 32 |
| 30 | 54 | 9·052192 | 7 130 | 10·947808 | 9·054972 | 7 132 | 10·945028 | 10·002779 | 27 7 | 9·997221 | 6 | 30 |
| 29 | 56 | 9·052749 | 8 149 | 10·947251 | 9·055535 | 8 150 | 10·944465 | 10·002786 | 28 7 | 9·997214 | 4 | 31 |
| 30 | 58 | 9·053304 | 9 167 | 10·946696 | 9·056098 | 9 169 | 10·943902 | 10·002794 | 29 7 | 9·997206 | 2 | 30 |
| 30 | 26 | 9·053859 | 10 186 | 10·946141 | 9·056659 | 10 188 | 10·943341 | 10·002801 | 30 7 | 9·997199 | 0 | 30 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

83° — $5^{h}\ 34^{m}$

## LOG. SINES, COSINES, &c.

0h 26m — 6°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 9·053859 | | 10·946141 | 9·056659 | | 10·943341 | 10·002801 | | 9·997199 | 34 | 30 |
| 30 | 2 | 9·054413 | 1″ 18 | 10·945587 | 9·057221 | 1″ 19 | 10·942779 | 10·002808 | 1″ 0 | 9·997192 | 58 | 30 |
| 31 | 4 | 9·054966 | 2 37 | 10·945034 | 9·057781 | 2 37 | 10·942219 | 10·002815 | 2 0 | 9·997185 | 56 | 29 |
| 30 | 6 | 9·055519 | 3 55 | 10·944481 | 9·058341 | 3 56 | 10·941659 | 10·002822 | 3 1 | 9·997178 | 54 | 30 |
| 32 | 8 | 9·056071 | 4 73 | 10·943929 | 9·058900 | 4 74 | 10·941100 | 10·002830 | 4 1 | 9·997170 | 52 | 28 |
| 30 | 10 | 9·056622 | 5 92 | 10·943378 | 9·059459 | 5 93 | 10·940541 | 10·002837 | 5 1 | 9·997163 | 50 | 30 |
| 33 | 12 | 9·057172 | 6 110 | 10·942828 | 9·060016 | 6 111 | 10·939984 | 10·002844 | 6 1 | 9·997156 | 48 | 27 |
| 30 | 14 | 9·057722 | 7 128 | 10·942278 | 9·060573 | 7 130 | 10·939427 | 10·002851 | 7 2 | 9·997149 | 46 | 30 |
| 34 | 16 | 9·058271 | 8 147 | 10·941729 | 9·061130 | 8 149 | 10·938870 | 10·002859 | 8 2 | 9·997141 | 44 | 26 |
| 30 | 18 | 9·058820 | 9 165 | 10·941180 | 9·061685 | 9 167 | 10·938315 | 10·002866 | 9 2 | 9·997134 | 42 | 30 |
| 35 | 20 | 9·059367 | 10 183 | 10·940633 | 9·062240 | 10 186 | 10·937760 | 10·002873 | 10 2 | 9·997127 | 40 | 25 |
| 30 | 22 | 9·059914 | 1 18 | 10·940086 | 9·062795 | 1 18 | 10·937205 | 10·002880 | 11 3 | 9·997120 | 38 | 30 |
| 36 | 24 | 9·060460 | 2 36 | 10·939540 | 9·063348 | 2 37 | 10·936652 | 10·002888 | 12 3 | 9·997112 | 36 | 24 |
| 30 | 26 | 9·061006 | 3 54 | 10·938994 | 9·063901 | 3 55 | 10·936099 | 10·002895 | 13 3 | 9·997105 | 34 | 30 |
| 37 | 28 | 9·061551 | 4 73 | 10·938449 | 9·064453 | 4 73 | 10·935547 | 10·002902 | 14 4 | 9·997098 | 32 | 23 |
| 30 | 30 | 9·062095 | 5 91 | 10·937905 | 9·065005 | 5 92 | 10·934995 | 10·002910 | 15 4 | 9·997090 | 30 | 30 |
| 38 | 32 | 9·062639 | 6 109 | 10·937361 | 9·065556 | 6 110 | 10·934444 | 10·002917 | 16 4 | 9·997083 | 28 | 22 |
| 30 | 34 | 9·063181 | 7 127 | 10·936819 | 9·066106 | 7 129 | 10·933894 | 10·002924 | 17 4 | 9·997076 | 26 | 30 |
| 39 | 36 | 9·063724 | 8 145 | 10·936276 | 9·066655 | 8 147 | 10·933345 | 10·002932 | 18 4 | 9·997068 | 24 | 21 |
| 30 | 38 | 9·064265 | 9 163 | 10·935735 | 9·067204 | 9 165 | 10·932796 | 10·002939 | 19 4 | 9·997061 | 22 | 30 |
| 40 | 40 | 9·064806 | 10 181 | 10·935194 | 9·067752 | 10 184 | 10·932248 | 10·002947 | 20 5 | 9·997053 | 20 | 20 |
| 30 | 42 | 9·065346 | 1 18 | 10·934654 | 9·068300 | 1 18 | 10·931700 | 10·002954 | 21 5 | 9·997046 | 18 | 30 |
| 41 | 44 | 9·065885 | 2 36 | 10·934115 | 9·068846 | 2 36 | 10·931154 | 10·002961 | 22 5 | 9·997039 | 16 | 19 |
| 30 | 46 | 9·066424 | 3 54 | 10·933576 | 9·069393 | 3 54 | 10·930607 | 10·002969 | 23 6 | 9·997031 | 14 | 30 |
| 42 | 48 | 9·066962 | 4 72 | 10·933038 | 9·069938 | 4 73 | 10·930062 | 10·002976 | 24 6 | 9·997024 | 12 | 18 |
| 30 | 50 | 9·067499 | 5 90 | 10·932501 | 9·070483 | 5 91 | 10·929517 | 10·002984 | 25 6 | 9·997016 | 10 | 30 |
| 43 | 52 | 9·068036 | 6 107 | 10·931964 | 9·071027 | 6 109 | 10·928973 | 10·002991 | 26 7 | 9·997009 | 8 | 17 |
| 30 | 54 | 9·068572 | 7 125 | 10·931428 | 9·071570 | 7 127 | 10·928430 | 10·002998 | 27 7 | 9·997002 | 6 | 30 |
| 44 | 56 | 9·069107 | 8 143 | 10·930893 | 9·072113 | 8 145 | 10·927887 | 10·003006 | 28 7 | 9·996994 | 4 | 16 |
| 30 | 58 | 9·069642 | 9 161 | 10·930358 | 9·072655 | 9 163 | 10·927345 | 10·003013 | 29 7 | 9·996987 | 2 | 30 |
| 45 | 27 | 9·070176 | 10 179 | 10·929824 | 9·073197 | 10 181 | 10·926803 | 10·003021 | 30 7 | 9·996979 | 33 | 15 |
| 30 | 2 | 9·070709 | 1 18 | 10·929291 | 9·073738 | 1 18 | 10·926262 | 10·003028 | 1 0 | 9·996972 | 58 | 30 |
| 46 | 4 | 9·071242 | 2 35 | 10·928758 | 9·074278 | 2 36 | 10·925722 | 10·003036 | 2 1 | 9·996964 | 56 | 14 |
| 30 | 6 | 9·071774 | 3 53 | 10·928226 | 9·074817 | 3 54 | 10·925183 | 10·003043 | 3 1 | 9·996957 | 54 | 30 |
| 47 | 8 | 9·072306 | 4 71 | 10·927694 | 9·075356 | 4 72 | 10·924644 | 10·003051 | 4 1 | 9·996949 | 52 | 13 |
| 30 | 10 | 9·072836 | 5 88 | 10·927164 | 9·075895 | 5 90 | 10·924105 | 10·003058 | 5 1 | 9·996942 | 50 | 30 |
| 48 | 12 | 9·073366 | 6 106 | 10·926634 | 9·076432 | 6 107 | 10·923568 | 10·003066 | 6 2 | 9·996934 | 48 | 12 |
| 30 | 14 | 9·073896 | 7 124 | 10·926104 | 9·076969 | 7 125 | 10·923031 | 10·003073 | 7 2 | 9·996927 | 46 | 30 |
| 49 | 16 | 9·074424 | 8 141 | 10·925576 | 9·077505 | 8 143 | 10·922495 | 10·003081 | 8 2 | 9·996919 | 44 | 11 |
| 30 | 18 | 9·074952 | 9 159 | 10·925047 | 9·078041 | 9 161 | 10·921959 | 10·003089 | 9 2 | 9·996911 | 42 | 30 |
| 50 | 20 | 9·075480 | 10 177 | 10·924520 | 9·078576 | 10 179 | 10·921424 | 10·003096 | 10 3 | 9·996904 | 40 | 10 |
| 30 | 22 | 9·076007 | 1 17 | 10·923993 | 9·079110 | 1 18 | 10·920890 | 10·003104 | 11 3 | 9·996896 | 38 | 30 |
| 51 | 24 | 9·076533 | 2 35 | 10·923467 | 9·079644 | 2 35 | 10·920356 | 10·003111 | 12 3 | 9·996889 | 36 | 9 |
| 30 | 26 | 9·077058 | 3 52 | 10·922942 | 9·080177 | 3 53 | 10·919823 | 10·003119 | 13 3 | 9·996881 | 34 | 30 |
| 52 | 28 | 9·077583 | 4 70 | 10·922417 | 9·080710 | 4 71 | 10·919290 | 10·003126 | 14 4 | 9·996874 | 32 | 8 |
| 30 | 30 | 9·078107 | 5 87 | 10·921893 | 9·081241 | 5 89 | 10·918759 | 10·003134 | 15 4 | 9·996866 | 30 | 30 |
| 53 | 32 | 9·078631 | 6 105 | 10·921369 | 9·081773 | 6 106 | 10·918227 | 10·003142 | 16 4 | 9·996858 | 28 | 7 |
| 30 | 34 | 9·079154 | 7 122 | 10·920846 | 9·082303 | 7 124 | 10·917697 | 10·003149 | 17 4 | 9·996851 | 26 | 30 |
| 54 | 36 | 9·079676 | 8 140 | 10·920324 | 9·082833 | 8 142 | 10·917167 | 10·003157 | 18 5 | 9·996843 | 24 | 6 |
| 30 | 38 | 9·080198 | 9 157 | 10·919802 | 9·083362 | 9 160 | 10·916638 | 10·003165 | 19 5 | 9·996835 | 22 | 30 |
| 55 | 40 | 9·080719 | 10 175 | 10·919281 | 9·083891 | 10 177 | 10·916109 | 10·003172 | 20 5 | 9·996828 | 20 | 5 |
| 30 | 42 | 9·081239 | 1 17 | 10·918761 | 9·084419 | 1 18 | 10·915581 | 10·003180 | 21 5 | 9·996820 | 18 | 30 |
| 56 | 44 | 9·081759 | 2 34 | 10·918241 | 9·084947 | 2 35 | 10·915053 | 10·003188 | 22 6 | 9·996812 | 16 | 4 |
| 30 | 46 | 9·082278 | 3 52 | 10·917722 | 9·085473 | 3 53 | 10·914527 | 10·003195 | 23 6 | 9·996805 | 14 | 30 |
| 57 | 48 | 9·082797 | 4 69 | 10·917203 | 9·086000 | 4 70 | 10·914000 | 10·003203 | 24 6 | 9·996797 | 12 | 3 |
| 30 | 50 | 9·083314 | 5 86 | 10·916685 | 9·086525 | 5 88 | 10·913475 | 10·003211 | 25 6 | 9·996789 | 16 | 30 |
| 58 | 52 | 9·083832 | 6 103 | 10·916168 | 9·087050 | 6 105 | 10·912950 | 10·003218 | 26 7 | 9·996782 | 8 | 2 |
| 30 | 54 | 9·084348 | 7 121 | 10·915652 | 9·087574 | 7 123 | 10·912426 | 10·003226 | 27 7 | 9·996774 | 6 | 30 |
| 59 | 56 | 9·084864 | 8 138 | 10·915136 | 9·088098 | 8 140 | 10·911902 | 10·003234 | 28 7 | 9·996766 | 4 | 1 |
| 30 | 58 | 9·085380 | 9 155 | 10·914620 | 9·088621 | 9 158 | 10·911379 | 10·003242 | 29 7 | 9·996758 | 2 | 30 |
| 60 | 28 | 9·085894 | 10 172 | 10·914106 | 9·089144 | 10 175 | 10·910856 | 10·003249 | 30 8 | 9·996751 | 0 | 0 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

83° — 5h 32m

## LOG. SINES, COSINES, &c.

0h 28m — 7° 

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 9·085894 | | 10·914106 | 9·089144 | | 10·910856 | 10·003249 | | 9·996751 | 32 | 60 |
| 30 | 2 | 9·086409 | 1″ 17 | 10·913591 | 9·089666 | 1″ 17 | 10·910334 | 10·003257 | 1″ 0 | 9·996743 | 58 | 30 |
| 1 | 4 | 9·086922 | 2 34 | 10·913078 | 9·090187 | 2 35 | 10·909813 | 10·003265 | 2 1 | 9·996735 | 56 | 59 |
| 30 | 6 | 9·087435 | 3 51 | 10·912565 | 9·090708 | 3 52 | 10·909292 | 10·003273 | 3 1 | 9·996727 | 54 | 30 |
| 2 | 8 | 9·087947 | 4 68 | 10·912053 | 9·091228 | 4 69 | 10·908772 | 10·003280 | 4 1 | 9·996720 | 52 | 58 |
| 30 | 10 | 9·088459 | 5 85 | 10·911541 | 9·091747 | 5 87 | 10·908253 | 10·003288 | 5 1 | 9·996712 | 50 | 30 |
| 3 | 12 | 9·088970 | 6 102 | 10·911030 | 9·092266 | 6 104 | 10·907734 | 10·003296 | 6 2 | 9·996704 | 48 | 57 |
| 30 | 14 | 9·089480 | 7 119 | 10·910520 | 9·092784 | 7 121 | 10·907216 | 10·003304 | 7 2 | 9·996696 | 46 | 30 |
| 4 | 16 | 9·089990 | 8 136 | 10·910010 | 9·093302 | 8 138 | 10·906698 | 10·003312 | 8 2 | 9·996688 | 44 | 56 |
| 30 | 18 | 9·090500 | 9 153 | 10·909500 | 9·093819 | 9 156 | 10·906181 | 10·003320 | 9 2 | 9·996681 | 42 | 30 |
| 5 | 20 | 9·091008 | 10 170 | 10·908992 | 9·094336 | 10 173 | 10·905664 | 10·003327 | 10 3 | 9·996673 | 40 | 55 |
| 30 | 22 | 9·091516 | 1 17 | 10·908484 | 9·094851 | 1 17 | 10·905149 | 10·003335 | 11 3 | 9·996665 | 38 | 30 |
| 6 | 24 | 9·092024 | 2 34 | 10·907976 | 9·095367 | 2 34 | 10·904633 | 10·003343 | 12 3 | 9·996657 | 36 | 54 |
| 30 | 26 | 9·092530 | 3 50 | 10·907470 | 9·095881 | 3 51 | 10·904119 | 10·003351 | 13 3 | 9·996649 | 34 | 30 |
| 7 | 28 | 9·093037 | 4 67 | 10·906963 | 9·096395 | 4 68 | 10·903605 | 10·003359 | 14 4 | 9·996641 | 32 | 53 |
| 30 | 30 | 9·093542 | 5 84 | 10·906458 | 9·096909 | 5 86 | 10·903091 | 10·003367 | 15 4 | 9·996633 | 30 | 30 |
| 8 | 32 | 9·094047 | 6 101 | 10·905953 | 9·097422 | 6 103 | 10·902578 | 10·003375 | 16 4 | 9·996625 | 28 | 52 |
| 30 | 34 | 9·094552 | 7 118 | 10·905448 | 9·097934 | 7 120 | 10·902066 | 10·003383 | 17 4 | 9·996618 | 26 | 30 |
| 9 | 36 | 9·095056 | 8 135 | 10·904944 | 9·098446 | 8 137 | 10·901554 | 10·003390 | 18 5 | 9·996610 | 24 | 51 |
| 30 | 38 | 9·095559 | 9 151 | 10·904441 | 9·098957 | 9 154 | 10·901043 | 10·003398 | 19 5 | 9·996602 | 22 | 30 |
| 10 | 40 | 9·096062 | 10 168 | 10·903938 | 9·099468 | 10 171 | 10·900532 | 10·003406 | 20 5 | 9·996594 | 20 | 50 |
| 30 | 42 | 9·096564 | 1 17 | 10·903436 | 9·099978 | 1 17 | 10·900022 | 10·003414 | 21 6 | 9·996586 | 18 | 30 |
| 11 | 44 | 9·097065 | 2 33 | 10·902935 | 9·100487 | 2 34 | 10·899513 | 10·003422 | 22 6 | 9·996578 | 16 | 49 |
| 30 | 46 | 9·097566 | 3 50 | 10·902434 | 9·100996 | 3 51 | 10·899004 | 10·003430 | 23 6 | 9·996570 | 14 | 30 |
| 12 | 48 | 9·098066 | 4 67 | 10·901934 | 9·101504 | 4 68 | 10·898496 | 10·003438 | 24 6 | 9·996562 | 12 | 48 |
| 30 | 50 | 9·098566 | 5 83 | 10·901434 | 9·102012 | 5 85 | 10·897988 | 10·003446 | 25 7 | 9·996554 | 10 | 30 |
| 13 | 52 | 9·099065 | 6 100 | 10·900935 | 9·102519 | 6 101 | 10·897481 | 10·003454 | 26 7 | 9·996546 | 8 | 47 |
| 30 | 54 | 9·099564 | 7 116 | 10·900436 | 9·103026 | 7 118 | 10·896974 | 10·003462 | 27 7 | 9·996538 | 6 | 30 |
| 14 | 56 | 9·100062 | 8 133 | 10·899938 | 9·103532 | 8 135 | 10·896468 | 10·003470 | 28 7 | 9·996530 | 4 | 46 |
| 30 | 58 | 9·100559 | 9 150 | 10·899441 | 9·104037 | 9 152 | 10·895963 | 10·003478 | 29 8 | 9·996522 | 2 | 30 |
| 15 | 29 | 9·101056 | 10 166 | 10·898944 | 9·104542 | 10 169 | 10·895458 | 10·003486 | 30 8 | 9·996514 | 31 | 45 |
| 30 | 2 | 9·101552 | 1 16 | 10·898448 | 9·105046 | 1 17 | 10·894954 | 10·003494 | 1 0 | 9·996506 | 58 | 30 |
| 16 | 4 | 9·102048 | 2 33 | 10·897952 | 9·105550 | 2 33 | 10·894450 | 10·003502 | 2 1 | 9·996498 | 56 | 44 |
| 30 | 6 | 9·102543 | 3 49 | 10·897457 | 9·106053 | 3 50 | 10·893947 | 10·003510 | 3 1 | 9·996490 | 54 | 30 |
| 17 | 8 | 9·103037 | 4 66 | 10·896963 | 9·106556 | 4 67 | 10·893444 | 10·003518 | 4 1 | 9·996482 | 52 | 43 |
| 30 | 10 | 9·103531 | 5 82 | 10·896469 | 9·107058 | 5 84 | 10·892942 | 10·003527 | 5 1 | 9·996474 | 50 | 30 |
| 18 | 12 | 9·104025 | 6 99 | 10·895975 | 9·107559 | 6 100 | 10·892441 | 10·003535 | 6 2 | 9·996465 | 48 | 42 |
| 30 | 14 | 9·104517 | 7 115 | 10·895483 | 9·108060 | 7 117 | 10·891940 | 10·003543 | 7 2 | 9·996457 | 46 | 30 |
| 19 | 16 | 9·105010 | 8 132 | 10·894990 | 9·108560 | 8 134 | 10·891440 | 10·003551 | 8 2 | 9·996449 | 44 | 41 |
| 30 | 18 | 9·105501 | 9 148 | 10·894499 | 9·109060 | 9 150 | 10·890940 | 10·003559 | 9 2 | 9·996441 | 42 | 30 |
| 20 | 20 | 9·105992 | 10 165 | 10·894008 | 9·109559 | 10 167 | 10·890441 | 10·003567 | 10 3 | 9·996433 | 40 | 40 |
| 30 | 22 | 9·106483 | 1 16 | 10·893517 | 9·110058 | 1 17 | 10·889942 | 10·003575 | 11 3 | 9·996425 | 38 | 30 |
| 21 | 24 | 9·106973 | 2 33 | 10·893027 | 9·110556 | 2 33 | 10·889444 | 10·003583 | 12 3 | 9·996417 | 36 | 39 |
| 30 | 26 | 9·107462 | 3 49 | 10·892538 | 9·111054 | 3 50 | 10·888946 | 10·003591 | 13 4 | 9·996409 | 34 | 30 |
| 22 | 28 | 9·107951 | 4 65 | 10·892049 | 9·111551 | 4 66 | 10·888449 | 10·003600 | 14 4 | 9·996400 | 32 | 38 |
| 30 | 30 | 9·108439 | 5 81 | 10·891561 | 9·112047 | 5 83 | 10·887953 | 10·003608 | 15 4 | 9·996392 | 30 | 30 |
| 23 | 32 | 9·108927 | 6 98 | 10·891073 | 9·112543 | 6 99 | 10·887457 | 10·003616 | 16 4 | 9·996384 | 28 | 37 |
| 30 | 34 | 9·109414 | 7 114 | 10·890586 | 9·113039 | 7 116 | 10·886961 | 10·003624 | 17 5 | 9·996376 | 26 | 30 |
| 24 | 36 | 9·109901 | 8 130 | 10·890099 | 9·113533 | 8 132 | 10·886467 | 10·003632 | 18 5 | 9·996368 | 24 | 36 |
| 30 | 38 | 9·110387 | 9 146 | 10·889613 | 9·114028 | 9 149 | 10·885972 | 10·003641 | 19 5 | 9·996359 | 22 | 30 |
| 25 | 40 | 9·110873 | 10 163 | 10·889127 | 9·114521 | 10 165 | 10·885479 | 10·003649 | 20 5 | 9·996351 | 20 | 35 |
| 30 | 42 | 9·111358 | 1 16 | 10·888642 | 9·115015 | 1 16 | 10·884985 | 10·003657 | 21 6 | 9·996343 | 18 | 30 |
| 26 | 44 | 9·111842 | 2 32 | 10·888158 | 9·115507 | 2 33 | 10·884493 | 10·003665 | 22 6 | 9·996335 | 16 | 34 |
| 30 | 46 | 9·112326 | 3 48 | 10·887674 | 9·115999 | 3 49 | 10·884001 | 10·003674 | 23 6 | 9·996327 | 14 | 30 |
| 27 | 48 | 9·112809 | 4 64 | 10·887191 | 9·116491 | 4 65 | 10·883509 | 10·003682 | 24 7 | 9·996318 | 12 | 33 |
| 30 | 50 | 9·113292 | 5 80 | 10·886708 | 9·116982 | 5 82 | 10·883018 | 10·003690 | 25 7 | 9·996310 | 10 | 30 |
| 28 | 52 | 9·113774 | 6 96 | 10·886226 | 9·117472 | 6 98 | 10·882528 | 10·003698 | 26 7 | 9·996302 | 8 | 32 |
| 30 | 54 | 9·114256 | 7 112 | 10·885744 | 9·117962 | 7 114 | 10·882038 | 10·003707 | 27 7 | 9·996293 | 6 | 30 |
| 29 | 56 | 9·114737 | 8 129 | 10·885263 | 9·118452 | 8 131 | 10·881548 | 10·003715 | 28 8 | 9·996285 | 4 | 31 |
| 30 | 58 | 9·115218 | 9 145 | 10·884782 | 9·118941 | 9 147 | 10·881059 | 10·003723 | 29 8 | 9·996277 | 2 | 30 |
| 30 | 30 | 9·115698 | 10 161 | 10·884302 | 9·119429 | 10 163 | 10·880571 | 10·003731 | 30 8 | 9·996269 | 0 | 30 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

82° — 5h 30m

## LOG. SINES, COSINES, &c.

0ʰ 30ᵐ 7°

| ' " | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ' " |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 9·115698 | | 10·884302 | 9·119429 | | 10·880571 | 10·003731 | | 9·996269 | 30 | 30 |
| 30 | 2 | 9·116177 | 1" 16 | 10·883823 | 9·119917 | 1" 16 | 10·880083 | 10·003740 | 1" 0 | 9·996260 | 58 | 30 |
| 31 | 4 | 9·116656 | 2 32 | 10·883344 | 9·120404 | 2 32 | 10·879596 | 10·003748 | 2 1 | 9·996252 | 56 | 29 |
| 30 | 6 | 9·117135 | 3 48 | 10·882865 | 9·120891 | 3 49 | 10·879109 | 10·003756 | 3 1 | 9·996244 | 54 | 30 |
| 32 | 8 | 9·117613 | 4 64 | 10·882387 | 9·121377 | 4 65 | 10·878623 | 10·003765 | 4 1 | 9·996235 | 52 | 28 |
| 30 | 10 | 9·118090 | 5 80 | 10·881910 | 9·121863 | 5 81 | 10·878137 | 10·003773 | 5 1 | 9·996227 | 50 | 30 |
| 33 | 12 | 9·118567 | 6 95 | 10·881433 | 9·122348 | 6 97 | 10·877652 | 10·003781 | 6 2 | 9·996219 | 48 | 27 |
| 30 | 14 | 9·119043 | 7 111 | 10·880957 | 9·122833 | 7 113 | 10·877167 | 10·003790 | 7 2 | 9·996210 | 46 | 30 |
| 34 | 16 | 9·119519 | 8 127 | 10·880481 | 9·123317 | 8 129 | 10·876683 | 10·003798 | 8 2 | 9·996202 | 44 | 26 |
| 30 | 18 | 9·119994 | 9 143 | 10·880006 | 9·123801 | 9 146 | 10·876199 | 10·003807 | 9 3 | 9·996193 | 42 | 30 |
| 35 | 20 | 9·120469 | 10 159 | 10·879531 | 9·124284 | 10 162 | 10·875716 | 10·003815 | 10 3 | 9·996185 | 40 | 25 |
| 30 | 22 | 9·120943 | 1 16 | 10·879057 | 9·124766 | 1 16 | 10·875234 | 10·003823 | 11 3 | 9·996177 | 38 | 30 |
| 36 | 24 | 9·121417 | 2 31 | 10·878583 | 9·125249 | 2 32 | 10·874751 | 10·003832 | 12 3 | 9·996168 | 36 | 24 |
| 30 | 26 | 9·121890 | 3 47 | 10·878110 | 9·125730 | 3 48 | 10·874270 | 10·003840 | 13 4 | 9·996160 | 34 | 30 |
| 37 | 28 | 9·122362 | 4 63 | 10·877638 | 9·126211 | 4 64 | 10·873789 | 10·003849 | 14 4 | 9·996151 | 32 | 23 |
| 30 | 30 | 9·122835 | 5 79 | 10·877165 | 9·126692 | 5 80 | 10·873308 | 10·003857 | 15 4 | 9·996143 | 30 | 30 |
| 38 | 32 | 9·123306 | 6 94 | 10·876694 | 9·127172 | 6 96 | 10·872828 | 10·003866 | 16 5 | 9·996134 | 28 | 22 |
| 30 | 34 | 9·123777 | 7 110 | 10·876223 | 9·127651 | 7 112 | 10·872349 | 10·003874 | 17 5 | 9·996126 | 26 | 30 |
| 39 | 36 | 9·124248 | 8 126 | 10·875752 | 9·128130 | 8 128 | 10·871870 | 10·003883 | 18 5 | 9·996117 | 24 | 21 |
| 30 | 38 | 9·124718 | 9 141 | 10·875282 | 9·128609 | 9 144 | 10·871391 | 10·003891 | 19 5 | 9·996109 | 22 | 30 |
| 40 | 40 | 9·125187 | 10 157 | 10·874813 | 9·129087 | 10 160 | 10·870913 | 10·003900 | 20 6 | 9·996100 | 20 | 20 |
| 30 | 42 | 9·125656 | 1 16 | 10·874344 | 9·129564 | 1 16 | 10·870436 | 10·003908 | 21 6 | 9·996092 | 18 | 30 |
| 41 | 44 | 9·126125 | 2 31 | 10·873875 | 9·130041 | 2 32 | 10·869959 | 10·003917 | 22 6 | 9·996083 | 16 | 19 |
| 30 | 46 | 9·126593 | 3 47 | 10·873407 | 9·130518 | 3 47 | 10·869482 | 10·003925 | 23 7 | 9·996075 | 14 | 30 |
| 42 | 48 | 9·127060 | 4 62 | 10·872940 | 9·130994 | 4 63 | 10·869006 | 10·003934 | 24 7 | 9·996066 | 12 | 18 |
| 30 | 50 | 9·127527 | 5 78 | 10·872473 | 9·131469 | 5 79 | 10·868531 | 10·003942 | 25 7 | 9·996058 | 10 | 30 |
| 43 | 52 | 9·127993 | 6 93 | 10·872007 | 9·131944 | 6 95 | 10·868056 | 10·003951 | 26 7 | 9·996049 | 8 | 17 |
| 30 | 54 | 9·128459 | 7 109 | 10·871541 | 9·132419 | 7 111 | 10·867581 | 10·003959 | 27 8 | 9·996041 | 6 | 30 |
| 44 | 56 | 9·128925 | 8 124 | 10·871075 | 9·132893 | 8 127 | 10·867107 | 10·003968 | 28 8 | 9·996032 | 4 | 16 |
| 30 | 58 | 9·129390 | 9 140 | 10·870610 | 9·133366 | 9 142 | 10·866634 | 10·003977 | 29 8 | 9·996023 | 2 | 30 |
| 45 | 31 | 9·129854 | 10 155 | 10·870146 | 9·133839 | 10 158 | 10·866161 | 10·003985 | 30 8 | 9·996015 | 29 | 15 |
| 30 | 2 | 9·130318 | 1 15 | 10·869682 | 9·134312 | 1 16 | 10·865688 | 10·003994 | 1 0 | 9·996006 | 58 | 30 |
| 46 | 4 | 9·130781 | 2 31 | 10·869219 | 9·134784 | 2 31 | 10·865216 | 10·004002 | 2 1 | 9·995998 | 56 | 14 |
| 30 | 6 | 9·131244 | 3 46 | 10·868756 | 9·135255 | 3 47 | 10·864745 | 10·004011 | 3 1 | 9·995989 | 54 | 30 |
| 47 | 8 | 9·131706 | 4 62 | 10·868294 | 9·135726 | 4 63 | 10·864274 | 10·004020 | 4 1 | 9·995980 | 52 | 13 |
| 30 | 10 | 9·132168 | 5 77 | 10·867832 | 9·136197 | 5 78 | 10·863803 | 10·004028 | 5 1 | 9·995972 | 50 | 30 |
| 48 | 12 | 9·132630 | 6 92 | 10·867370 | 9·136667 | 6 94 | 10·863333 | 10·004037 | 6 2 | 9·995963 | 48 | 12 |
| 30 | 14 | 9·133091 | 7 108 | 10·866909 | 9·137136 | 7 110 | 10·862864 | 10·004046 | 7 2 | 9·995954 | 46 | 30 |
| 49 | 16 | 9·133551 | 8 123 | 10·866449 | 9·137605 | 8 125 | 10·862395 | 10·004054 | 8 2 | 9·995946 | 44 | 11 |
| 30 | 18 | 9·134011 | 9 139 | 10·865989 | 9·138074 | 9 141 | 10·861926 | 10·004063 | 9 3 | 9·995937 | 42 | 30 |
| 50 | 20 | 9·134470 | 10 154 | 10·865530 | 9·138542 | 10 157 | 10·861458 | 10·004072 | 10 3 | 9·995928 | 40 | 10 |
| 30 | 22 | 9·134929 | 1 15 | 10·865071 | 9·139009 | 1 16 | 10·860991 | 10·004080 | 11 3 | 9·995920 | 38 | 30 |
| 51 | 24 | 9·135387 | 2 30 | 10·864613 | 9·139476 | 2 31 | 10·860524 | 10·004089 | 12 3 | 9·995911 | 36 | 9 |
| 30 | 26 | 9·135845 | 3 46 | 10·864155 | 9·139943 | 3 47 | 10·860057 | 10·004098 | 13 4 | 9·995902 | 34 | 30 |
| 52 | 28 | 9·136303 | 4 61 | 10·863697 | 9·140409 | 4 62 | 10·859591 | 10·004106 | 14 4 | 9·995894 | 32 | 8 |
| 30 | 30 | 9·136760 | 5 76 | 10·863240 | 9·140875 | 5 78 | 10·859125 | 10·004115 | 15 4 | 9·995885 | 30 | 30 |
| 53 | 32 | 9·137216 | 6 91 | 10·862784 | 9·141340 | 6 93 | 10·858660 | 10·004124 | 16 5 | 9·995876 | 28 | 7 |
| 30 | 34 | 9·137672 | 7 106 | 10·862328 | 9·141805 | 7 109 | 10·858195 | 10·004133 | 17 5 | 9·995867 | 26 | 30 |
| 54 | 36 | 9·138128 | 8 122 | 10·861872 | 9·142269 | 8 124 | 10·857731 | 10·004141 | 18 5 | 9·995859 | 24 | 6 |
| 30 | 38 | 9·138582 | 9 137 | 10·861418 | 9·142733 | 9 140 | 10·857267 | 10·004150 | 19 6 | 9·995850 | 22 | 30 |
| 55 | 40 | 9·139037 | 10 152 | 10·860963 | 9·143196 | 10 155 | 10·856804 | 10·004159 | 20 6 | 9·995841 | 20 | 5 |
| 30 | 42 | 9·139491 | 1 15 | 10·860509 | 9·143659 | 1 15 | 10·856341 | 10·004168 | 21 6 | 9·995832 | 18 | 30 |
| 56 | 44 | 9·139944 | 2 30 | 10·860056 | 9·144121 | 2 31 | 10·855879 | 10·004177 | 22 6 | 9·995823 | 16 | 4 |
| 30 | 46 | 9·140398 | 3 45 | 10·859602 | 9·144583 | 3 46 | 10·855417 | 10·004185 | 23 7 | 9·995815 | 14 | 30 |
| 57 | 48 | 9·140850 | 4 60 | 10·859150 | 9·145044 | 4 61 | 10·854956 | 10·004194 | 24 7 | 9·995806 | 12 | 3 |
| 30 | 50 | 9·141302 | 5 75 | 10·858698 | 9·145505 | 5 77 | 10·854495 | 10·004203 | 25 7 | 9·995797 | 10 | 30 |
| 58 | 52 | 9·141754 | 6 90 | 10·858246 | 9·145966 | 6 92 | 10·854034 | 10·004212 | 26 8 | 9·995788 | 8 | 2 |
| 30 | 54 | 9·142205 | 7 105 | 10·857795 | 9·146425 | 7 108 | 10·853575 | 10·004221 | 27 8 | 9·995779 | 6 | 30 |
| 59 | 56 | 9·142655 | 8 121 | 10·857345 | 9·146885 | 8 123 | 10·853115 | 10·004229 | 28 8 | 9·995771 | 4 | 1 |
| 30 | 58 | 9·143106 | 9 136 | 10·856894 | 9·147344 | 9 138 | 10·852656 | 10·004238 | 29 8 | 9·995762 | 2 | 30 |
| 60 | 32 | 9·143555 | 10 151 | 10·856445 | 9·147803 | 10 154 | 10·852197 | 10·004247 | 30 9 | 9·995753 | 0 | 0 |
| ' " | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ' " |

82° 5ʰ 28ᵐ

## LOG. SINES, COSINES, &c.

$0^h\ 32^m$ — 8°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 9·143555 | | 10·856445 | 9·147803 | | 10·852197 | 10·004247 | | 9·995753 | 28 | 60 |
| 30 | 2 | 9·144005 | 1″ 15 | 10·855995 | 9·148261 | 1″ 15 | 10·851739 | 10·004256 | 1″ 0 | 9·995744 | 58 | 30 |
| 1 | 4 | 9·144453 | 2 30 | 10·855547 | 9·148718 | 2 30 | 10·851282 | 10·004265 | 2 1 | 9·995735 | 56 | 59 |
| 30 | 6 | 9·144902 | 3 45 | 10·855098 | 9·149175 | 3 46 | 10·850825 | 10·004274 | 3 1 | 9·995726 | 54 | 30 |
| 2 | 8 | 9·145349 | 4 59 | 10·854651 | 9·149632 | 4 61 | 10·850368 | 10·004283 | 4 1 | 9·995717 | 52 | 58 |
| 30 | 10 | 9·145797 | 5 74 | 10·854203 | 9·150088 | 5 76 | 10·849912 | 10·004292 | 5 1 | 9·995708 | 50 | 30 |
| 3 | 12 | 9·146243 | 6 89 | 10·853757 | 9·150544 | 6 91 | 10·849456 | 10·004301 | 6 2 | 9·995699 | 48 | 57 |
| 30 | 14 | 9·146690 | 7 104 | 10·853310 | 9·151000 | 7 106 | 10·849000 | 10·004310 | 7 2 | 9·995690 | 46 | 30 |
| 4 | 16 | 9·147136 | 8 119 | 10·852864 | 9·151454 | 8 122 | 10·848546 | 10·004319 | 8 2 | 9·995681 | 44 | 56 |
| 30 | 18 | 9·147581 | 9 134 | 10·852419 | 9·151909 | 9 137 | 10·848091 | 10·004328 | 9 3 | 9·995672 | 42 | 30 |
| 5 | 20 | 9·148026 | 10 149 | 10·851974 | 9·152363 | 10 152 | 10·847637 | 10·004336 | 10 3 | 9·995664 | 40 | 55 |
| 30 | 22 | 9·148471 | 1 15 | 10·851529 | 9·152816 | 1 15 | 10·847184 | 10·004345 | 11 3 | 9·995655 | 38 | 30 |
| 6 | 24 | 9·148915 | 2 29 | 10·851085 | 9·153269 | 2 30 | 10·846731 | 10·004354 | 12 4 | 9·995646 | 36 | 54 |
| 30 | 26 | 9·149358 | 3 44 | 10·850642 | 9·153722 | 3 45 | 10·846278 | 10·004363 | 13 4 | 9·995637 | 34 | 30 |
| 7 | 28 | 9·149802 | 4 59 | 10·850198 | 9·154174 | 4 60 | 10·845826 | 10·004372 | 14 4 | 9·995628 | 32 | 53 |
| 30 | 30 | 9·150244 | 5 74 | 10·849756 | 9·154626 | 5 75 | 10·845374 | 10·004381 | 15 4 | 9·995619 | 30 | 30 |
| 8 | 32 | 9·150686 | 6 88 | 10·849314 | 9·155077 | 6 90 | 10·844923 | 10·004390 | 16 5 | 9·995610 | 28 | 52 |
| 30 | 34 | 9·151128 | 7 103 | 10·848872 | 9·155528 | 7 105 | 10·844472 | 10·004400 | 17 5 | 9·995601 | 26 | 30 |
| 9 | 36 | 9·151569 | 8 118 | 10·848431 | 9·155978 | 8 120 | 10·844022 | 10·004409 | 18 5 | 9·995591 | 24 | 51 |
| 30 | 38 | 9·152010 | 9 133 | 10·847990 | 9·156428 | 9 135 | 10·843572 | 10·004418 | 19 6 | 9·995582 | 22 | 30 |
| 10 | 40 | 9·152451 | 10 147 | 10·847549 | 9·156877 | 10 150 | 10·843123 | 10·004427 | 20 6 | 9·995573 | 20 | 50 |
| 30 | 42 | 9·152891 | 1 15 | 10·847109 | 9·157326 | 1 15 | 10·842674 | 10·004436 | 21 6 | 9·995564 | 18 | 30 |
| 11 | 44 | 9·153330 | 2 29 | 10·846670 | 9·157775 | 2 30 | 10·842225 | 10·004445 | 22 7 | 9·995555 | 16 | 49 |
| 30 | 46 | 9·153769 | 3 44 | 10·846231 | 9·158223 | 3 45 | 10·841777 | 10·004454 | 23 7 | 9·995546 | 14 | 30 |
| 12 | 48 | 9·154208 | 4 58 | 10·845792 | 9·158671 | 4 60 | 10·841329 | 10·004463 | 24 7 | 9·995537 | 12 | 48 |
| 30 | 50 | 9·154646 | 5 73 | 10·845354 | 9·159118 | 5 75 | 10·840882 | 10·004472 | 25 7 | 9·995528 | 10 | 30 |
| 13 | 52 | 9·155083 | 6 87 | 10·844917 | 9·159565 | 6 89 | 10·840435 | 10·004481 | 26 8 | 9·995519 | 8 | 47 |
| 30 | 54 | 9·155521 | 7 102 | 10·844479 | 9·160011 | 7 104 | 10·839989 | 10·004490 | 27 8 | 9·995510 | 6 | 30 |
| 14 | 56 | 9·155957 | 8 117 | 10·844043 | 9·160457 | 8 119 | 10·839543 | 10·004499 | 28 8 | 9·995501 | 4 | 46 |
| 30 | 58 | 9·156394 | 9 131 | 10·843606 | 9·160902 | 9 134 | 10·839098 | 10·004509 | 29 9 | 9·995491 | 2 | 30 |
| 15 | 33 | 9·156830 | 10 146 | 10·843170 | 9·161347 | 10 149 | 10·838653 | 10·004518 | 30 9 | 9·995482 | 27 | 45 |
| 30 | 2 | 9·157265 | 1 14 | 10·842735 | 9·161792 | 1 15 | 10·838208 | 10·004527 | 1 0 | 9·995473 | 58 | 30 |
| 16 | 4 | 9·157700 | 2 29 | 10·842300 | 9·162236 | 2 29 | 10·837764 | 10·004536 | 2 1 | 9·995464 | 56 | 44 |
| 30 | 6 | 9·158135 | 3 43 | 10·841865 | 9·162680 | 3 44 | 10·837320 | 10·004545 | 3 1 | 9·995455 | 54 | 30 |
| 17 | 8 | 9·158569 | 4 58 | 10·841431 | 9·163123 | 4 59 | 10·836877 | 10·004554 | 4 1 | 9·995446 | 52 | 43 |
| 30 | 10 | 9·159002 | 5 72 | 10·840998 | 9·163566 | 5 74 | 10·836434 | 10·004564 | 5 2 | 9·995436 | 50 | 30 |
| 18 | 12 | 9·159435 | 6 87 | 10·840565 | 9·164008 | 6 88 | 10·835992 | 10·004573 | 6 2 | 9·995427 | 48 | 42 |
| 30 | 14 | 9·159868 | 7 101 | 10·840132 | 9·164450 | 7 103 | 10·835550 | 10·004582 | 7 2 | 9·995418 | 46 | 30 |
| 19 | 16 | 9·160301 | 8 115 | 10·839699 | 9·164892 | 8 118 | 10·835108 | 10·004591 | 8 3 | 9·995409 | 44 | 41 |
| 30 | 18 | 9·160732 | 9 130 | 10·839268 | 9·165333 | 9 133 | 10·834667 | 10·004601 | 9 3 | 9·995399 | 42 | 30 |
| 20 | 20 | 9·161164 | 10 144 | 10·838836 | 9·165774 | 10 147 | 10·834226 | 10·004610 | 10 3 | 9·995390 | 40 | 40 |
| 30 | 22 | 9·161595 | 1 14 | 10·838405 | 9·166214 | 1 15 | 10·833786 | 10·004619 | 11 4 | 9·995381 | 38 | 30 |
| 21 | 24 | 9·162025 | 2 29 | 10·837975 | 9·166654 | 2 29 | 10·833346 | 10·004628 | 12 4 | 9·995372 | 36 | 39 |
| 30 | 26 | 9·162456 | 3 43 | 10·837544 | 9·167093 | 3 44 | 10·832907 | 10·004638 | 13 4 | 9·995362 | 34 | 30 |
| 22 | 28 | 9·162885 | 4 57 | 10·837115 | 9·167532 | 4 58 | 10·832468 | 10·004647 | 14 4 | 9·995353 | 32 | 38 |
| 30 | 30 | 9·163315 | 5 71 | 10·836685 | 9·167971 | 5 73 | 10·832029 | 10·004656 | 15 5 | 9·995344 | 30 | 30 |
| 23 | 32 | 9·163743 | 6 86 | 10·836257 | 9·168409 | 6 88 | 10·831591 | 10·004666 | 16 5 | 9·995334 | 28 | 37 |
| 30 | 34 | 9·164172 | 7 100 | 10·835828 | 9·168847 | 7 102 | 10·831153 | 10·004675 | 17 5 | 9·995325 | 26 | 30 |
| 24 | 36 | 9·164600 | 8 114 | 10·835400 | 9·169284 | 8 117 | 10·830716 | 10·004684 | 18 6 | 9·995316 | 24 | 36 |
| 30 | 38 | 9·165027 | 9 128 | 10·834973 | 9·169721 | 9 131 | 10·830279 | 10·004694 | 19 6 | 9·995307 | 22 | 30 |
| 25 | 40 | 9·165454 | 10 143 | 10·834546 | 9·170157 | 10 146 | 10·829843 | 10·004703 | 20 6 | 9·995297 | 20 | 35 |
| 30 | 42 | 9·165881 | 1 14 | 10·834119 | 9·170593 | 1 14 | 10·829407 | 10·004712 | 21 7 | 9·995288 | 18 | 30 |
| 26 | 44 | 9·166307 | 2 28 | 10·833693 | 9·171029 | 2 29 | 10·828971 | 10·004722 | 22 7 | 9·995278 | 16 | 34 |
| 30 | 46 | 9·166733 | 3 42 | 10·833267 | 9·171464 | 3 43 | 10·828536 | 10·004731 | 23 7 | 9·995269 | 14 | 30 |
| 27 | 48 | 9·167159 | 4 57 | 10·832841 | 9·171899 | 4 58 | 10·828101 | 10·004740 | 24 7 | 9·995260 | 12 | 33 |
| 30 | 50 | 9·167584 | 5 71 | 10·832416 | 9·172333 | 5 72 | 10·827667 | 10·004750 | 25 8 | 9·995250 | 10 | 30 |
| 28 | 52 | 9·168008 | 6 85 | 10·831992 | 9·172767 | 6 87 | 10·827233 | 10·004759 | 26 8 | 9·995241 | 8 | 32 |
| 30 | 54 | 9·168432 | 7 99 | 10·831568 | 9·173201 | 7 101 | 10·826799 | 10·004769 | 27 8 | 9·995232 | 6 | 30 |
| 29 | 56 | 9·168856 | 8 113 | 10·831144 | 9·173634 | 8 116 | 10·826366 | 10·004778 | 28 9 | 9·995222 | 4 | 31 |
| 30 | 58 | 9·169279 | 9 127 | 10·830721 | 9·174067 | 9 130 | 10·825933 | 10·004787 | 29 9 | 9·995213 | 2 | 30 |
| 30 | 34 | 9·169702 | 10 141 | 10·830298 | 9·174499 | 10 145 | 10·825501 | 10·004797 | 30 9 | 9·995203 | 0 | 30 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

81° — $5^h\ 26^m$

## LOG. SINES. COSINES, &c.

0ʰ 34ᵐ — 8°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 9·169702 | | 10·830298 | 9·174499 | | 10·825501 | 10·004797 | | 9·995203 | 26 | 30 |
| 30 | 2 | 9·170125 | 1″ 14 | 10·829875 | 9·174931 | 1″ 14 | 10·825069 | 10·004806 | 1″ 0 | 9·995194 | 58 | 30 |
| 31 | 4 | 9·170547 | 2 28 | 10·829453 | 9·175362 | 2 29 | 10·824638 | 10·004816 | 2 1 | 9·995184 | 56 | 29 |
| 30 | 6 | 9·170968 | 3 42 | 10·829032 | 9·175793 | 3 43 | 10·824207 | 10·004825 | 3 1 | 9·995175 | 54 | 30 |
| 32 | 8 | 9·171389 | 4 56 | 10·828611 | 9·176224 | 4 57 | 10·823776 | 10·004835 | 4 1 | 9·995165 | 52 | 28 |
| 30 | 10 | 9·171810 | 5 70 | 10·828190 | 9·176654 | 5 72 | 10·823346 | 10·004844 | 5 2 | 9·995156 | 50 | 30 |
| 33 | 12 | 9·172230 | 6 84 | 10·827770 | 9·177084 | 6 86 | 10·822916 | 10·004854 | 6 2 | 9·995146 | 48 | 27 |
| 30 | 14 | 9·172650 | 7 98 | 10·827350 | 9·177513 | 7 100 | 10·822487 | 10·004863 | 7 2 | 9·995137 | 46 | 30 |
| 34 | 16 | 9·173070 | 8 112 | 10·826930 | 9·177942 | 8 115 | 10·822058 | 10·004873 | 8 3 | 9·995127 | 44 | 26 |
| 30 | 18 | 9·173489 | 9 126 | 10·826511 | 9·178371 | 9 129 | 10·821629 | 10·004882 | 9 3 | 9·995118 | 42 | 30 |
| 35 | 20 | 9·173908 | 10 140 | 10·826092 | 9·178799 | 10 143 | 10·821201 | 10·004892 | 10 3 | 9·995108 | 40 | 25 |
| 30 | 22 | 9·174326 | 1 14 | 10·825674 | 9·179227 | 1 14 | 10·820773 | 10·004901 | 11 4 | 9·995099 | 38 | 30 |
| 36 | 24 | 9·174744 | 2 28 | 10·825256 | 9·179655 | 2 28 | 10·820345 | 10·004911 | 12 4 | 9·995089 | 36 | 24 |
| 30 | 26 | 9·175161 | 3 41 | 10·824839 | 9·180082 | 3 43 | 10·819918 | 10·004920 | 13 4 | 9·995080 | 34 | 30 |
| 37 | 28 | 9·175578 | 4 55 | 10·824422 | 9·180508 | 4 57 | 10·819492 | 10·004930 | 14 4 | 9·995070 | 32 | 23 |
| 30 | 30 | 9·175995 | 5 69 | 10·824005 | 9·180934 | 5 71 | 10·819066 | 10·004939 | 15 5 | 9·995061 | 30 | 30 |
| 38 | 32 | 9·176411 | 6 83 | 10·823589 | 9·181360 | 6 85 | 10·818640 | 10·004949 | 16 5 | 9·995051 | 28 | 22 |
| 30 | 34 | 9·176827 | 7 97 | 10·823173 | 9·181786 | 7 99 | 10·818214 | 10·004959 | 17 5 | 9·995041 | 26 | 30 |
| 39 | 36 | 9·177242 | 8 111 | 10·822758 | 9·182211 | 8 114 | 10·817789 | 10·004968 | 18 6 | 9·995032 | 24 | 21 |
| 30 | 38 | 9·177657 | 9 124 | 10·822343 | 9·182635 | 9 128 | 10·817365 | 10·004978 | 19 6 | 9·995022 | 22 | 30 |
| 40 | 40 | 9·178072 | 10 138 | 10·821928 | 9·183059 | 10 142 | 10·816941 | 10·004987 | 20 6 | 9·995013 | 20 | 20 |
| 30 | 42 | 9·178486 | 1 14 | 10·821514 | 9·183483 | 1 14 | 10·816517 | 10·004997 | 21 7 | 9·995003 | 18 | 30 |
| 41 | 44 | 9·178900 | 2 27 | 10·821100 | 9·183907 | 2 28 | 10·816093 | 10·005007 | 22 7 | 9·994993 | 16 | 19 |
| 30 | 46 | 9·179313 | 3 41 | 10·820687 | 9·184330 | 3 42 | 10·815670 | 10·005016 | 23 7 | 9·994984 | 14 | 30 |
| 42 | 48 | 9·179726 | 4 55 | 10·820274 | 9·184752 | 4 56 | 10·815248 | 10·005026 | 24 8 | 9·994974 | 12 | 18 |
| 30 | 50 | 9·180139 | 5 69 | 10·819861 | 9·185175 | 5 70 | 10·814825 | 10·005036 | 25 8 | 9·994964 | 10 | 30 |
| 43 | 52 | 9·180551 | 6 82 | 10·819449 | 9·185597 | 6 84 | 10·814403 | 10·005045 | 26 8 | 9·994955 | 8 | 17 |
| 30 | 54 | 9·180963 | 7 96 | 10·819037 | 9·186018 | 7 98 | 10·813982 | 10·005055 | 27 9 | 9·994945 | 6 | 30 |
| 44 | 56 | 9·181374 | 8 110 | 10·818626 | 9·186439 | 8 113 | 10·813561 | 10·005065 | 28 9 | 9·994935 | 4 | 16 |
| 30 | 58 | 9·181785 | 9 124 | 10·818215 | 9·186860 | 9 127 | 10·813140 | 10·005075 | 29 9 | 9·994925 | 2 | 30 |
| 45 | 35 | 9·182196 | 10 137 | 10·817804 | 9·187280 | 10 141 | 10·812720 | 10·005084 | 30 10 | 9·994916 | 25 | 15 |
| 30 | 2 | 9·182606 | 1 14 | 10·817394 | 9·187700 | 1 14 | 10·812300 | 10·005094 | 1 0 | 9·994906 | 58 | 30 |
| 46 | 4 | 9·183016 | 2 27 | 10·816984 | 9·188120 | 2 28 | 10·811880 | 10·005104 | 2 1 | 9·994896 | 56 | 14 |
| 30 | 6 | 9·183425 | 3 41 | 10·816575 | 9·188539 | 3 42 | 10·811461 | 10·005113 | 3 1 | 9·994887 | 54 | 30 |
| 47 | 8 | 9·183834 | 4 54 | 10·816166 | 9·188958 | 4 56 | 10·811042 | 10·005123 | 4 1 | 9·994877 | 52 | 13 |
| 30 | 10 | 9·184243 | 5 68 | 10·815757 | 9·189376 | 5 70 | 10·810624 | 10·005133 | 5 2 | 9·994867 | 50 | 30 |
| 48 | 12 | 9·184651 | 6 82 | 10·815349 | 9·189794 | 6 84 | 10·810206 | 10·005143 | 6 2 | 9·994857 | 48 | 12 |
| 30 | 14 | 9·185059 | 7 95 | 10·814941 | 9·190212 | 7 98 | 10·809788 | 10·005153 | 7 2 | 9·994847 | 46 | 30 |
| 49 | 16 | 9·185466 | 8 109 | 10·814534 | 9·190629 | 8 111 | 10·809371 | 10·005162 | 8 3 | 9·994838 | 44 | 11 |
| 30 | 18 | 9·185874 | 9 122 | 10·814126 | 9·191046 | 9 125 | 10·808954 | 10·005172 | 9 3 | 9·994828 | 42 | 30 |
| 50 | 20 | 9·186280 | 10 136 | 10·813720 | 9·191462 | 10 139 | 10·808538 | 10·005182 | 10 3 | 9·994818 | 40 | 10 |
| 30 | 22 | 9·186686 | 1 13 | 10·813314 | 9·191878 | 1 14 | 10·808122 | 10·005192 | 11 4 | 9·994808 | 38 | 30 |
| 51 | 24 | 9·187092 | 2 27 | 10·812908 | 9·192294 | 2 28 | 10·807706 | 10·005202 | 12 4 | 9·994798 | 36 | 9 |
| 30 | 26 | 9·187498 | 3 40 | 10·812502 | 9·192709 | 3 41 | 10·807291 | 10·005211 | 13 4 | 9·994789 | 34 | 30 |
| 52 | 28 | 9·187903 | 4 54 | 10·812097 | 9·193124 | 4 55 | 10·806876 | 10·005221 | 14 5 | 9·994779 | 32 | 8 |
| 30 | 30 | 9·188308 | 5 67 | 10·811692 | 9·193539 | 5 69 | 10·806461 | 10·005231 | 15 5 | 9·994769 | 30 | 30 |
| 53 | 32 | 9·188712 | 6 81 | 10·811288 | 9·193953 | 6 83 | 10·806047 | 10·005241 | 16 5 | 9·994759 | 28 | 7 |
| 30 | 34 | 9·189116 | 7 94 | 10·810884 | 9·194367 | 7 97 | 10·805633 | 10·005251 | 17 6 | 9·994749 | 26 | 30 |
| 54 | 36 | 9·189519 | 8 108 | 10·810481 | 9·194780 | 8 110 | 10·805220 | 10·005261 | 18 6 | 9·994739 | 24 | 6 |
| 30 | 38 | 9·189923 | 9 121 | 10·810077 | 9·195193 | 9 124 | 10·804807 | 10·005271 | 19 6 | 9·994729 | 22 | 30 |
| 55 | 40 | 9·190325 | 10 135 | 10·809675 | 9·195606 | 10 138 | 10·804394 | 10·005280 | 20 7 | 9·994720 | 20 | 5 |
| 30 | 42 | 9·190728 | 1 13 | 10·809272 | 9·196018 | 1 14 | 10·803982 | 10·005290 | 21 7 | 9·994710 | 18 | 30 |
| 56 | 44 | 9·191130 | 2 27 | 10·808870 | 9·196430 | 2 27 | 10·803570 | 10·005300 | 22 7 | 9·994700 | 16 | 4 |
| 30 | 46 | 9·191532 | 3 40 | 10·808468 | 9·196842 | 3 41 | 10·803158 | 10·005310 | 23 8 | 9·994690 | 14 | 30 |
| 57 | 48 | 9·191933 | 4 53 | 10·808067 | 9·197253 | 4 55 | 10·802747 | 10·005320 | 24 8 | 9·994680 | 12 | 3 |
| 30 | 50 | 9·192334 | 5 67 | 10·807666 | 9·197664 | 5 68 | 10·802336 | 10·005330 | 25 8 | 9·994670 | 10 | 30 |
| 58 | 52 | 9·192734 | 6 80 | 10·807266 | 9·198074 | 6 82 | 10·801926 | 10·005340 | 26 9 | 9·994660 | 8 | 2 |
| 30 | 54 | 9·193134 | 7 93 | 10·806866 | 9·198484 | 7 96 | 10·801516 | 10·005350 | 27 9 | 9·994650 | 6 | 30 |
| 59 | 56 | 9·193534 | 8 107 | 10·806466 | 9·198894 | 8 109 | 10·801106 | 10·005360 | 28 9 | 9·994640 | 4 | 1 |
| 30 | 58 | 9·193933 | 9 120 | 10·806067 | 9·199304 | 9 123 | 10·800696 | 10·005370 | 29 10 | 9·994630 | 2 | 30 |
| 60 | 36 | 9·194332 | 10 133 | 10·805668 | 9·199713 | 10 137 | 10·800287 | 10·005380 | 30 10 | 9·994620 | 0 | 0 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

81° — 5ʰ 24ᵐ

## LOG. SINES, COSINES, &c.

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| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 9·194332 | | 10·805668 | 9·199715 | | 10·800287 | 10·005380 | | 9·994620 | 24 | 60 |
| 30 | 2 | 9·194731 | 1″ 13 | 10·805269 | 9·200121 | 1″ 13 | 10·799879 | 10·005390 | 1″ 0 | 9·994610 | 58 | 30 |
| 1 | 4 | 9·195129 | 2 26 | 10·804871 | 9·200529 | 2 27 | 10·799471 | 10·005400 | 2 1 | 9·994600 | 56 | 59 |
| 30 | 6 | 9·195527 | 3 39 | 10·804473 | 9·200937 | 3 40 | 10·799063 | 10·005410 | 3 1 | 9·994590 | 54 | 30 |
| 2 | 8 | 9·195925 | 4 52 | 10·804075 | 9·201345 | 4 54 | 10·798655 | 10·005420 | 4 1 | 9·994580 | 52 | 58 |
| 30 | 10 | 9·196322 | 5 65 | 10·803678 | 9·201752 | 5 67 | 10·798248 | 10·005430 | 5 2 | 9·994570 | 50 | 30 |
| 3 | 12 | 9·196719 | 6 79 | 10·803281 | 9·202159 | 6 81 | 10·797841 | 10·005440 | 6 2 | 9·994560 | 48 | 57 |
| 30 | 14 | 9·197115 | 7 92 | 10·802885 | 9·202565 | 7 94 | 10·797435 | 10·005450 | 7 2 | 9·994550 | 46 | 30 |
| 4 | 16 | 9·197511 | 8 105 | 10·802489 | 9·202971 | 8 108 | 10·797029 | 10·005460 | 8 3 | 9·994540 | 44 | 56 |
| 30 | 18 | 9·197907 | 9 118 | 10·802093 | 9·203377 | 9 121 | 10·796623 | 10·005470 | 9 3 | 9·994530 | 42 | 30 |
| 5 | 20 | 9·198302 | 10 131 | 10·801698 | 9·203782 | 10 134 | 10·796218 | 10·005481 | 10 3 | 9·994519 | 40 | 55 |
| 30 | 22 | 9·198697 | 11 144 | 10·801303 | 9·204188 | 11 148 | 10·795812 | 10·005491 | 11 4 | 9·994509 | 38 | 30 |
| 6 | 24 | 9·199091 | 12 157 | 10·800909 | 9·204592 | 12 161 | 10·795408 | 10·005501 | 12 4 | 9·994499 | 36 | 54 |
| 30 | 26 | 9·199486 | 13 170 | 10·800514 | 9·204996 | 13 175 | 10·795004 | 10·005511 | 13 4 | 9·994489 | 34 | 30 |
| 7 | 28 | 9·199879 | 14 183 | 10·800121 | 9·205400 | 14 188 | 10·794600 | 10·005521 | 14 5 | 9·994479 | 32 | 53 |
| 30 | 30 | 9·200273 | 15 197 | 10·799727 | 9·205804 | 15 201 | 10·794196 | 10·005531 | 15 5 | 9·994469 | 30 | 30 |
| 8 | 32 | 9·200666 | 16 210 | 10·799334 | 9·206207 | 16 215 | 10·793793 | 10·005541 | 16 5 | 9·994459 | 28 | 52 |
| 30 | 34 | 9·201059 | 17 223 | 10·798941 | 9·206610 | 17 229 | 10·793390 | 10·005552 | 17 6 | 9·994448 | 26 | 30 |
| 9 | 36 | 9·201451 | 18 236 | 10·798549 | 9·207013 | 18 242 | 10·792987 | 10·005562 | 18 6 | 9·994438 | 24 | 51 |
| 30 | 38 | 9·201843 | 19 249 | 10·798157 | 9·207415 | 19 255 | 10·792585 | 10·005572 | 19 6 | 9·994428 | 22 | 30 |
| 10 | 40 | 9·202234 | 20 262 | 10·797766 | 9·207817 | 20 269 | 10·792183 | 10·005582 | 20 7 | 9·994418 | 20 | 50 |
| 30 | 42 | 9·202626 | 21 275 | 10·797374 | 9·208218 | 21 282 | 10·791782 | 10·005592 | 21 7 | 9·994408 | 18 | 30 |
| 11 | 44 | 9·203017 | 22 288 | 10·796983 | 9·208619 | 22 295 | 10·791381 | 10·005602 | 22 7 | 9·994398 | 16 | 49 |
| 30 | 46 | 9·203407 | 23 301 | 10·796593 | 9·209020 | 23 309 | 10·790980 | 10·005613 | 23 8 | 9·994387 | 14 | 30 |
| 12 | 48 | 9·203797 | 24 315 | 10·796203 | 9·209420 | 24 323 | 10·790580 | 10·005623 | 24 8 | 9·994377 | 12 | 48 |
| 30 | 50 | 9·204187 | 25 328 | 10·795813 | 9·209820 | 25 336 | 10·790180 | 10·005633 | 25 8 | 9·994367 | 10 | 30 |
| 13 | 52 | 9·204577 | 26 341 | 10·795423 | 9·210220 | 26 350 | 10·789780 | 10·005643 | 26 9 | 9·994357 | 8 | 47 |
| 30 | 54 | 9·204966 | 27 354 | 10·795034 | 9·210619 | 27 363 | 10·789381 | 10·005654 | 27 9 | 9·994346 | 6 | 30 |
| 14 | 56 | 9·205354 | 28 367 | 10·794646 | 9·211018 | 28 376 | 10·788982 | 10·005664 | 28 9 | 9·994336 | 4 | 46 |
| 30 | 58 | 9·205743 | 29 380 | 10·794257 | 9·211417 | 29 390 | 10·788583 | 10·005674 | 29 10 | 9·994326 | 2 | 30 |
| 15 | 37 | 9·206131 | 30 393 | 10·793869 | 9·211815 | 30 403 | 10·788185 | 10·005684 | 30 10 | 9·994316 | 23 | 45 |
| 30 | 2 | 9·206519 | 1 13 | 10·793481 | 9·212213 | 1 13 | 10·787787 | 10·005695 | 1 0 | 9·994305 | 58 | 30 |
| 16 | 4 | 9·206906 | 2 25 | 10·793094 | 9·212611 | 2 26 | 10·787389 | 10·005705 | 2 1 | 9·994295 | 56 | 44 |
| 30 | 6 | 9·207293 | 3 38 | 10·792707 | 9·213008 | 3 39 | 10·786992 | 10·005715 | 3 1 | 9·994285 | 54 | 30 |
| 17 | 8 | 9·207679 | 4 51 | 10·792321 | 9·213405 | 4 52 | 10·786595 | 10·005726 | 4 1 | 9·994274 | 52 | 43 |
| 30 | 10 | 9·208066 | 5 64 | 10·791934 | 9·213802 | 5 65 | 10·786198 | 10·005736 | 5 2 | 9·994264 | 50 | 30 |
| 18 | 12 | 9·208452 | 6 76 | 10·791548 | 9·214198 | 6 79 | 10·785802 | 10·005746 | 6 2 | 9·994254 | 48 | 42 |
| 30 | 14 | 9·208837 | 7 89 | 10·791163 | 9·214594 | 7 92 | 10·785406 | 10·005757 | 7 2 | 9·994243 | 46 | 30 |
| 19 | 16 | 9·209222 | 8 102 | 10·790778 | 9·214989 | 8 105 | 10·785011 | 10·005767 | 8 3 | 9·994233 | 44 | 41 |
| 30 | 18 | 9·209607 | 9 115 | 10·790393 | 9·215385 | 9 118 | 10·784615 | 10·005777 | 9 3 | 9·994223 | 42 | 30 |
| 20 | 20 | 9·209992 | 10 127 | 10·790008 | 9·215780 | 10 131 | 10·784220 | 10·005788 | 10 3 | 9·994212 | 40 | 40 |
| 30 | 22 | 9·210376 | 11 140 | 10·789624 | 9·216174 | 11 144 | 10·783826 | 10·005798 | 11 4 | 9·994202 | 38 | 30 |
| 21 | 24 | 9·210760 | 12 153 | 10·789240 | 9·216568 | 12 157 | 10·783432 | 10·005809 | 12 4 | 9·994191 | 36 | 39 |
| 30 | 26 | 9·211143 | 13 166 | 10·788857 | 9·216962 | 13 170 | 10·783038 | 10·005819 | 13 4 | 9·994181 | 34 | 30 |
| 22 | 28 | 9·211526 | 14 178 | 10·788474 | 9·217356 | 14 183 | 10·782644 | 10·005829 | 14 5 | 9·994171 | 32 | 38 |
| 30 | 30 | 9·211909 | 15 191 | 10·788091 | 9·217749 | 15 196 | 10·782251 | 10·005840 | 15 5 | 9·994160 | 30 | 30 |
| 23 | 32 | 9·212291 | 16 204 | 10·787709 | 9·218142 | 16 210 | 10·781858 | 10·005850 | 16 5 | 9·994150 | 28 | 37 |
| 30 | 34 | 9·212674 | 17 217 | 10·787326 | 9·218534 | 17 223 | 10·781466 | 10·005861 | 17 6 | 9·994139 | 26 | 30 |
| 24 | 36 | 9·213055 | 18 229 | 10·786945 | 9·218926 | 18 236 | 10·781074 | 10·005871 | 18 6 | 9·994129 | 24 | 36 |
| 30 | 38 | 9·213437 | 19 242 | 10·786563 | 9·219318 | 19 249 | 10·780682 | 10·005882 | 19 6 | 9·994118 | 22 | 30 |
| 25 | 40 | 9·213818 | 20 255 | 10·786182 | 9·219710 | 20 262 | 10·780290 | 10·005892 | 20 7 | 9·994108 | 20 | 35 |
| 30 | 42 | 9·214198 | 21 268 | 10·785802 | 9·220101 | 21 275 | 10·779899 | 10·005903 | 21 7 | 9·994097 | 18 | 30 |
| 26 | 44 | 9·214579 | 22 280 | 10·785421 | 9·220492 | 22 288 | 10·779508 | 10·005913 | 22 7 | 9·994087 | 16 | 34 |
| 30 | 46 | 9·214959 | 23 293 | 10·785041 | 9·220882 | 23 301 | 10·779118 | 10·005924 | 23 8 | 9·994076 | 14 | 30 |
| 27 | 48 | 9·215338 | 24 306 | 10·784662 | 9·221272 | 24 314 | 10·778728 | 10·005934 | 24 8 | 9·994066 | 12 | 33 |
| 30 | 50 | 9·215718 | 25 319 | 10·784282 | 9·221662 | 25 327 | 10·778338 | 10·005945 | 25 8 | 9·994055 | 10 | 30 |
| 28 | 52 | 9·216097 | 26 331 | 10·783903 | 9·222052 | 26 341 | 10·777948 | 10·005955 | 26 9 | 9·994045 | 8 | 32 |
| 30 | 54 | 9·216475 | 27 344 | 10·783525 | 9·222441 | 27 354 | 10·777559 | 10·005966 | 27 9 | 9·994034 | 6 | 30 |
| 29 | 56 | 9·216854 | 28 357 | 10·783146 | 9·222830 | 28 367 | 10·777170 | 10·005976 | 28 10 | 9·994024 | 4 | 31 |
| 30 | 58 | 9·217232 | 29 370 | 10·782768 | 9·223218 | 29 380 | 10·776782 | 10·005987 | 29 10 | 9·994013 | 2 | 30 |
| 30 | 38 | 9·217609 | 30 382 | 10·782391 | 9·223607 | 30 393 | 10·776393 | 10·005997 | 30 10 | 9·994003 | 0 | 30 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

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## LOG. SINES, COSINES, &c.

$0^h\ 38^m$ 9°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 9·217609 | | 10·782391 | 9·223607 | | 10·776393 | 10·005997 | | 9·994003 | 22 | 30 |
| 30 | 2 | 9·217987 | 1″ 12 | 10·782013 | 9·223994 | 1″ 13 | 10·776006 | 10·006008 | 1″ 0 | 9·993992 | 58 | 30 |
| 31 | 4 | 9·218363 | 2 25 | 10·781637 | 9·224382 | 2 25 | 10·775618 | 10·006018 | 2 1 | 9·993982 | 56 | 29 |
| 30 | 6 | 9·218740 | 3 37 | 10·781260 | 9·224769 | 3 38 | 10·775231 | 10·006029 | 3 1 | 9·993971 | 54 | 30 |
| 32 | 8 | 9·219116 | 4 50 | 10·780884 | 9·225156 | 4 51 | 10·774844 | 10·006040 | 4 1 | 9·993960 | 52 | 28 |
| 30 | 10 | 9·219492 | 5 62 | 10·780508 | 9·225543 | 5 64 | 10·774457 | 10·006050 | 5 2 | 9·993950 | 50 | 30 |
| 33 | 12 | 9·219868 | 6 74 | 10·780132 | 9·225929 | 6 77 | 10·774071 | 10·006061 | 6 2 | 9·993939 | 48 | 27 |
| 30 | 14 | 9·220243 | 7 87 | 10·779757 | 9·226315 | 7 90 | 10·773685 | 10·006072 | 7 2 | 9·993928 | 46 | 30 |
| 34 | 16 | 9·220618 | 8 99 | 10·779382 | 9·226700 | 8 102 | 10·773300 | 10·006082 | 8 3 | 9·993918 | 44 | 26 |
| 30 | 18 | 9·220993 | 9 112 | 10·779007 | 9·227086 | 9 115 | 10·772914 | 10·006093 | 9 3 | 9·993907 | 42 | 30 |
| 35 | 20 | 9·221367 | 10 124 | 10·778633 | 9·227471 | 10 128 | 10·772529 | 10·006103 | 10 4 | 9·993897 | 40 | 25 |
| 30 | 22 | 9·221741 | 11 136 | 10·778259 | 9·227855 | 11 140 | 10·772145 | 10·006114 | 11 4 | 9·993886 | 38 | 30 |
| 36 | 24 | 9·222115 | 12 149 | 10·777885 | 9·228239 | 12 153 | 10·771761 | 10·006125 | 12 4 | 9·993875 | 36 | 24 |
| 30 | 26 | 9·222488 | 13 161 | 10·777512 | 9·228623 | 13 166 | 10·771377 | 10·006136 | 13 5 | 9·993864 | 34 | 30 |
| 37 | 28 | 9·222861 | 14 174 | 10·777139 | 9·229007 | 14 179 | 10·770993 | 10·006146 | 14 5 | 9·993854 | 32 | 23 |
| 30 | 30 | 9·223234 | 15 186 | 10·776766 | 9·229390 | 15 192 | 10·770610 | 10·006157 | 15 5 | 9·993843 | 30 | 30 |
| 38 | 32 | 9·223606 | 16 198 | 10·776394 | 9·229773 | 16 204 | 10·770227 | 10·006168 | 16 6 | 9·993832 | 28 | 22 |
| 30 | 34 | 9·223978 | 17 211 | 10·776022 | 9·230156 | 17 217 | 10·769844 | 10·006178 | 17 6 | 9·993822 | 26 | 30 |
| 39 | 36 | 9·224349 | 18 223 | 10·775651 | 9·230539 | 18 230 | 10·769461 | 10·006189 | 18 6 | 9·993811 | 24 | 21 |
| 30 | 38 | 9·224721 | 19 236 | 10·775279 | 9·230921 | 19 243 | 10·769079 | 10·006200 | 19 7 | 9·993800 | 22 | 30 |
| 40 | 40 | 9·225092 | 20 248 | 10·774908 | 9·231302 | 20 255 | 10·768698 | 10·006211 | 20 7 | 9·993789 | 20 | 20 |
| 30 | 42 | 9·225462 | 21 261 | 10·774538 | 9·231684 | 21 268 | 10·768316 | 10·006221 | 21 7 | 9·993779 | 18 | 30 |
| 41 | 44 | 9·225833 | 22 273 | 10·774167 | 9·232065 | 22 281 | 10·767935 | 10·006232 | 22 8 | 9·993768 | 16 | 19 |
| 30 | 46 | 9·226203 | 23 286 | 10·773797 | 9·232446 | 23 294 | 10·767554 | 10·006243 | 23 8 | 9·993757 | 14 | 30 |
| 42 | 48 | 9·226573 | 24 298 | 10·773427 | 9·232826 | 24 307 | 10·767174 | 10·006254 | 24 9 | 9·993746 | 12 | 18 |
| 30 | 50 | 9·226942 | 25 310 | 10·773058 | 9·233206 | 25 320 | 10·766794 | 10·006265 | 25 9 | 9·993735 | 10 | 30 |
| 43 | 52 | 9·227311 | 26 323 | 10·772689 | 9·233586 | 26 332 | 10·766414 | 10·006275 | 26 9 | 9·993725 | 8 | 17 |
| 30 | 54 | 9·227680 | 27 335 | 10·772320 | 9·233966 | 27 345 | 10·766034 | 10·006286 | 27 10 | 9·993714 | 6 | 30 |
| 44 | 56 | 9·228048 | 28 348 | 10·771952 | 9·234345 | 28 358 | 10·765655 | 10·006297 | 28 10 | 9·993703 | 4 | 16 |
| 30 | 58 | 9·228416 | 29 360 | 10·771584 | 9·234724 | 29 371 | 10·765276 | 10·006308 | 29 10 | 9·993692 | 2 | 30 |
| 45 | 39 | 9·228784 | 30 372 | 10·771216 | 9·235103 | 30 383 | 10·764897 | 10·006319 | 30 11 | 9·993681 | 21 | 15 |
| 30 | 2 | 9·229151 | 1 12 | 10·770849 | 9·235481 | 1 12 | 10·764519 | 10·006330 | 1 0 | 9·993670 | 58 | 30 |
| 46 | 4 | 9·229518 | 2 24 | 10·770482 | 9·235859 | 2 25 | 10·764141 | 10·006340 | 2 1 | 9·993660 | 56 | 14 |
| 30 | 6 | 9·229885 | 3 36 | 10·770115 | 9·236237 | 3 37 | 10·763763 | 10·006351 | 3 1 | 9·993649 | 54 | 30 |
| 47 | 8 | 9·230252 | 4 48 | 10·769748 | 9·236614 | 4 50 | 10·763386 | 10·006362 | 4 1 | 9·993638 | 52 | 13 |
| 30 | 10 | 9·230618 | 5 60 | 10·769382 | 9·236991 | 5 62 | 10·763009 | 10·006373 | 5 2 | 9·993627 | 50 | 30 |
| 48 | 12 | 9·230984 | 6 73 | 10·769016 | 9·237368 | 6 75 | 10·762632 | 10·006384 | 6 2 | 9·993616 | 48 | 12 |
| 30 | 14 | 9·231349 | 7 85 | 10·768651 | 9·237744 | 7 87 | 10·762256 | 10·006395 | 7 3 | 9·993605 | 46 | 30 |
| 49 | 16 | 9·231715 | 8 97 | 10·768285 | 9·238120 | 8 100 | 10·761880 | 10·006406 | 8 3 | 9·993594 | 44 | 11 |
| 30 | 18 | 9·232079 | 9 109 | 10·767921 | 9·238496 | 9 112 | 10·761504 | 10·006417 | 9 3 | 9·993583 | 42 | 30 |
| 50 | 20 | 9·232444 | 10 121 | 10·767556 | 9·238872 | 10 125 | 10·761128 | 10·006428 | 10 4 | 9·993572 | 40 | 10 |
| 30 | 22 | 9·232808 | 11 133 | 10·767192 | 9·239247 | 11 137 | 10·760753 | 10·006439 | 11 4 | 9·993561 | 38 | 30 |
| 51 | 24 | 9·233172 | 12 145 | 10·766828 | 9·239622 | 12 150 | 10·760378 | 10·006450 | 12 4 | 9·993550 | 36 | 9 |
| 30 | 26 | 9·233536 | 13 157 | 10·766464 | 9·239996 | 13 162 | 10·760004 | 10·006461 | 13 5 | 9·993539 | 34 | 30 |
| 52 | 28 | 9·233899 | 14 169 | 10·766101 | 9·240371 | 14 175 | 10·759629 | 10·006472 | 14 5 | 9·993528 | 32 | 8 |
| 30 | 30 | 9·234262 | 15 181 | 10·765738 | 9·240745 | 15 187 | 10·759255 | 10·006483 | 15 6 | 9·993517 | 30 | 30 |
| 53 | 32 | 9·234625 | 16 193 | 10·765375 | 9·241118 | 16 200 | 10·758882 | 10·006494 | 16 6 | 9·993506 | 28 | 7 |
| 30 | 34 | 9·234987 | 17 206 | 10·765013 | 9·241492 | 17 212 | 10·758508 | 10·006505 | 17 7 | 9·993495 | 26 | 30 |
| 54 | 36 | 9·235349 | 18 218 | 10·764651 | 9·241865 | 18 224 | 10·758135 | 10·006516 | 18 7 | 9·993484 | 24 | 6 |
| 30 | 38 | 9·235711 | 19 230 | 10·764289 | 9·242238 | 19 237 | 10·757762 | 10·006527 | 19 7 | 9·993473 | 22 | 30 |
| 55 | 40 | 9·236073 | 20 242 | 10·763927 | 9·242610 | 20 249 | 10·757390 | 10·006538 | 20 7 | 9·993462 | 20 | 5 |
| 30 | 42 | 9·236434 | 21 254 | 10·763566 | 9·242982 | 21 261 | 10·757018 | 10·006549 | 21 8 | 9·993451 | 18 | 30 |
| 56 | 44 | 9·236795 | 22 266 | 10·763205 | 9·243354 | 22 274 | 10·756646 | 10·006560 | 22 8 | 9·993440 | 16 | 4 |
| 30 | 46 | 9·237155 | 23 278 | 10·762845 | 9·243726 | 23 286 | 10·756274 | 10·006571 | 23 8 | 9·993429 | 14 | 30 |
| 57 | 48 | 9·237515 | 24 290 | 10·762485 | 9·244097 | 24 299 | 10·755903 | 10·006582 | 24 9 | 9·993418 | 12 | 3 |
| 30 | 50 | 9·237875 | 25 302 | 10·762125 | 9·244468 | 25 311 | 10·755532 | 10·006593 | 25 9 | 9·993407 | 10 | 30 |
| 58 | 52 | 9·238235 | 26 314 | 10·761765 | 9·244839 | 26 323 | 10·755161 | 10·006604 | 26 9 | 9·993396 | 8 | 2 |
| 30 | 54 | 9·238594 | 27 327 | 10·761406 | 9·245209 | 27 336 | 10·754791 | 10·006615 | 27 10 | 9·993385 | 6 | 30 |
| 59 | 56 | 9·238953 | 28 338 | 10·761047 | 9·245579 | 28 348 | 10·754421 | 10·006626 | 28 10 | 9·993374 | 4 | 1 |
| 30 | 58 | 9·239312 | 29 351 | 10·760688 | 9·245949 | 29 361 | 10·754051 | 10·006637 | 29 11 | 9·993363 | 2 | 30 |
| 60 | 40 | 9·239670 | 30 363 | 10·760330 | 9·246319 | 30 374 | 10·753681 | 10·006649 | 30 11 | 9·993351 | 0 | 0 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

80° $5^h\ 20^m$

## LOG. SINES, COSINES, &c.

$0^h\ 40^m$ — 10°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 9·239670 | | 10·760330 | 9·246319 | | 10·753681 | 10·006649 | | 9·993351 | 20 | 60 |
| 30 | 2 | 9·240028 | 1″ 12 | 10·759972 | 9·246688 | 1″ 12 | 10·753312 | 10·006660 | 1″ 0 | 9·993340 | 58 | 30 |
| 1 | 4 | 9·240386 | 2 24 | 10·759614 | 9·247057 | 2 24 | 10·752943 | 10·006671 | 2 1 | 9·993329 | 56 | 59 |
| 30 | 6 | 9·240744 | 3 35 | 10·759256 | 9·247426 | 3 36 | 10·752574 | 10·006682 | 3 1 | 9·993318 | 54 | 30 |
| 2 | 8 | 9·241101 | 4 47 | 10·758899 | 9·247794 | 4 49 | 10·752206 | 10·006693 | 4 2 | 9·993307 | 52 | 58 |
| 30 | 10 | 9·241458 | 5 59 | 10·758542 | 9·248162 | 5 61 | 10·751838 | 10·006704 | 5 2 | 9·993296 | 50 | 30 |
| 3 | 12 | 9·241814 | 6 71 | 10·758186 | 9·248530 | 6 73 | 10·751470 | 10·006716 | 6 2 | 9·993284 | 48 | 57 |
| 30 | 14 | 9·242170 | 7 83 | 10·757830 | 9·248897 | 7 85 | 10·751103 | 10·006727 | 7 3 | 9·993273 | 46 | 30 |
| 4 | 16 | 9·242526 | 8 94 | 10·757474 | 9·249264 | 8 97 | 10·750736 | 10·006738 | 8 3 | 9·993262 | 44 | 56 |
| 30 | 18 | 9·242882 | 9 106 | 10·757118 | 9·249631 | 9 110 | 10·750369 | 10·006749 | 9 3 | 9·993251 | 42 | 30 |
| 5 | 20 | 9·243237 | 10 118 | 10·756763 | 9·249998 | 10 122 | 10·750002 | 10·006760 | 10 4 | 9·993240 | 40 | 55 |
| 30 | 22 | 9·243592 | 11 130 | 10·756408 | 9·250364 | 11 134 | 10·749636 | 10·006772 | 11 4 | 9·993228 | 38 | 30 |
| 6 | 24 | 9·243947 | 12 141 | 10·756053 | 9·250730 | 12 146 | 10·749270 | 10·006783 | 12 5 | 9·993217 | 36 | 54 |
| 30 | 26 | 9·244302 | 13 53 | 10·755698 | 9·251096 | 13 158 | 10·748904 | 10·006794 | 13 5 | 9·993206 | 34 | 30 |
| 7 | 28 | 9·244656 | 14 165 | 10·755344 | 9·251461 | 14 170 | 10·748539 | 10·006805 | 14 5 | 9·993195 | 32 | 53 |
| 30 | 30 | 9·245010 | 15 177 | 10·754990 | 9·251826 | 15 183 | 10·748174 | 10·006817 | 15 6 | 9·993183 | 30 | 30 |
| 8 | 32 | 9·245363 | 16 189 | 10·754637 | 9·252191 | 16 195 | 10·747809 | 10·006828 | 16 6 | 9·993172 | 28 | 52 |
| 30 | 34 | 9·245717 | 17 200 | 10·754283 | 9·252556 | 17 207 | 10·747444 | 10·006839 | 17 6 | 9·993161 | 26 | 30 |
| 9 | 36 | 9·246069 | 18 212 | 10·753931 | 9·252920 | 18 219 | 10·747080 | 10·006851 | 18 7 | 9·993149 | 24 | 51 |
| 30 | 38 | 9·246422 | 19 224 | 10·753578 | 9·253284 | 19 231 | 10·746716 | 10·006862 | 19 7 | 9·993138 | 22 | 30 |
| 10 | 40 | 9·246775 | 20 236 | 10·753225 | 9·253648 | 20 243 | 10·746352 | 10·006873 | 20 8 | 9·993127 | 20 | 50 |
| 30 | 42 | 9·247127 | 21 248 | 10·752873 | 9·254011 | 21 256 | 10·745989 | 10·006885 | 21 8 | 9·993115 | 18 | 30 |
| 11 | 44 | 9·247478 | 22 259 | 10·752522 | 9·254374 | 22 268 | 10·745626 | 10·006896 | 22 8 | 9·993104 | 16 | 49 |
| 30 | 46 | 9·247830 | 23 271 | 10·752170 | 9·254737 | 23 280 | 10·745263 | 10·006907 | 23 9 | 9·993093 | 14 | 30 |
| 12 | 48 | 9·248181 | 24 283 | 10·751819 | 9·255100 | 24 292 | 10·744900 | 10·006919 | 24 9 | 9·993081 | 12 | 48 |
| 30 | 50 | 9·248532 | 25 295 | 10·751468 | 9·255462 | 25 304 | 10·744538 | 10·006930 | 25 9 | 9·993070 | 10 | 30 |
| 13 | 52 | 9·248883 | 26 307 | 10·751117 | 9·255824 | 26 316 | 10·744176 | 10·006941 | 26 10 | 9·993059 | 8 | 47 |
| 30 | 54 | 9·249233 | 27 318 | 10·750767 | 9·256186 | 27 329 | 10·743814 | 10·006953 | 27 10 | 9·993047 | 6 | 30 |
| 14 | 56 | 9·249583 | 28 330 | 10·750417 | 9·256547 | 28 341 | 10·743453 | 10·006964 | 28 11 | 9·993036 | 4 | 46 |
| 30 | 58 | 9·249933 | 29 342 | 10·750067 | 9·256908 | 29 353 | 10·743092 | 10·006976 | 29 11 | 9·993024 | 2 | 30 |
| 15 | 1 | 9·250282 | 30 354 | 10·749718 | 9·257269 | 30 365 | 10·742731 | 10·006987 | 30 11 | 9·993013 | 19 | 45 |
| 30 | 2 | 9·250631 | 1″ 11 | 10·749369 | 9·257630 | 1 12 | 10·742370 | 10·006998 | 1 0 | 9·993002 | 58 | 30 |
| 16 | 4 | 9·250980 | 2 23 | 10·749020 | 9·257990 | 2 24 | 10·742010 | 10·007010 | 2 1 | 9·992990 | 56 | 44 |
| 30 | 6 | 9·251329 | 3 34 | 10·748671 | 9·258350 | 3 36 | 10·741650 | 10·007021 | 3 1 | 9·992979 | 54 | 30 |
| 17 | 8 | 9·251677 | 4 46 | 10·748323 | 9·258710 | 4 48 | 10·741290 | 10·007033 | 4 2 | 9·992967 | 52 | 43 |
| 30 | 10 | 9·252025 | 5 57 | 10·747975 | 9·259069 | 5 59 | 10·740931 | 10·007044 | 5 2 | 9·992956 | 50 | 30 |
| 18 | 12 | 9·252373 | 6 69 | 10·747627 | 9·259429 | 6 71 | 10·740571 | 10·007056 | 6 2 | 9·992944 | 48 | 42 |
| 30 | 14 | 9·252720 | 7 80 | 10·747280 | 9·259787 | 7 83 | 10·740213 | 10·007067 | 7 3 | 9·992933 | 46 | 30 |
| 19 | 16 | 9·253067 | 8 92 | 10·746933 | 9·260146 | 8 95 | 10·739854 | 10·007079 | 8 3 | 9·992921 | 44 | 41 |
| 30 | 18 | 9·253414 | 9 103 | 10·746586 | 9·260504 | 9 107 | 10·739496 | 10·007090 | 9 3 | 9·992910 | 42 | 30 |
| 20 | 20 | 9·253761 | 10 115 | 10·746239 | 9·260863 | 10 119 | 10·739137 | 10·007102 | 10 4 | 9·992898 | 40 | 40 |
| 30 | 22 | 9·254107 | 11 126 | 10·745893 | 9·261220 | 11 131 | 10·738780 | 10·007113 | 11 4 | 9·992887 | 38 | 30 |
| 21 | 24 | 9·254453 | 12 138 | 10·745547 | 9·261578 | 12 143 | 10·738422 | 10·007125 | 12 5 | 9·992875 | 36 | 39 |
| 30 | 26 | 9·254799 | 13 149 | 10·745201 | 9·261935 | 13 155 | 10·738065 | 10·007136 | 13 5 | 9·992864 | 34 | 30 |
| 22 | 28 | 9·255144 | 14 161 | 10·744856 | 9·262292 | 14 167 | 10·737708 | 10·007148 | 14 5 | 9·992852 | 32 | 38 |
| 30 | 30 | 9·255490 | 15 172 | 10·744510 | 9·262649 | 15 178 | 10·737351 | 10·007159 | 15 6 | 9·992841 | 30 | 30 |
| 23 | 32 | 9·255834 | 16 184 | 10·744166 | 9·263005 | 16 190 | 10·736995 | 10·007171 | 16 6 | 9·992829 | 28 | 37 |
| 30 | 34 | 9·256179 | 17 195 | 10·743821 | 9·263361 | 17 202 | 10·736639 | 10·007182 | 17 6 | 9·992818 | 26 | 30 |
| 24 | 36 | 9·256523 | 18 207 | 10·743477 | 9·263717 | 18 214 | 10·736283 | 10·007194 | 18 7 | 9·992806 | 24 | 36 |
| 30 | 38 | 9·256867 | 19 218 | 10·743133 | 9·264073 | 19 226 | 10·735927 | 10·007206 | 19 7 | 9·992794 | 22 | 30 |
| 25 | 40 | 9·257211 | 20 230 | 10·742789 | 9·264428 | 20 238 | 10·735572 | 10·007217 | 20 8 | 9·992783 | 20 | 35 |
| 30 | 42 | 9·257554 | 21 241 | 10·742446 | 9·264783 | 21 250 | 10·735217 | 10·007229 | 21 8 | 9·992771 | 18 | 30 |
| 26 | 44 | 9·257898 | 22 253 | 10·742102 | 9·265138 | 22 262 | 10·734862 | 10·007241 | 22 8 | 9·992759 | 16 | 34 |
| 30 | 46 | 9·258241 | 23 264 | 10·741759 | 9·265493 | 23 274 | 10·734507 | 10·007252 | 23 9 | 9·992748 | 14 | 30 |
| 27 | 48 | 9·258583 | 24 276 | 10·741417 | 9·265847 | 24 285 | 10·734153 | 10·007265 | 24 9 | 9·992736 | 12 | 33 |
| 30 | 50 | 9·258926 | 25 287 | 10·741074 | 9·266201 | 25 297 | 10·733799 | 10·007276 | 25 10 | 9·992724 | 10 | 30 |
| 28 | 52 | 9·259268 | 26 299 | 10·740732 | 9·266555 | 26 309 | 10·733445 | 10·007287 | 26 10 | 9·992713 | 8 | 32 |
| 30 | 54 | 9·259609 | 27 310 | 10·740391 | 9·266908 | 27 321 | 10·733092 | 10·007299 | 27 10 | 9·992701 | 6 | 30 |
| 29 | 56 | 9·259951 | 28 322 | 10·740049 | 9·267261 | 28 333 | 10·732739 | 10·007310 | 28 11 | 9·992690 | 4 | 31 |
| 30 | 58 | 9·260292 | 29 333 | 10·739708 | 9·267614 | 29 345 | 10·732386 | 10·007322 | 29 11 | 9·992678 | 2 | 30 |
| 30 | 2 | 9·260633 | 30 345 | 10·739367 | 9·267967 | 30 357 | 10·732033 | 10·007334 | 30 12 | 9·992666 | 0 | 30 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

79° — $5^h\ 19^m$

## LOG. SINES, COSINES, &c.

0h 42m — 10°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 9·260633 | | 10·739367 | 9·267967 | | 10·732033 | 10·007334 | | 9·992666 | 18 | 30 |
| 30 | 2 | 9·260974 | 1″ 11 | 10·739026 | 9·268319 | 1″ 12 | 10·731681 | 10·007346 | 1″ 0 | 9·992654 | 58 | 30 |
| 31 | 4 | 9·261314 | 2 22 | 10·738686 | 9·268671 | 2 23 | 10·731329 | 10·007357 | 2 1 | 9·992643 | 56 | 29 |
| 30 | 6 | 9·261654 | 3 34 | 10·738346 | 9·269023 | 3 35 | 10·730977 | 10·007369 | 3 1 | 9·992631 | 54 | 30 |
| 32 | 8 | 9·261994 | 4 45 | 10·738006 | 9·269375 | 4 46 | 10·730625 | 10·007381 | 4 2 | 9·992619 | 52 | 28 |
| 30 | 10 | 9·262334 | 5 56 | 10·737666 | 9·269726 | 5 58 | 10·730274 | 10·007393 | 5 2 | 9·992607 | 50 | 30 |
| 33 | 12 | 9·262673 | 6 67 | 10·737327 | 9·270077 | 6 70 | 10·729923 | 10·007404 | 6 2 | 9·992596 | 48 | 27 |
| 30 | 14 | 9·263012 | 7 78 | 10·736988 | 9·270428 | 7 81 | 10·729572 | 10·007416 | 7 3 | 9·992584 | 46 | 30 |
| 34 | 16 | 9·263351 | 8 90 | 10·736649 | 9·270779 | 8 93 | 10·729221 | 10·007428 | 8 3 | 9·992572 | 44 | 26 |
| 30 | 18 | 9·263689 | 9 101 | 10·736311 | 9·271129 | 9 105 | 10·728871 | 10·007440 | 9 4 | 9·992560 | 42 | 30 |
| 35 | 20 | 9·264027 | 10 112 | 10·735973 | 9·271479 | 10 116 | 10·728521 | 10·007451 | 10 4 | 9·992549 | 40 | 25 |
| 30 | 22 | 9·264365 | 11 123 | 10·735635 | 9·271829 | 11 128 | 10·728171 | 10·007463 | 11 4 | 9·992537 | 38 | 30 |
| 36 | 24 | 9·264703 | 12 135 | 10·735297 | 9·272178 | 12 139 | 10·727822 | 10·007475 | 12 5 | 9·992525 | 36 | 24 |
| 30 | 26 | 9·265040 | 13 146 | 10·734960 | 9·272527 | 13 151 | 10·727473 | 10·007487 | 13 5 | 9·992513 | 34 | 30 |
| 37 | 28 | 9·265377 | 14 157 | 10·734623 | 9·272876 | 14 162 | 10·727124 | 10·007499 | 14 6 | 9·992501 | 32 | 23 |
| 30 | 30 | 9·265714 | 15 168 | 10·734286 | 9·273225 | 15 174 | 10·726775 | 10·007511 | 15 6 | 9·992489 | 30 | 30 |
| 38 | 32 | 9·266051 | 16 179 | 10·733949 | 9·273573 | 16 186 | 10·726427 | 10·007522 | 16 6 | 9·992478 | 28 | 22 |
| 30 | 34 | 9·266387 | 17 191 | 10·733613 | 9·273921 | 17 197 | 10·726079 | 10·007534 | 17 7 | 9·992466 | 26 | 30 |
| 39 | 36 | 9·266723 | 18 202 | 10·733277 | 9·274269 | 18 209 | 10·725731 | 10·007546 | 18 7 | 9·992454 | 24 | 21 |
| 30 | 38 | 9·267059 | 19 213 | 10·732941 | 9·274617 | 19 221 | 10·725383 | 10·007558 | 19 7 | 9·992442 | 22 | 30 |
| 40 | 40 | 9·267395 | 20 224 | 10·732605 | 9·274964 | 20 232 | 10·725036 | 10·007570 | 20 8 | 9·992430 | 20 | 20 |
| 30 | 42 | 9·267730 | 21 236 | 10·732270 | 9·275312 | 21 244 | 10·724688 | 10·007582 | 21 8 | 9·992418 | 18 | 30 |
| 41 | 44 | 9·268065 | 22 247 | 10·731935 | 9·275658 | 22 256 | 10·724342 | 10·007594 | 22 9 | 9·992406 | 16 | 19 |
| 30 | 46 | 9·268399 | 23 258 | 10·731601 | 9·276005 | 23 267 | 10·723995 | 10·007606 | 23 9 | 9·992394 | 14 | 30 |
| 42 | 48 | 9·268734 | 24 269 | 10·731266 | 9·276351 | 24 279 | 10·723649 | 10·007618 | 24 9 | 9·992382 | 12 | 18 |
| 30 | 50 | 9·269068 | 25 280 | 10·730932 | 9·276698 | 25 290 | 10·723302 | 10·007630 | 25 10 | 9·992370 | 10 | 30 |
| 43 | 52 | 9·269402 | 26 292 | 10·730598 | 9·277043 | 26 302 | 10·722957 | 10·007641 | 26 10 | 9·992359 | 8 | 17 |
| 30 | 54 | 9·269736 | 27 303 | 10·730264 | 9·277389 | 27 314 | 10·722611 | 10·007653 | 27 11 | 9·992347 | 6 | 30 |
| 44 | 56 | 9·270069 | 28 315 | 10·729931 | 9·277734 | 28 325 | 10·722266 | 10·007665 | 28 11 | 9·992335 | 4 | 16 |
| 30 | 58 | 9·270402 | 29 326 | 10·729598 | 9·278079 | 29 337 | 10·721921 | 10·007677 | 29 11 | 9·992323 | 2 | 30 |
| 45 | 43 | 9·270735 | 30 337 | 10·729265 | 9·278424 | 30 349 | 10·721576 | 10·007689 | 30 12 | 9·992311 | 17 | 15 |
| 30 | 2 | 9·271067 | 1 11 | 10·728933 | 9·278769 | 1 11 | 10·721231 | 10·007701 | 1 0 | 9·992299 | 58 | 30 |
| 46 | 4 | 9·271400 | 2 22 | 10·728600 | 9·279113 | 2 23 | 10·720887 | 10·007713 | 2 1 | 9·992287 | 56 | 14 |
| 30 | 6 | 9·271732 | 3 33 | 10·728268 | 9·279457 | 3 34 | 10·720543 | 10·007725 | 3 1 | 9·992275 | 54 | 30 |
| 47 | 8 | 9·272064 | 4 44 | 10·727936 | 9·279801 | 4 45 | 10·720199 | 10·007737 | 4 2 | 9·992263 | 52 | 13 |
| 30 | 10 | 9·272395 | 5 55 | 10·727605 | 9·280144 | 5 57 | 10·719856 | 10·007749 | 5 2 | 9·992251 | 50 | 30 |
| 48 | 12 | 9·272726 | 6 66 | 10·727274 | 9·280488 | 6 68 | 10·719512 | 10·007761 | 6 2 | 9·992239 | 48 | 12 |
| 30 | 14 | 9·273057 | 7 77 | 10·726943 | 9·280831 | 7 79 | 10·719169 | 10·007774 | 7 3 | 9·992226 | 46 | 30 |
| 49 | 16 | 9·273388 | 8 88 | 10·726612 | 9·281174 | 8 91 | 10·718826 | 10·007786 | 8 3 | 9·992214 | 44 | 11 |
| 30 | 18 | 9·273718 | 9 99 | 10·726282 | 9·281516 | 9 102 | 10·718484 | 10·007798 | 9 4 | 9·992202 | 42 | 30 |
| 50 | 20 | 9·274049 | 10 110 | 10·725951 | 9·281858 | 10 114 | 10·718142 | 10·007810 | 10 4 | 9·992190 | 40 | 10 |
| 30 | 22 | 9·274379 | 11 121 | 10·725621 | 9·282201 | 11 125 | 10·717799 | 10·007822 | 11 4 | 9·992178 | 38 | 30 |
| 51 | 24 | 9·274708 | 12 132 | 10·725292 | 9·282542 | 12 136 | 10·717458 | 10·007834 | 12 5 | 9·992166 | 36 | 9 |
| 30 | 26 | 9·275038 | 13 142 | 10·724962 | 9·282884 | 13 148 | 10·717116 | 10·007846 | 13 5 | 9·992154 | 34 | 30 |
| 52 | 28 | 9·275367 | 14 153 | 10·724633 | 9·283225 | 14 159 | 10·716775 | 10·007858 | 14 6 | 9·992142 | 32 | 8 |
| 30 | 30 | 9·275696 | 15 164 | 10·724304 | 9·283566 | 15 170 | 10·716434 | 10·007870 | 15 6 | 9·992130 | 30 | 30 |
| 53 | 32 | 9·276025 | 16 175 | 10·723975 | 9·283907 | 16 182 | 10·716093 | 10·007882 | 16 6 | 9·992118 | 28 | 7 |
| 30 | 34 | 9·276353 | 17 186 | 10·723647 | 9·284248 | 17 193 | 10·715752 | 10·007895 | 17 7 | 9·992105 | 26 | 30 |
| 54 | 36 | 9·276681 | 18 197 | 10·723319 | 9·284588 | 18 205 | 10·715412 | 10·007907 | 18 7 | 9·992093 | 24 | 6 |
| 30 | 38 | 9·277009 | 19 208 | 10·722991 | 9·284928 | 19 216 | 10·715072 | 10·007919 | 19 8 | 9·992081 | 22 | 30 |
| 55 | 40 | 9·277337 | 20 219 | 10·722663 | 9·285268 | 20 227 | 10·714732 | 10·007931 | 20 8 | 9·992069 | 20 | 5 |
| 30 | 42 | 9·277664 | 21 230 | 10·722336 | 9·285607 | 21 239 | 10·714393 | 10·007943 | 21 8 | 9·992057 | 18 | 30 |
| 56 | 44 | 9·277991 | 22 241 | 10·722009 | 9·285947 | 22 250 | 10·714053 | 10·007956 | 22 9 | 9·992044 | 16 | 4 |
| 30 | 46 | 9·278318 | 23 252 | 10·721682 | 9·286286 | 23 261 | 10·713714 | 10·007968 | 23 9 | 9·992032 | 14 | 30 |
| 57 | 48 | 9·278645 | 24 263 | 10·721355 | 9·286624 | 24 273 | 10·713376 | 10·007980 | 24 10 | 9·992020 | 12 | 3 |
| 30 | 50 | 9·278971 | 25 274 | 10·721029 | 9·286963 | 25 284 | 10·713037 | 10·007992 | 25 10 | 9·992008 | 10 | 30 |
| 58 | 52 | 9·279297 | 26 285 | 10·720703 | 9·287301 | 26 295 | 10·712699 | 10·008004 | 26 10 | 9·991996 | 8 | 2 |
| 30 | 54 | 9·279623 | 27 296 | 10·720377 | 9·287639 | 27 307 | 10·712361 | 10·008017 | 27 11 | 9·991983 | 6 | 30 |
| 59 | 56 | 9·279948 | 28 307 | 10·720052 | 9·287977 | 28 318 | 10·712023 | 10·008029 | 28 11 | 9·991971 | 4 | 1 |
| 30 | 58 | 9·280274 | 29 318 | 10·719726 | 9·288315 | 29 330 | 10·711685 | 10·008041 | 29 12 | 9·991959 | 2 | 30 |
| 60 | 44 | 9·280599 | 30 329 | 10·719401 | 9·288652 | 30 341 | 10·711348 | 10·008053 | 30 12 | 9·991947 | 0 | 0 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

79° — 5h 16m

LOG. SINES, COSINES, &c.

0h 44m — 11°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 9·280599 | | 10·719401 | 9·288652 | | 10·711348 | 10·008053 | | 9·991947 | 16 | 60 |
| 30 | 2 | 9·280924 | 1″ 11 | 10·719076 | 9·288989 | 1″ 11 | 10·711011 | 10·008066 | 1″ 0 | 9·991934 | 58 | 30 |
| 1 | 4 | 9·281248 | 2 21 | 10·718752 | 9·289326 | 2 22 | 10·710674 | 10·008078 | 2 1 | 9·991922 | 56 | 59 |
| 30 | 6 | 9·281573 | 3 32 | 10·718427 | 9·289663 | 3 33 | 10·710337 | 10·008090 | 3 1 | 9·991910 | 54 | 30 |
| 2 | 8 | 9·281897 | 4 43 | 10·718103 | 9·289999 | 4 44 | 10·710001 | 10·008103 | 4 2 | 9·991897 | 52 | 58 |
| 30 | 10 | 9·282220 | 5 53 | 10·717780 | 9·290335 | 5 56 | 10·709665 | 10·008115 | 5 2 | 9·991885 | 50 | 30 |
| 3 | 12 | 9·282544 | 6 64 | 10·717456 | 9·290671 | 6 67 | 10·709329 | 10·008127 | 6 2 | 9·991873 | 48 | 57 |
| 30 | 14 | 9·282867 | 7 75 | 10·717133 | 9·291007 | 7 78 | 10·708993 | 10·008140 | 7 3 | 9·991860 | 46 | 30 |
| 4 | 16 | 9·283190 | 8 86 | 10·716810 | 9·291342 | 8 89 | 10·708658 | 10·008152 | 8 3 | 9·991848 | 44 | 56 |
| 30 | 18 | 9·283513 | 9 96 | 10·716487 | 9·291678 | 9 100 | 10·708322 | 10·008164 | 9 4 | 9·991836 | 42 | 30 |
| 5 | 20 | 9·283836 | 10 107 | 10·716164 | 9·292013 | 10 111 | 10·707987 | 10·008177 | 10 4 | 9·991823 | 40 | 55 |
| 30 | 22 | 9·284158 | 11 118 | 10·715842 | 9·292347 | 11 122 | 10·707653 | 10·008189 | 11 5 | 9·991811 | 38 | 30 |
| 6 | 24 | 9·284480 | 12 128 | 10·715520 | 9·292682 | 12 133 | 10·707318 | 10·008201 | 12 5 | 9·991799 | 36 | 54 |
| 30 | 26 | 9·284802 | 13 139 | 10·715198 | 9·293016 | 13 145 | 10·706984 | 10·008214 | 13 5 | 9·991786 | 34 | 30 |
| 7 | 28 | 9·285124 | 14 150 | 10·714876 | 9·293350 | 14 156 | 10·706650 | 10·008226 | 14 6 | 9·991774 | 32 | 53 |
| 30 | 30 | 9·285445 | 15 160 | 10·714555 | 9·293684 | 15 167 | 10·706316 | 10·008239 | 15 6 | 9·991761 | 30 | 30 |
| 8 | 32 | 9·285766 | 16 171 | 10·714234 | 9·294017 | 16 178 | 10·705983 | 10·008251 | 16 7 | 9·991749 | 28 | 52 |
| 30 | 34 | 9·286087 | 17 182 | 10·713913 | 9·294351 | 17 189 | 10·705649 | 10·008264 | 17 7 | 9·991736 | 26 | 30 |
| 9 | 36 | 9·286408 | 18 193 | 10·713592 | 9·294684 | 18 200 | 10·705316 | 10·008276 | 18 7 | 9·991724 | 24 | 51 |
| 30 | 38 | 9·286728 | 19 203 | 10·713272 | 9·295016 | 19 211 | 10·704984 | 10·008288 | 19 8 | 9·991712 | 22 | 30 |
| 10 | 40 | 9·287048 | 20 214 | 10·712952 | 9·295349 | 20 222 | 10·704651 | 10·008301 | 20 8 | 9·991699 | 20 | 50 |
| 30 | 42 | 9·287368 | 21 225 | 10·712632 | 9·295681 | 21 233 | 10·704319 | 10·008313 | 21 9 | 9·991687 | 18 | 30 |
| 11 | 44 | 9·287688 | 22 235 | 10·712312 | 9·296013 | 22 245 | 10·703987 | 10·008326 | 22 9 | 9·991674 | 16 | 49 |
| 30 | 46 | 9·288007 | 23 246 | 10·711993 | 9·296345 | 23 256 | 10·703655 | 10·008338 | 23 10 | 9·991662 | 14 | 30 |
| 12 | 48 | 9·288326 | 24 257 | 10·711674 | 9·296677 | 24 267 | 10·703323 | 10·008351 | 24 10 | 9·991649 | 12 | 48 |
| 30 | 50 | 9·288645 | 25 267 | 10·711355 | 9·297008 | 25 278 | 10·702992 | 10·008363 | 25 10 | 9·991637 | 10 | 30 |
| 13 | 52 | 9·288964 | 26 278 | 10·711036 | 9·297339 | 26 289 | 10·702661 | 10·008376 | 26 11 | 9·991624 | 8 | 47 |
| 30 | 54 | 9·289282 | 27 289 | 10·710718 | 9·297670 | 27 300 | 10·702330 | 10·008388 | 27 11 | 9·991612 | 6 | 30 |
| 14 | 56 | 9·289600 | 28 300 | 10·710400 | 9·298001 | 28 311 | 10·701999 | 10·008401 | 28 12 | 9·991599 | 4 | 46 |
| 30 | 58 | 9·289918 | 29 310 | 10·710082 | 9·298332 | 29 322 | 10·701668 | 10·008414 | 29 12 | 9·991586 | 2 | 30 |
| 15 | **45** | 9·290236 | 30 321 | 10·709764 | 9·298662 | 30 334 | 10·701338 | 10·008426 | 30 12 | 9·991574 | **15** | 45 |
| 30 | 2 | 9·290553 | 1 10 | 10·709447 | 9·298992 | 1 11 | 10·701008 | 10·008439 | 1 0 | 9·991561 | 58 | 30 |
| 16 | 4 | 9·290870 | 2 21 | 10·709130 | 9·299322 | 2 22 | 10·700678 | 10·008451 | 2 1 | 9·991549 | 56 | 44 |
| 30 | 6 | 9·291187 | 3 31 | 10·708813 | 9·299651 | 3 33 | 10·700349 | 10·008464 | 3 1 | 9·991536 | 54 | 30 |
| 17 | 8 | 9·291504 | 4 42 | 10·708496 | 9·299980 | 4 44 | 10·700020 | 10·008476 | 4 2 | 9·991524 | 52 | 43 |
| 30 | 10 | 9·291820 | 5 52 | 10·708180 | 9·300309 | 5 54 | 10·699691 | 10·008489 | 5 2 | 9·991511 | 50 | 30 |
| 18 | 12 | 9·292137 | 6 63 | 10·707863 | 9·300638 | 6 65 | 10·699362 | 10·008502 | 6 3 | 9·991498 | 48 | 42 |
| 30 | 14 | 9·292453 | 7 73 | 10·707547 | 9·300967 | 7 76 | 10·699033 | 10·008514 | 7 3 | 9·991486 | 46 | 30 |
| 19 | 16 | 9·292768 | 8 84 | 10·707232 | 9·301295 | 8 87 | 10·698705 | 10·008527 | 8 3 | 9·991473 | 44 | 41 |
| 30 | 18 | 9·293084 | 9 94 | 10·706916 | 9·301624 | 9 98 | 10·698376 | 10·008540 | 9 4 | 9·991460 | 42 | 30 |
| 20 | 20 | 9·293399 | 10 105 | 10·706601 | 9·301951 | 10 109 | 10·698049 | 10·008552 | 10 4 | 9·991448 | 40 | 40 |
| 30 | 22 | 9·293714 | 11 115 | 10·706286 | 9·302279 | 11 120 | 10·697721 | 10·008565 | 11 5 | 9·991435 | 38 | 30 |
| 21 | 24 | 9·294029 | 12 126 | 10·705971 | 9·302607 | 12 131 | 10·697393 | 10·008578 | 12 5 | 9·991422 | 36 | 39 |
| 30 | 26 | 9·294344 | 13 136 | 10·705656 | 9·302934 | 13 142 | 10·697066 | 10·008590 | 13 6 | 9·991410 | 34 | 30 |
| 22 | 28 | 9·294658 | 14 147 | 10·705342 | 9·303261 | 14 153 | 10·696739 | 10·008603 | 14 6 | 9·991397 | 32 | 38 |
| 30 | 30 | 9·294972 | 15 157 | 10·705028 | 9·303588 | 15 163 | 10·696412 | 10·008616 | 15 6 | 9·991384 | 30 | 30 |
| 23 | 32 | 9·295286 | 16 168 | 10·704714 | 9·303914 | 16 174 | 10·696086 | 10·008628 | 16 7 | 9·991372 | 28 | 37 |
| 30 | 34 | 9·295600 | 17 178 | 10·704400 | 9·304241 | 17 185 | 10·695759 | 10·008641 | 17 7 | 9·991359 | 26 | 30 |
| 24 | 36 | 9·295913 | 18 188 | 10·704087 | 9·304567 | 18 196 | 10·695433 | 10·008654 | 18 8 | 9·991346 | 24 | 36 |
| 30 | 38 | 9·296226 | 19 199 | 10·703774 | 9·304893 | 19 207 | 10·695107 | 10·008667 | 19 8 | 9·991333 | 22 | 30 |
| 25 | 40 | 9·296539 | 20 209 | 10·703461 | 9·305218 | 20 218 | 10·694782 | 10·008679 | 20 8 | 9·991321 | 20 | 35 |
| 30 | 42 | 9·296852 | 21 220 | 10·703148 | 9·305544 | 21 229 | 10·694456 | 10·008692 | 21 9 | 9·991308 | 18 | 30 |
| 26 | 44 | 9·297164 | 22 230 | 10·702836 | 9·305869 | 22 240 | 10·694131 | 10·008705 | 22 9 | 9·991295 | 16 | 34 |
| 30 | 46 | 9·297476 | 23 241 | 10·702524 | 9·306194 | 23 251 | 10·693806 | 10·008718 | 23 10 | 9·991282 | 14 | 30 |
| 27 | 48 | 9·297788 | 24 251 | 10·702212 | 9·306519 | 24 262 | 10·693481 | 10·008730 | 24 10 | 9·991270 | 12 | 33 |
| 30 | 50 | 9·298100 | 25 262 | 10·701900 | 9·306843 | 25 272 | 10·693157 | 10·008743 | 25 11 | 9·991257 | 10 | 30 |
| 28 | 52 | 9·298412 | 26 272 | 10·701588 | 9·307168 | 26 283 | 10·692832 | 10·008756 | 26 11 | 9·991244 | 8 | 32 |
| 30 | 54 | 9·298723 | 27 283 | 10·701277 | 9·307492 | 27 294 | 10·692508 | 10·008769 | 27 11 | 9·991231 | 6 | 30 |
| 29 | 56 | 9·299034 | 28 293 | 10·700966 | 9·307816 | 28 305 | 10·692184 | 10·008782 | 28 12 | 9·991218 | 4 | 31 |
| 30 | 58 | 9·299345 | 29 304 | 10·700655 | 9·308139 | 29 316 | 10·691861 | 10·008794 | 29 12 | 9·991206 | 2 | 30 |
| 30 | **46** | 9·299655 | 30 314 | 10·700345 | 9·308463 | 30 327 | 10·691537 | 10·008807 | 30 13 | 9·991193 | 0 | 30 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

78° — 5h 14m

## LOG. SINES. COSINES, &c.

0h 46m — 11°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 9·299655 | | 10·700345 | 9·308463 | | 10·691537 | 10·008807 | | 9·991193 | 14 | 30 |
| 30 | 2 | 9·299966 | 1″ 10 | 10·700034 | 9·308786 | 1″ 11 | 10·691214 | 10·008820 | 1″ 0 | 9·991180 | 58 | 30 |
| 31 | 4 | 9·300276 | 2 21 | 10·699724 | 9·309109 | 2 21 | 10·690891 | 10·008833 | 2 1 | 9·991167 | 56 | 29 |
| 30 | 6 | 9·300586 | 3 31 | 10·699414 | 9·309432 | 3 32 | 10·690568 | 10·008846 | 3 1 | 9·991154 | 54 | 30 |
| 32 | 8 | 9·300895 | 4 41 | 10·699105 | 9·309754 | 4 43 | 10·690246 | 10·008859 | 4 2 | 9·991141 | 52 | 28 |
| 30 | 10 | 9·301205 | 5 51 | 10·698795 | 9·310076 | 5 53 | 10·689924 | 10·008872 | 5 2 | 9·991128 | 50 | 30 |
| 33 | 12 | 9·301514 | 6 61 | 10·698486 | 9·310399 | 6 64 | 10·689601 | 10·008885 | 6 3 | 9·991115 | 48 | 27 |
| 30 | 14 | 9·301823 | 7 71 | 10·698177 | 9·310720 | 7 75 | 10·689280 | 10·008897 | 7 3 | 9·991103 | 46 | 30 |
| 34 | 16 | 9·302132 | 8 82 | 10·697868 | 9·311042 | 8 85 | 10·688958 | 10·008910 | 8 3 | 9·991090 | 44 | 26 |
| 30 | 18 | 9·302440 | 9 92 | 10·697560 | 9·311364 | 9 96 | 10·688636 | 10·008923 | 9 4 | 9·991077 | 42 | 30 |
| 35 | 20 | 9·302748 | 10 102 | 10·697252 | 9·311685 | 10 107 | 10·688315 | 10·008936 | 10 4 | 9·991064 | 40 | 25 |
| 30 | 22 | 9·303057 | 11 113 | 10·696943 | 9·312006 | 11 117 | 10·687994 | 10·008949 | 11 5 | 9·991051 | 38 | 30 |
| 36 | 24 | 9·303364 | 12 123 | 10·696636 | 9·312327 | 12 128 | 10·687673 | 10·008962 | 12 5 | 9·991038 | 36 | 24 |
| 30 | 26 | 9·303672 | 13 133 | 10·696328 | 9·312647 | 13 139 | 10·687353 | 10·008975 | 13 6 | 9·991025 | 34 | 30 |
| 37 | 28 | 9·303979 | 14 143 | 10·696021 | 9·312968 | 14 149 | 10·687032 | 10·008988 | 14 6 | 9·991012 | 32 | 23 |
| 30 | 30 | 9·304287 | 15 153 | 10·695713 | 9·313288 | 15 160 | 10·686712 | 10·009001 | 15 6 | 9·990999 | 30 | 30 |
| 38 | 32 | 9·304593 | 16 164 | 10·695407 | 9·313608 | 16 171 | 10·686392 | 10·009014 | 16 7 | 9·990986 | 28 | 22 |
| 30 | 34 | 9·304900 | 17 174 | 10·695100 | 9·313927 | 17 181 | 10·686073 | 10·009027 | 17 7 | 9·990973 | 26 | 30 |
| 39 | 36 | 9·305207 | 18 184 | 10·694793 | 9·314247 | 18 192 | 10·685753 | 10·009040 | 18 8 | 9·990960 | 24 | 21 |
| 30 | 38 | 9·305513 | 19 194 | 10·694487 | 9·314566 | 19 203 | 10·685434 | 10·009053 | 19 8 | 9·990947 | 22 | 30 |
| 40 | 40 | 9·305819 | 20 205 | 10·694181 | 9·314885 | 20 213 | 10·685115 | 10·009066 | 20 9 | 9·990934 | 20 | 20 |
| 30 | 42 | 9·306125 | 21 215 | 10·693875 | 9·315204 | 21 224 | 10·684796 | 10·009079 | 21 9 | 9·990921 | 18 | 30 |
| 41 | 44 | 9·306430 | 22 225 | 10·693570 | 9·315523 | 22 235 | 10·684477 | 10·009092 | 22 10 | 9·990908 | 16 | 19 |
| 30 | 46 | 9·306736 | 23 235 | 10·693264 | 9·315841 | 23 245 | 10·684159 | 10·009105 | 23 10 | 9·990895 | 14 | 30 |
| 42 | 48 | 9·307041 | 24 245 | 10·692959 | 9·316159 | 24 256 | 10·683841 | 10·009118 | 24 10 | 9·990882 | 12 | 18 |
| 30 | 50 | 9·307346 | 25 256 | 10·692654 | 9·316477 | 25 267 | 10·683523 | 10·009132 | 25 11 | 9·990868 | 10 | 30 |
| 43 | 52 | 9·307650 | 26 266 | 10·692350 | 9·316795 | 26 277 | 10·683205 | 10·009145 | 26 11 | 9·990855 | 8 | 17 |
| 30 | 54 | 9·307955 | 27 276 | 10·692045 | 9·317113 | 27 288 | 10·682887 | 10·009158 | 27 12 | 9·990842 | 6 | 30 |
| 44 | 56 | 9·308259 | 28 286 | 10·691741 | 9·317430 | 28 299 | 10·682570 | 10·009171 | 28 12 | 9·990829 | 4 | 16 |
| 30 | 58 | 9·308563 | 29 297 | 10·691437 | 9·317747 | 29 309 | 10·682253 | 10·009184 | 29 13 | 9·990816 | 2 | 30 |
| 45 | 47 | 9·308867 | 30 307 | 10·691133 | 9·318064 | 30 320 | 10·681936 | 10·009197 | 30 13 | 9·990803 | 23 | 15 |
| 30 | 2 | 9·309170 | 1 10 | 10·690830 | 9·318381 | 1 10 | 10·681619 | 10·009210 | 1 0 | 9·990790 | 58 | 30 |
| 46 | 4 | 9·309474 | 2 20 | 10·690526 | 9·318697 | 2 21 | 10·681303 | 10·009223 | 2 1 | 9·990777 | 56 | 14 |
| 30 | 6 | 9·309777 | 3 30 | 10·690223 | 9·319013 | 3 31 | 10·680987 | 10·009237 | 3 1 | 9·990763 | 54 | 30 |
| 47 | 8 | 9·310080 | 4 40 | 10·689920 | 9·319330 | 4 42 | 10·680670 | 10·009250 | 4 2 | 9·990750 | 52 | 13 |
| 30 | 10 | 9·310382 | 5 50 | 10·689618 | 9·319645 | 5 52 | 10·680355 | 10·009263 | 5 2 | 9·990737 | 50 | 30 |
| 48 | 12 | 9·310685 | 6 60 | 10·689315 | 9·319961 | 6 63 | 10·680039 | 10·009276 | 6 3 | 9·990724 | 48 | 12 |
| 30 | 14 | 9·310987 | 7 70 | 10·689013 | 9·320277 | 7 73 | 10·679723 | 10·009289 | 7 3 | 9·990711 | 46 | 30 |
| 49 | 16 | 9·311289 | 8 80 | 10·688711 | 9·320592 | 8 84 | 10·679408 | 10·009303 | 8 4 | 9·990697 | 44 | 11 |
| 30 | 18 | 9·311591 | 9 90 | 10·688409 | 9·320907 | 9 94 | 10·679093 | 10·009316 | 9 4 | 9·990684 | 42 | 30 |
| 50 | 20 | 9·311893 | 10 100 | 10·688107 | 9·321222 | 10 104 | 10·678778 | 10·009329 | 10 4 | 9·990671 | 40 | 10 |
| 30 | 22 | 9·312194 | 11 110 | 10·687806 | 9·321536 | 11 115 | 10·678464 | 10·009342 | 11 5 | 9·990658 | 38 | 30 |
| 51 | 24 | 9·312495 | 12 120 | 10·687505 | 9·321851 | 12 125 | 10·678149 | 10·009355 | 12 5 | 9·990645 | 36 | 9 |
| 30 | 26 | 9·312796 | 13 130 | 10·687204 | 9·322165 | 13 136 | 10·677835 | 10·009369 | 13 6 | 9·990631 | 34 | 30 |
| 52 | 28 | 9·313097 | 14 140 | 10·686903 | 9·322479 | 14 146 | 10·677521 | 10·009382 | 14 6 | 9·990618 | 32 | 8 |
| 30 | 30 | 9·313397 | 15 150 | 10·686603 | 9·322793 | 15 157 | 10·677207 | 10·009395 | 15 7 | 9·990605 | 30 | 30 |
| 53 | 32 | 9·313698 | 16 160 | 10·686302 | 9·323106 | 16 167 | 10·676894 | 10·009409 | 16 7 | 9·990591 | 28 | 7 |
| 30 | 34 | 9·313998 | 17 170 | 10·686002 | 9·323420 | 17 178 | 10·676580 | 10·009422 | 17 8 | 9·990578 | 26 | 30 |
| 54 | 36 | 9·314297 | 18 180 | 10·685703 | 9·323733 | 18 188 | 10·676267 | 10·009435 | 18 8 | 9·990565 | 24 | 6 |
| 30 | 38 | 9·314597 | 19 190 | 10·685403 | 9·324046 | 19 199 | 10·675954 | 10·009449 | 19 8 | 9·990552 | 22 | 30 |
| 55 | 40 | 9·314897 | 20 200 | 10·685103 | 9·324358 | 20 209 | 10·675642 | 10·009462 | 20 9 | 9·990538 | 20 | 5 |
| 30 | 42 | 9·315196 | 21 210 | 10·684804 | 9·324671 | 21 219 | 10·675329 | 10·009475 | 21 9 | 9·990525 | 18 | 30 |
| 56 | 44 | 9·315495 | 22 220 | 10·684505 | 9·324983 | 22 230 | 10·675017 | 10·009489 | 22 10 | 9·990511 | 16 | 4 |
| 30 | 46 | 9·315793 | 23 230 | 10·684207 | 9·325295 | 23 240 | 10·674705 | 10·009502 | 23 10 | 9·990498 | 14 | 30 |
| 57 | 48 | 9·316092 | 24 240 | 10·683908 | 9·325607 | 24 251 | 10·674393 | 10·009515 | 24 11 | 9·990485 | 12 | 3 |
| 30 | 50 | 9·316390 | 25 250 | 10·683610 | 9·325919 | 25 261 | 10·674081 | 10·009529 | 25 11 | 9·990471 | 10 | 30 |
| 58 | 52 | 9·316689 | 26 260 | 10·683311 | 9·32623[illegible] | 26 272 | 10·673769 | 10·009542 | 26 12 | 9·990458 | 8 | 2 |
| 30 | 54 | 9·316986 | 27 270 | 10·683014 | 9·326542 | 27 282 | 10·673458 | 10·009555 | 27 12 | 9·990445 | 6 | 30 |
| 59 | 56 | 9·317284 | 28 280 | 10·682716 | 9·326853 | 28 293 | 10·673147 | 10·009569 | 28 12 | 9·990431 | 4 | 1 |
| 30 | 58 | 9·317582 | 29 290 | 10·682418 | 9·327164 | 29 303 | 10·672836 | 10·009582 | 29 13 | 9·990418 | 2 | 30 |
| 60 | 48 | 9·317879 | 30 300 | 10·682121 | 9·327475 | 30 313 | 10·672525 | 10·009596 | 30 13 | 9·990404 | 0 | 0 |
| ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

78° — 5h 12m

## LOG. SINES, COSINES, &c.

0ʰ 48ᵐ — 12°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 9·317879 | | 10·682121 | 9·327475 | | 10·672525 | 10·009596 | | 9·990404 | 12 | 60 |
| 30 | 2 | 9·318176 | 1″ 10 | 10·681824 | 9·327785 | 1″ 10 | 10·672215 | 10·009609 | 1″ 0 | 9·990391 | 58 | 30 |
| 1 | 4 | 9·318473 | 2 20 | 10·681527 | 9·328095 | 2 20 | 10·671905 | 10·009622 | 2 1 | 9·990378 | 56 | 59 |
| 30 | 6 | 9·318769 | 3 29 | 10·681231 | 9·328405 | 3 31 | 10·671595 | 10·009636 | 3 1 | 9·990364 | 54 | 30 |
| 2 | 8 | 9·319066 | 4 39 | 10·680934 | 9·328715 | 4 41 | 10·671285 | 10·009649 | 4 2 | 9·990351 | 52 | 58 |
| 30 | 10 | 9·319362 | 5 49 | 10·680638 | 9·329025 | 5 51 | 10·670975 | 10·009663 | 5 2 | 9·990337 | 50 | 30 |
| 3 | 12 | 9·319658 | 6 59 | 10·680342 | 9·329334 | 6 61 | 10·670666 | 10·009676 | 6 3 | 9·990324 | 48 | 57 |
| 30 | 14 | 9·319954 | 7 69 | 10·680046 | 9·329644 | 7 72 | 10·670356 | 10·009690 | 7 3 | 9·990310 | 46 | 30 |
| 4 | 16 | 9·320249 | 8 78 | 10·679751 | 9·329953 | 8 82 | 10·670047 | 10·009703 | 8 4 | 9·990297 | 44 | 56 |
| 30 | 18 | 9·320545 | 9 88 | 10·679455 | 9·330262 | 9 92 | 10·669738 | 10·009717 | 9 4 | 9·990283 | 42 | 30 |
| 5 | 20 | 9·320840 | 10 98 | 10·679160 | 9·330570 | 10 102 | 10·669430 | 10·009730 | 10 5 | 9·990270 | 40 | 55 |
| 30 | 22 | 9·321135 | 11 108 | 10·678865 | 9·330879 | 11 113 | 10·669121 | 10·009744 | 11 5 | 9·990256 | 38 | 30 |
| 6 | 24 | 9·321430 | 12 118 | 10·678570 | 9·331187 | 12 123 | 10·668813 | 10·009757 | 12 5 | 9·990243 | 36 | 54 |
| 30 | 26 | 9·321724 | 13 127 | 10·678276 | 9·331495 | 13 133 | 10·668505 | 10·009771 | 13 6 | 9·990229 | 34 | 30 |
| 7 | 28 | 9·322019 | 14 137 | 10·677981 | 9·331803 | 14 143 | 10·668197 | 10·009785 | 14 6 | 9·990215 | 32 | 53 |
| 30 | 30 | 9·322313 | 15 147 | 10·677687 | 9·332111 | 15 154 | 10·667889 | 10·009798 | 15 7 | 9·990202 | 30 | 30 |
| 8 | 32 | 9·322607 | 16 157 | 10·677393 | 9·332418 | 16 164 | 10·667582 | 10·009812 | 16 7 | 9·990188 | 28 | 52 |
| 30 | 34 | 9·322900 | 17 167 | 10·677100 | 9·332726 | 17 174 | 10·667274 | 10·009825 | 17 8 | 9·990175 | 26 | 30 |
| 9 | 36 | 9·323194 | 18 176 | 10·676806 | 9·333033 | 18 184 | 10·666967 | 10·009839 | 18 8 | 9·990161 | 24 | 51 |
| 30 | 38 | 9·323487 | 19 186 | 10·676513 | 9·333340 | 19 195 | 10·666660 | 10·009852 | 19 9 | 9·990148 | 22 | 30 |
| 10 | 40 | 9·323780 | 20 196 | 10·676220 | 9·333646 | 20 205 | 10·666354 | 10·009866 | 20 9 | 9·990134 | 20 | 50 |
| 30 | 42 | 9·324073 | 21 206 | 10·675927 | 9·333953 | 21 215 | 10·666047 | 10·009880 | 21 9 | 9·990120 | 18 | 30 |
| 11 | 44 | 9·324366 | 22 216 | 10·675634 | 9·334259 | 22 225 | 10·665741 | 10·009893 | 22 10 | 9·990107 | 16 | 49 |
| 30 | 46 | 9·324658 | 23 225 | 10·675342 | 9·334565 | 23 236 | 10·665435 | 10·009907 | 23 10 | 9·990093 | 14 | 30 |
| 12 | 48 | 9·324950 | 24 235 | 10·675050 | 9·334871 | 24 246 | 10·665129 | 10·009921 | 24 11 | 9·990079 | 12 | 48 |
| 30 | 50 | 9·325243 | 25 245 | 10·674757 | 9·335177 | 25 256 | 10·664823 | 10·009934 | 25 11 | 9·990066 | 10 | 30 |
| 13 | 52 | 9·325534 | 26 255 | 10·674466 | 9·335482 | 26 266 | 10·664518 | 10·009948 | 26 12 | 9·990052 | 8 | 47 |
| 30 | 54 | 9·325826 | 27 265 | 10·674174 | 9·335788 | 27 277 | 10·664212 | 10·009962 | 27 12 | 9·990038 | 6 | 30 |
| 14 | 56 | 9·326117 | 28 274 | 10·673883 | 9·336093 | 28 287 | 10·663907 | 10·009975 | 28 13 | 9·990025 | 4 | 46 |
| 30 | 58 | 9·326409 | 29 284 | 10·673591 | 9·336398 | 29 297 | 10·663602 | 10·009989 | 29 13 | 9·990011 | 2 | 30 |
| 15 | 49 | 9·326700 | 30 294 | 10·673300 | 9·336702 | 30 307 | 10·663298 | 10·010003 | 30 14 | 9·989997 | 11 | 45 |
| 30 | 2 | 9·326991 | 1 10 | 10·673009 | 9·337007 | 1 10 | 10·662993 | 10·010016 | 1 0 | 9·989984 | 58 | 30 |
| 16 | 4 | 9·327281 | 2 19 | 10·672719 | 9·337311 | 2 20 | 10·662689 | 10·010030 | 2 1 | 9·989970 | 56 | 44 |
| 30 | 6 | 9·327572 | 3 29 | 10·672428 | 9·337615 | 3 30 | 10·662385 | 10·010044 | 3 1 | 9·989956 | 54 | 30 |
| 17 | 8 | 9·327862 | 4 38 | 10·672138 | 9·337919 | 4 40 | 10·662081 | 10·010058 | 4 2 | 9·989942 | 52 | 43 |
| 30 | 10 | 9·328152 | 5 48 | 10·671848 | 9·338223 | 5 50 | 10·661777 | 10·010071 | 5 2 | 9·989929 | 50 | 30 |
| 18 | 12 | 9·328442 | 6 58 | 10·671558 | 9·338527 | 6 60 | 10·661473 | 10·010085 | 6 3 | 9·989915 | 48 | 42 |
| 30 | 14 | 9·328731 | 7 67 | 10·671269 | 9·338830 | 7 70 | 10·661170 | 10·010099 | 7 3 | 9·989901 | 46 | 30 |
| 19 | 16 | 9·329021 | 8 77 | 10·670979 | 9·339133 | 8 80 | 10·660867 | 10·010113 | 8 4 | 9·989887 | 44 | 41 |
| 30 | 18 | 9·329310 | 9 86 | 10·670690 | 9·339436 | 9 90 | 10·660564 | 10·010127 | 9 4 | 9·989873 | 42 | 30 |
| 20 | 20 | 9·329599 | 10 96 | 10·670401 | 9·339739 | 10 101 | 10·660261 | 10·010140 | 10 5 | 9·989860 | 40 | 40 |
| 30 | 22 | 9·329888 | 11 106 | 10·670112 | 9·340042 | 11 111 | 10·659958 | 10·010154 | 11 5 | 9·989846 | 38 | 30 |
| 21 | 24 | 9·330176 | 12 115 | 10·669824 | 9·340344 | 12 121 | 10·659656 | 10·010168 | 12 5 | 9·989832 | 36 | 39 |
| 30 | 26 | 9·330465 | 13 125 | 10·669535 | 9·340646 | 13 131 | 10·659354 | 10·010182 | 13 6 | 9·989818 | 34 | 30 |
| 22 | 28 | 9·330753 | 14 134 | 10·669247 | 9·340948 | 14 141 | 10·659052 | 10·010196 | 14 6 | 9·989804 | 32 | 38 |
| 30 | 30 | 9·331041 | 15 144 | 10·668959 | 9·341250 | 15 151 | 10·658750 | 10·010210 | 15 7 | 9·989790 | 30 | 30 |
| 23 | 32 | 9·331320 | 16 154 | 10·668671 | 9·341552 | 16 161 | 10·658448 | 10·010223 | 16 7 | 9·989777 | 28 | 37 |
| 30 | 34 | 9·331616 | 17 163 | 10·668384 | 9·341853 | 17 171 | 10·658147 | 10·010237 | 17 8 | 9·989763 | 26 | 30 |
| 24 | 36 | 9·331903 | 18 173 | 10·668097 | 9·342155 | 18 181 | 10·657845 | 10·010251 | 18 8 | 9·989749 | 24 | 36 |
| 30 | 38 | 9·332191 | 19 182 | 10·667809 | 9·342456 | 19 191 | 10·657544 | 10·010265 | 19 9 | 9·989735 | 22 | 30 |
| 25 | 40 | 9·332478 | 20 192 | 10·667522 | 9·342757 | 20 201 | 10·657243 | 10·010279 | 20 9 | 9·989721 | 20 | 35 |
| 30 | 42 | 9·332764 | 21 202 | 10·667236 | 9·343057 | 21 211 | 10·656943 | 10·010293 | 21 9 | 9·989707 | 18 | 30 |
| 26 | 44 | 9·333051 | 22 211 | 10·666949 | 9·343358 | 22 221 | 10·656642 | 10·010307 | 22 10 | 9·989693 | 16 | 34 |
| 30 | 46 | 9·333337 | 23 221 | 10·666663 | 9·343658 | 23 231 | 10·656342 | 10·010321 | 23 10 | 9·989679 | 14 | 30 |
| 27 | 48 | 9·333624 | 24 230 | 10·666376 | 9·343958 | 24 241 | 10·656042 | 10·010335 | 24 11 | 9·989665 | 12 | 33 |
| 30 | 50 | 9·333910 | 25 240 | 10·666090 | 9·344258 | 25 252 | 10·655742 | 10·010349 | 25 11 | 9·989651 | 10 | 30 |
| 28 | 52 | 9·334195 | 26 250 | 10·665805 | 9·344558 | 26 262 | 10·655442 | 10·010363 | 26 12 | 9·989637 | 8 | 32 |
| 30 | 54 | 9·334481 | 27 259 | 10·665519 | 9·344858 | 27 272 | 10·655142 | 10·010377 | 27 12 | 9·989623 | 6 | 30 |
| 29 | 56 | 9·334767 | 28 269 | 10·665233 | 9·345157 | 28 282 | 10·654843 | 10·010390 | 28 13 | 9·989610 | 4 | 31 |
| 30 | 58 | 9·335052 | 29 278 | 10·664948 | 9·345456 | 29 292 | 10·654544 | 10·010404 | 29 13 | 9·989596 | 2 | 30 |
| 30 | 50 | 9·335337 | 30 288 | 10·664663 | 9·345755 | 30 302 | 10·654245 | 10·010418 | 30 14 | 9·989582 | 0 | 30 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

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## LOG. SINES, COSINES, &c.

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| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 9·335337 | | 10·664663 | 9·345755 | | 10·654245 | 10·010418 | | 9·989582 | 10 | 30 |
| 30 | 2 | 9·335622 | 1 9 | 10·664378 | 9·346054 | 1″ 10 | 10·653946 | 10·010432 | 1″ 0 | 9·989568 | 58 | 30 |
| 31 | 4 | 9·335906 | 2 19 | 10·664094 | 9·346353 | 2 20 | 10·653647 | 10·010447 | 2 1 | 9·989553 | 56 | 29 |
| 30 | 6 | 9·336191 | 3 28 | 10·663809 | 9·346651 | 3 30 | 10·653349 | 10·010461 | 3 1 | 9·989539 | 54 | 30 |
| 32 | 8 | 9·336475 | 4 38 | 10·663525 | 9·346949 | 4 39 | 10·653051 | 10·010475 | 4 2 | 9·989525 | 52 | 28 |
| 30 | 10 | 9·336759 | 5 47 | 10·663241 | 9·347248 | 5 49 | 10·652752 | 10·010489 | 5 2 | 9·989511 | 50 | 30 |
| 33 | 12 | 9·337043 | 6 56 | 10·662957 | 9·347545 | 6 59 | 10·652455 | 10·010503 | 6 3 | 9·989497 | 48 | 27 |
| 30 | 14 | 9·337326 | 7 66 | 10·662674 | 9·347843 | 7 69 | 10·652157 | 10·010517 | 7 3 | 9·989483 | 46 | 30 |
| 34 | 16 | 9·337610 | 8 75 | 10·662390 | 9·348141 | 8 80 | 10·651859 | 10·010531 | 8 4 | 9·989469 | 44 | 26 |
| 30 | 18 | 9·337893 | 9 85 | 10·662107 | 9·348438 | 9 89 | 10·651562 | 10·010545 | 9 4 | 9·989455 | 42 | 30 |
| 35 | 20 | 9·338176 | 10 94 | 10·661824 | 9·348735 | 10 99 | 10·651265 | 10·010559 | 10 5 | 9·989441 | 40 | 25 |
| 30 | 22 | 9·338459 | 11 103 | 10·661541 | 9·349032 | 11 109 | 10·650968 | 10·010573 | 11 5 | 9·989427 | 38 | 30 |
| 36 | 24 | 9·338742 | 12 113 | 10·661258 | 9·349329 | 12 118 | 10·650671 | 10·010587 | 12 6 | 9·989413 | 36 | 24 |
| 30 | 26 | 9·339024 | 13 122 | 10·660976 | 9·349626 | 13 128 | 10·650374 | 10·010601 | 13 6 | 9·989399 | 34 | 30 |
| 37 | 28 | 9·339307 | 14 132 | 10·660693 | 9·349922 | 14 138 | 10·650078 | 10·010615 | 14 7 | 9·989385 | 32 | 23 |
| 30 | 30 | 9·339589 | 15 141 | 10·660411 | 9·350218 | 15 148 | 10·649782 | 10·010630 | 15 7 | 9·989370 | 30 | 30 |
| 38 | 32 | 9·339871 | 16 150 | 10·660129 | 9·350514 | 16 158 | 10·649486 | 10·010644 | 16 8 | 9·989356 | 28 | 22 |
| 30 | 34 | 9·340152 | 17 160 | 10·659848 | 9·350810 | 17 168 | 10·649190 | 10·010658 | 17 8 | 9·989342 | 26 | 30 |
| 39 | 36 | 9·340434 | 18 169 | 10·659566 | 9·351106 | 18 178 | 10·648894 | 10·010672 | 18 8 | 9·989328 | 24 | 21 |
| 30 | 38 | 9·340715 | 19 179 | 10·659285 | 9·351401 | 19 188 | 10·648599 | 10·010686 | 19 9 | 9·989314 | 22 | 30 |
| 40 | 40 | 9·340996 | 20 188 | 10·659004 | 9·351697 | 20 197 | 10·648303 | 10·010700 | 20 9 | 9·989300 | 20 | 20 |
| 30 | 42 | 9·341277 | 21 197 | 10·658723 | 9·351992 | 21 207 | 10·648008 | 10·010715 | 21 10 | 9·989285 | 18 | 30 |
| 41 | 44 | 9·341558 | 22 207 | 10·658442 | 9·352287 | 22 217 | 10·647713 | 10·010729 | 22 10 | 9·989271 | 16 | 19 |
| 30 | 46 | 9·341839 | 23 216 | 10·658161 | 9·352582 | 23 227 | 10·647418 | 10·010743 | 23 11 | 9·989257 | 14 | 30 |
| 42 | 48 | 9·342119 | 24 226 | 10·657881 | 9·352876 | 24 237 | 10·647124 | 10·010757 | 24 11 | 9·989243 | 12 | 18 |
| 30 | 50 | 9·342399 | 25 235 | 10·657601 | 9·353171 | 25 247 | 10·646829 | 10·010772 | 25 12 | 9·989228 | 10 | 30 |
| 43 | 52 | 9·342679 | 26 244 | 10·657321 | 9·353465 | 26 257 | 10·646535 | 10·010786 | 26 12 | 9·989214 | 8 | 17 |
| 30 | 54 | 9·342959 | 27 254 | 10·657041 | 9·353759 | 27 266 | 10·646241 | 10·010800 | 27 13 | 9·989200 | 6 | 30 |
| 44 | 56 | 9·343239 | 28 263 | 10·656761 | 9·354053 | 28 276 | 10·645947 | 10·010814 | 28 13 | 9·989186 | 4 | 16 |
| 30 | 58 | 9·343518 | 29 273 | 10·656482 | 9·354347 | 29 286 | 10·645653 | 10·010829 | 29 14 | 9·989171 | 2 | 30 |
| 45 | 51 | 9·343797 | 30 282 | 10·656203 | 9·354640 | 30 296 | 10·645360 | 10·010843 | 30 14 | 9·989157 | 9 | 15 |
| 30 | 2 | 9·344076 | 1 9 | 10·655924 | 9·354934 | 1 10 | 10·645066 | 10·010857 | 1 0 | 9·989143 | 58 | 30 |
| 46 | 4 | 9·344355 | 2 18 | 10·655645 | 9·355227 | 2 19 | 10·644773 | 10·010872 | 2 1 | 9·989128 | 56 | 14 |
| 30 | 6 | 9·344634 | 3 28 | 10·655366 | 9·355520 | 3 29 | 10·644480 | 10·010886 | 3 1 | 9·989114 | 54 | 30 |
| 47 | 8 | 9·344912 | 4 37 | 10·655088 | 9·355813 | 4 39 | 10·644187 | 10·010900 | 4 2 | 9·989100 | 52 | 13 |
| 30 | 10 | 9·345191 | 5 46 | 10·654809 | 9·356105 | 5 48 | 10·643895 | 10·010915 | 5 2 | 9·989085 | 50 | 30 |
| 48 | 12 | 9·345469 | 6 55 | 10·654531 | 9·356398 | 6 58 | 10·643602 | 10·010929 | 6 3 | 9·989071 | 48 | 12 |
| 30 | 14 | 9·345747 | 7 64 | 10·654253 | 9·356690 | 7 68 | 10·643310 | 10·010943 | 7 3 | 9·989057 | 46 | 30 |
| 49 | 16 | 9·346024 | 8 73 | 10·653976 | 9·356982 | 8 77 | 10·643018 | 10·010958 | 8 4 | 9·989043 | 44 | 11 |
| 30 | 18 | 9·346302 | 9 83 | 10·653698 | 9·357274 | 9 87 | 10·642726 | 10·010972 | 9 4 | 9·989028 | 42 | 30 |
| 50 | 20 | 9·346579 | 10 92 | 10·653421 | 9·357566 | 10 97 | 10·642434 | 10·010986 | 10 5 | 9·989014 | 40 | 10 |
| 30 | 22 | 9·346857 | 11 101 | 10·653143 | 9·357857 | 11 106 | 10·642143 | 10·011001 | 11 5 | 9·988999 | 38 | 30 |
| 51 | 24 | 9·347134 | 12 111 | 10·652866 | 9·358149 | 12 116 | 10·641851 | 10·011015 | 12 6 | 9·988985 | 36 | 9 |
| 30 | 26 | 9·347410 | 13 120 | 10·652590 | 9·358440 | 13 126 | 10·641560 | 10·011030 | 13 6 | 9·988970 | 34 | 30 |
| 52 | 28 | 9·347687 | 14 129 | 10·652313 | 9·358731 | 14 135 | 10·641269 | 10·011044 | 14 7 | 9·988956 | 32 | 8 |
| 30 | 30 | 9·347963 | 15 138 | 10·652037 | 9·359022 | 15 145 | 10·640978 | 10·011058 | 15 7 | 9·988942 | 30 | 30 |
| 53 | 32 | 9·348240 | 16 147 | 10·651760 | 9·359313 | 16 155 | 10·640687 | 10·011073 | 16 8 | 9·988927 | 28 | 7 |
| 30 | 34 | 9·348516 | 17 157 | 10·651484 | 9·359603 | 17 164 | 10·640397 | 10·011087 | 17 8 | 9·988913 | 26 | 30 |
| 54 | 36 | 9·348792 | 18 166 | 10·651208 | 9·359893 | 18 174 | 10·640107 | 10·011102 | 18 9 | 9·988898 | 24 | 6 |
| 30 | 38 | 9·349067 | 19 175 | 10·650933 | 9·360184 | 19 184 | 10·639816 | 10·011116 | 19 9 | 9·988884 | 22 | 30 |
| 55 | 40 | 9·349343 | 20 184 | 10·650657 | 9·360474 | 20 193 | 10·639526 | 10·011131 | 20 10 | 9·988869 | 20 | 5 |
| 30 | 42 | 9·349618 | 21 193 | 10·650382 | 9·360763 | 21 203 | 10·639237 | 10·011145 | 21 10 | 9·988855 | 18 | 30 |
| 56 | 44 | 9·349893 | 22 203 | 10·650107 | 9·361053 | 22 213 | 10·638947 | 10·011160 | 22 11 | 9·988840 | 16 | 4 |
| 30 | 46 | 9·350168 | 23 212 | 10·649832 | 9·361343 | 23 222 | 10·638657 | 10·011174 | 23 11 | 9·988826 | 14 | 30 |
| 57 | 48 | 9·350443 | 24 221 | 10·649557 | 9·361632 | 24 232 | 10·638368 | 10·011189 | 24 12 | 9·988811 | 12 | 3 |
| 30 | 50 | 9·350718 | 25 230 | 10·649282 | 9·361921 | 25 242 | 10·638079 | 10·011203 | 25 12 | 9·988797 | 10 | 30 |
| 58 | 52 | 9·350992 | 26 239 | 10·649008 | 9·362210 | 26 251 | 10·637790 | 10·011218 | 26 12 | 9·988782 | 8 | 2 |
| 30 | 54 | 9·351266 | 27 249 | 10·648734 | 9·362499 | 27 261 | 10·637501 | 10·011232 | 27 13 | 9·988768 | 6 | 30 |
| 59 | 56 | 9·351540 | 28 258 | 10·648460 | 9·362787 | 28 271 | 10·637213 | 10·011247 | 28 13 | 9·988753 | 4 | 1 |
| 30 | 58 | 9·351814 | 29 267 | 10·648186 | 9·363076 | 29 280 | 10·636924 | 10·011261 | 29 14 | 9·988739 | 2 | 30 |
| 60 | 52 | 9·352088 | 30 276 | 10·647912 | 9·363364 | 30 290 | 10·636636 | 10·011276 | 30 14 | 9·988724 | 0 | 0 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

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| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 9·352088 | | 10·647912 | 9·363364 | | 10·636636 | 10·011276 | | 9·988724 | 8 | 60 |
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| 1 | 4 | 9·352635 | 2 18 | 10·647365 | 9·363940 | 2 19 | 10·636060 | 10·011305 | 2 1 | 9·988695 | 56 | 59 |
| 30 | 6 | 9·352908 | 3 27 | 10·647092 | 9·364228 | 3 29 | 10·635772 | 10·011320 | 3 1 | 9·988680 | 54 | 30 |
| 2 | 8 | 9·353181 | 4 36 | 10·646819 | 9·364515 | 4 38 | 10·635485 | 10·011334 | 4 2 | 9·988666 | 52 | 58 |
| 30 | 10 | 9·353454 | 5 45 | 10·646546 | 9·364803 | 5 48 | 10·635197 | 10·011349 | 5 2 | 9·988651 | 50 | 30 |
| 3 | 12 | 9·353726 | 6 54 | 10·646274 | 9·365090 | 6 57 | 10·634910 | 10·011364 | 6 3 | 9·988636 | 48 | 57 |
| 30 | 14 | 9·353999 | 7 63 | 10·646001 | 9·365377 | 7 67 | 10·634623 | 10·011378 | 7 3 | 9·988622 | 46 | 30 |
| 4 | 16 | 9·354271 | 8 72 | 10·645729 | 9·365664 | 8 76 | 10·634336 | 10·011393 | 8 4 | 9·988607 | 44 | 56 |
| 30 | 18 | 9·354543 | 9 81 | 10·645457 | 9·365951 | 9 86 | 10·634049 | 10·011408 | 9 4 | 9·988592 | 42 | 30 |
| 5 | 20 | 9·354815 | 10 90 | 10·645185 | 9·366237 | 10 95 | 10·633763 | 10·011422 | 10 5 | 9·988578 | 40 | 55 |
| 30 | 22 | 9·355087 | 11 99 | 10·644913 | 9·366524 | 11 105 | 10·633476 | 10·011437 | 11 5 | 9·988563 | 38 | 30 |
| 6 | 24 | 9·355358 | 12 108 | 10·644642 | 9·366810 | 12 114 | 10·633190 | 10·011452 | 12 6 | 9·988548 | 36 | 54 |
| 30 | 26 | 9·355630 | 13 117 | 10·644370 | 9·367096 | 13 124 | 10·632904 | 10·011466 | 13 6 | 9·988534 | 34 | 30 |
| 7 | 28 | 9·355901 | 14 126 | 10·644099 | 9·367382 | 14 133 | 10·632618 | 10·011481 | 14 7 | 9·988519 | 32 | 53 |
| 30 | 30 | 9·356172 | 15 135 | 10·643828 | 9·367668 | 15 143 | 10·632332 | 10·011496 | 15 7 | 9·988504 | 30 | 30 |
| 8 | 32 | 9·356443 | 16 144 | 10·643557 | 9·367953 | 16 152 | 10·632047 | 10·011511 | 16 8 | 9·988489 | 28 | 52 |
| 30 | 34 | 9·356713 | 17 153 | 10·643287 | 9·368239 | 17 162 | 10·631761 | 10·011525 | 17 8 | 9·988475 | 26 | 30 |
| 9 | 36 | 9·356984 | 18 162 | 10·643016 | 9·368524 | 18 171 | 10·631476 | 10·011540 | 18 9 | 9·988460 | 24 | 51 |
| 30 | 38 | 9·357254 | 19 171 | 10·642746 | 9·368809 | 19 181 | 10·631191 | 10·011555 | 19 9 | 9·988445 | 22 | 30 |
| 10 | 40 | 9·357524 | 20 181 | 10·642476 | 9·369094 | 20 190 | 10·630906 | 10·011570 | 20 10 | 9·988430 | 20 | 50 |
| 30 | 42 | 9·357794 | 21 190 | 10·642206 | 9·369378 | 21 200 | 10·630622 | 10·011584 | 21 10 | 9·988416 | 18 | 30 |
| 11 | 44 | 9·358064 | 22 199 | 10·641936 | 9·369663 | 22 209 | 10·630337 | 10·011599 | 22 11 | 9·988401 | 16 | 49 |
| 30 | 46 | 9·358333 | 23 208 | 10·641667 | 9·369947 | 23 219 | 10·630053 | 10·011614 | 23 11 | 9·988386 | 14 | 30 |
| 12 | 48 | 9·358603 | 24 217 | 10·641397 | 9·370232 | 24 228 | 10·629768 | 10·011629 | 24 12 | 9·988371 | 12 | 48 |
| 30 | 50 | 9·358872 | 25 226 | 10·641128 | 9·370516 | 25 238 | 10·629484 | 10·011644 | 25 12 | 9·988356 | 10 | 30 |
| 13 | 52 | 9·359141 | 26 235 | 10·640859 | 9·370799 | 26 248 | 10·629201 | 10·011658 | 26 13 | 9·988342 | 8 | 47 |
| 30 | 54 | 9·359410 | 27 244 | 10·640590 | 9·371083 | 27 257 | 10·628917 | 10·011673 | 27 13 | 9·988327 | 6 | 30 |
| 14 | 56 | 9·359678 | 28 253 | 10·640322 | 9·371367 | 28 267 | 10·628633 | 10·011688 | 28 14 | 9·988312 | 4 | 46 |
| 30 | 58 | 9·359947 | 29 262 | 10·640053 | 9·371650 | 29 276 | 10·628350 | 10·011703 | 29 14 | 9·988297 | 2 | 30 |
| 15 | **53** | 9·360215 | 30 271 | 10·639785 | 9·371933 | 30 286 | 10·628067 | 10·011718 | 30 15 | 9·988282 | **7** | 45 |
| 30 | 2 | 9·360484 | 1 9 | 10·639516 | 9·372216 | 1 10 | 10·627784 | 10·011733 | 1 0 | 9·988267 | 58 | 30 |
| 16 | 4 | 9·360752 | 2 18 | 10·639248 | 9·372499 | 2 19 | 10·627501 | 10·011748 | 2 1 | 9·988252 | 56 | 44 |
| 30 | 6 | 9·361019 | 3 26 | 10·638981 | 9·372782 | 3 28 | 10·627218 | 10·011763 | 3 1 | 9·988237 | 54 | 30 |
| 17 | 8 | 9·361287 | 4 35 | 10·638713 | 9·373064 | 4 37 | 10·626936 | 10·011777 | 4 2 | 9·988223 | 52 | 43 |
| 30 | 10 | 9·361554 | 5 44 | 10·638446 | 9·373347 | 5 47 | 10·626653 | 10·011792 | 5 2 | 9·988208 | 50 | 30 |
| 18 | 12 | 9·361822 | 6 53 | 10·638178 | 9·373629 | 6 56 | 10·626371 | 10·011807 | 6 3 | 9·988193 | 48 | 42 |
| 30 | 14 | 9·362089 | 7 62 | 10·637911 | 9·373911 | 7 65 | 10·626089 | 10·011822 | 7 3 | 9·988178 | 46 | 30 |
| 19 | 16 | 9·362356 | 8 70 | 10·637644 | 9·374193 | 8 75 | 10·625807 | 10·011837 | 8 4 | 9·988163 | 44 | 41 |
| 30 | 18 | 9·362623 | 9 79 | 10·637377 | 9·374475 | 9 84 | 10·625525 | 10·011852 | 9 4 | 9·988148 | 42 | 30 |
| 20 | 20 | 9·362889 | 10 88 | 10·637111 | 9·374756 | 10 93 | 10·625244 | 10·011867 | 10 5 | 9·988133 | 40 | 40 |
| 30 | 22 | 9·363156 | 11 97 | 10·636844 | 9·375038 | 11 103 | 10·624962 | 10·011882 | 11 5 | 9·988118 | 38 | 30 |
| 21 | 24 | 9·363422 | 12 106 | 10·636578 | 9·375319 | 12 112 | 10·624681 | 10·011897 | 12 6 | 9·988103 | 36 | 39 |
| 30 | 26 | 9·363688 | 13 115 | 10·636312 | 9·375600 | 13 122 | 10·624400 | 10·011912 | 13 6 | 9·988088 | 34 | 30 |
| 22 | 28 | 9·363954 | 14 124 | 10·636046 | 9·375881 | 14 131 | 10·624119 | 10·011927 | 14 7 | 9·988073 | 32 | 38 |
| 30 | 30 | 9·364220 | 15 133 | 10·635780 | 9·376162 | 15 140 | 10·623838 | 10·011942 | 15 7 | 9·988058 | 30 | 30 |
| 23 | 32 | 9·364485 | 16 142 | 10·635515 | 9·376442 | 16 150 | 10·623558 | 10·011957 | 16 8 | 9·988043 | 28 | 37 |
| 30 | 34 | 9·364751 | 17 151 | 10·635249 | 9·376723 | 17 158 | 10·623277 | 10·011972 | 17 8 | 9·988028 | 26 | 30 |
| 24 | 36 | 9·365016 | 18 159 | 10·634984 | 9·377003 | 18 168 | 10·622997 | 10·011987 | 18 9 | 9·988013 | 24 | 36 |
| 30 | 38 | 9·365281 | 19 168 | 10·634719 | 9·377283 | 19 178 | 10·622717 | 10·012002 | 19 9 | 9·987998 | 22 | 30 |
| 25 | 40 | 9·365546 | 20 177 | 10·634454 | 9·377563 | 20 187 | 10·622437 | 10·012017 | 20 10 | 9·987983 | 20 | 35 |
| 30 | 42 | 9·365810 | 21 186 | 10·634190 | 9·377843 | 21 196 | 10·622157 | 10·012032 | 21 10 | 9·987968 | 18 | 30 |
| 26 | 44 | 9·366075 | 22 195 | 10·633925 | 9·378122 | 22 206 | 10·621878 | 10·012047 | 22 11 | 9·987953 | 16 | 34 |
| 30 | 46 | 9·366339 | 23 203 | 10·633661 | 9·378402 | 23 215 | 10·621598 | 10·012063 | 23 11 | 9·987937 | 14 | 30 |
| 27 | 48 | 9·366604 | 24 212 | 10·633396 | 9·378681 | 24 224 | 10·621319 | 10·012078 | 24 12 | 9·987922 | 12 | 33 |
| 30 | 50 | 9·366868 | 25 221 | 10·633132 | 9·378960 | 25 234 | 10·621040 | 10·012093 | 25 12 | 9·987907 | 10 | 30 |
| 28 | 52 | 9·367131 | 26 230 | 10·632869 | 9·379239 | 26 243 | 10·620761 | 10·012108 | 26 13 | 9·987892 | 8 | 32 |
| 30 | 54 | 9·367395 | 27 239 | 10·632605 | 9·379518 | 27 252 | 10·620482 | 10·012123 | 27 13 | 9·987877 | 6 | 30 |
| 29 | 56 | 9·367659 | 28 248 | 10·632341 | 9·379797 | 28 262 | 10·620203 | 10·012138 | 28 14 | 9·987862 | 4 | 31 |
| 30 | 58 | 9·367922 | 29 257 | 10·632078 | 9·380075 | 29 271 | 10·619925 | 10·012153 | 29 14 | 9·987847 | 2 | 30 |
| 30 | **54** | 9·368185 | 30 264 | 10·631815 | 9·380354 | 30 280 | 10·619646 | 10·012168 | 30 15 | 9·987832 | 0 | 30 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

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## LOG. SINES, COSINES, &c.

$0^h\ 54^m$ — 13°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 9·368185 | | 10·631815 | 9·380354 | | 10·619646 | 10·012168 | | 9·987832 | 6 | 30 |
| 30 | 2 | 9·368448 | 1″ 9 | 10·631552 | 9·380632 | 1″ 9 | 10·619368 | 10·012184 | 1″ 1 | 9·987816 | 58 | 30 |
| 31 | 4 | 9·368711 | 2 17 | 10·631289 | 9·380910 | 2 18 | 10·619090 | 10·012199 | 2 1 | 9·987801 | 56 | 29 |
| 30 | 6 | 9·368974 | 3 26 | 10·631026 | 9·381188 | 3 28 | 10·618812 | 10·012214 | 3 2 | 9·987786 | 54 | 30 |
| 32 | 8 | 9·369236 | 4 35 | 10·630764 | 9·381466 | 4 37 | 10·618534 | 10·012229 | 4 2 | 9·987771 | 52 | 28 |
| 30 | 10 | 9·369499 | 5 43 | 10·630501 | 9·381743 | 5 46 | 10·618257 | 10·012244 | 5 3 | 9·987756 | 50 | 30 |
| 33 | 12 | 9·369761 | 6 52 | 10·630239 | 9·382020 | 6 55 | 10·617980 | 10·012260 | 6 3 | 9·987740 | 48 | 27 |
| 30 | 14 | 9·370023 | 7 61 | 10·629977 | 9·382298 | 7 64 | 10·617702 | 10·012275 | 7 4 | 9·987725 | 46 | 30 |
| 34 | 16 | 9·370285 | 8 70 | 10·629715 | 9·382575 | 8 74 | 10·617425 | 10·012290 | 8 4 | 9·987710 | 44 | 26 |
| 30 | 18 | 9·370546 | 9 78 | 10·629454 | 9·382852 | 9 83 | 10·617148 | 10·012305 | 9 5 | 9·987695 | 42 | 30 |
| 35 | 20 | 9·370808 | 10 87 | 10·629192 | 9·383129 | 10 92 | 10·616871 | 10·012321 | 10 5 | 9·987679 | 40 | 25 |
| 30 | 22 | 9·371069 | 11 95 | 10·628931 | 9·383405 | 11 101 | 10·616595 | 10·012336 | 11 6 | 9·987664 | 38 | 30 |
| 36 | 24 | 9·371330 | 12 104 | 10·628670 | 9·383682 | 12 110 | 10·616318 | 10·012351 | 12 6 | 9·987649 | 36 | 24 |
| 30 | 26 | 9·371591 | 13 113 | 10·628409 | 9·383958 | 13 120 | 10·616042 | 10·012366 | 13 7 | 9·987634 | 34 | 30 |
| 37 | 28 | 9·371852 | 14 122 | 10·628148 | 9·384234 | 14 129 | 10·615766 | 10·012382 | 14 7 | 9·987618 | 32 | 23 |
| 30 | 30 | 9·372113 | 15 130 | 10·627887 | 9·384510 | 15 138 | 10·615490 | 10·012397 | 15 8 | 9·987603 | 30 | 30 |
| 38 | 32 | 9·372373 | 16 139 | 10·627627 | 9·384786 | 16 147 | 10·615214 | 10·012412 | 16 8 | 9·987588 | 28 | 22 |
| 30 | 34 | 9·372634 | 17 148 | 10·627366 | 9·385062 | 17 156 | 10·614938 | 10·012428 | 17 9 | 9·987572 | 26 | 30 |
| 39 | 36 | 9·372894 | 18 156 | 10·627106 | 9·385337 | 18 166 | 10·614663 | 10·012443 | 18 9 | 9·987557 | 24 | 21 |
| 30 | 38 | 9·373154 | 19 165 | 10·626846 | 9·385612 | 19 175 | 10·614388 | 10·012458 | 19 10 | 9·987542 | 22 | 30 |
| 40 | 40 | 9·373414 | 20 174 | 10·626586 | 9·385888 | 20 184 | 10·614112 | 10·012474 | 20 10 | 9·987526 | 20 | 20 |
| 30 | 42 | 9·373674 | 21 182 | 10·626326 | 9·386163 | 21 193 | 10·613837 | 10·012489 | 21 11 | 9·987511 | 18 | 30 |
| 41 | 44 | 9·373933 | 22 191 | 10·626067 | 9·386438 | 22 202 | 10·613562 | 10·012504 | 22 11 | 9·987496 | 16 | 19 |
| 30 | 46 | 9·374192 | 23 200 | 10·625808 | 9·386712 | 23 212 | 10·613288 | 10·012520 | 23 12 | 9·987480 | 14 | 30 |
| 42 | 48 | 9·374452 | 24 208 | 10·625548 | 9·386987 | 24 221 | 10·613013 | 10·012535 | 24 12 | 9·987465 | 12 | 18 |
| 30 | 50 | 9·374711 | 25 217 | 10·625289 | 9·387261 | 25 230 | 10·612739 | 10·012551 | 25 13 | 9·987449 | 10 | 30 |
| 43 | 52 | 9·374970 | 26 226 | 10·625030 | 9·387536 | 26 239 | 10·612464 | 10·012566 | 26 13 | 9·987434 | 8 | 17 |
| 30 | 54 | 9·375228 | 27 235 | 10·624772 | 9·387810 | 27 248 | 10·612190 | 10·012581 | 27 14 | 9·987419 | 6 | 30 |
| 44 | 56 | 9·375487 | 28 243 | 10·624513 | 9·388084 | 28 258 | 10·611916 | 10·012597 | 28 14 | 9·987403 | 4 | 16 |
| 30 | 58 | 9·375745 | 29 252 | 10·624255 | 9·388358 | 29 267 | 10·611642 | 10·012612 | 29 15 | 9·987388 | 2 | 30 |
| 45 | 55 | 9·376003 | 30 261 | 10·623997 | 9·388631 | 30 276 | 10·611369 | 10·012628 | 30 15 | 9·987372 | 5 | 15 |
| 30 | 2 | 9·376261 | 1 8 | 10·623739 | 9·388905 | 1 9 | 10·611095 | 10·012643 | 1 1 | 9·987357 | 58 | 30 |
| 46 | 4 | 9·376519 | 2 17 | 10·623481 | 9·389178 | 2 18 | 10·610822 | 10·012659 | 2 1 | 9·987341 | 56 | 14 |
| 30 | 6 | 9·376777 | 3 25 | 10·623223 | 9·389451 | 3 27 | 10·610549 | 10·012674 | 3 2 | 9·987326 | 54 | 30 |
| 47 | 8 | 9·377035 | 4 34 | 10·622965 | 9·389724 | 4 36 | 10·610276 | 10·012690 | 4 2 | 9·987310 | 52 | 13 |
| 30 | 10 | 9·377292 | 5 42 | 10·622708 | 9·389997 | 5 45 | 10·610003 | 10·012705 | 5 3 | 9·987295 | 50 | 30 |
| 48 | 12 | 9·377549 | 6 51 | 10·622451 | 9·390270 | 6 54 | 10·609730 | 10·012721 | 6 3 | 9·987279 | 48 | 12 |
| 30 | 14 | 9·377806 | 7 59 | 10·622194 | 9·390543 | 7 63 | 10·609457 | 10·012736 | 7 4 | 9·987264 | 46 | 30 |
| 49 | 16 | 9·378063 | 8 68 | 10·621937 | 9·390815 | 8 72 | 10·609185 | 10·012752 | 8 4 | 9·987248 | 44 | 11 |
| 30 | 18 | 9·378320 | 9 76 | 10·621680 | 9·391087 | 9 81 | 10·608913 | 10·012767 | 9 5 | 9·987233 | 42 | 30 |
| 50 | 20 | 9·378577 | 10 85 | 10·621423 | 9·391360 | 10 90 | 10·608640 | 10·012783 | 10 5 | 9·987217 | 40 | 10 |
| 30 | 22 | 9·378833 | 11 94 | 10·621167 | 9·391632 | 11 99 | 10·608368 | 10·012798 | 11 6 | 9·987202 | 38 | 30 |
| 51 | 24 | 9·379089 | 12 102 | 10·620911 | 9·391903 | 12 108 | 10·608097 | 10·012814 | 12 6 | 9·987186 | 36 | 9 |
| 30 | 26 | 9·379346 | 13 111 | 10·620654 | 9·392175 | 13 118 | 10·607825 | 10·012830 | 13 7 | 9·987170 | 34 | 30 |
| 52 | 28 | 9·379601 | 14 119 | 10·620399 | 9·392447 | 14 127 | 10·607553 | 10·012845 | 14 7 | 9·987155 | 32 | 8 |
| 30 | 30 | 9·379857 | 15 128 | 10·620143 | 9·392718 | 15 136 | 10·607282 | 10·012861 | 15 8 | 9·987139 | 30 | 30 |
| 53 | 32 | 9·380113 | 16 136 | 10·619887 | 9·392989 | 16 145 | 10·607011 | 10·012876 | 16 8 | 9·987124 | 28 | 7 |
| 30 | 34 | 9·380368 | 17 145 | 10·619632 | 9·393260 | 17 154 | 10·606740 | 10·012892 | 17 9 | 9·987108 | 26 | 30 |
| 54 | 36 | 9·380624 | 18 153 | 10·619376 | 9·393531 | 18 163 | 10·606469 | 10·012908 | 18 9 | 9·987092 | 24 | 6 |
| 30 | 38 | 9·380879 | 19 162 | 10·619121 | 9·393802 | 19 172 | 10·606198 | 10·012923 | 19 10 | 9·987077 | 22 | 30 |
| 55 | 40 | 9·381134 | 20 170 | 10·618866 | 9·394073 | 20 181 | 10·605927 | 10·012939 | 20 10 | 9·987061 | 20 | 5 |
| 30 | 42 | 9·381389 | 21 179 | 10·618611 | 9·394343 | 21 190 | 10·605657 | 10·012955 | 21 11 | 9·987045 | 18 | 30 |
| 56 | 44 | 9·381643 | 22 187 | 10·618357 | 9·394614 | 22 199 | 10·605386 | 10·012970 | 22 11 | 9·987030 | 16 | 4 |
| 30 | 46 | 9·381898 | 23 196 | 10·618102 | 9·394884 | 23 208 | 10·605116 | 10·012986 | 23 12 | 9·987014 | 14 | 30 |
| 57 | 48 | 9·382152 | 24 204 | 10·617848 | 9·395154 | 24 217 | 10·604846 | 10·013002 | 24 12 | 9·986998 | 12 | 3 |
| 30 | 50 | 9·382406 | 25 213 | 10·617594 | 9·395424 | 25 226 | 10·604576 | 10·013017 | 25 13 | 9·986983 | 10 | 30 |
| 58 | 52 | 9·382661 | 26 222 | 10·617339 | 9·395694 | 26 235 | 10·604306 | 10·013033 | 26 14 | 9·986967 | 8 | 2 |
| 30 | 54 | 9·382914 | 27 230 | 10·617086 | 9·395963 | 27 244 | 10·604037 | 10·013049 | 27 14 | 9·986951 | 6 | 30 |
| 59 | 56 | 9·383168 | 28 239 | 10·616832 | 9·396233 | 28 253 | 10·603767 | 10·013064 | 28 15 | 9·986936 | 4 | 1 |
| 30 | 58 | 9·383422 | 29 247 | 10·616578 | 9·396502 | 29 262 | 10·603498 | 10·013080 | 29 15 | 9·986920 | 2 | 30 |
| 60 | 56 | 9·383675 | 30 256 | 10·616325 | 9·396771 | 30 271 | 10·603229 | 10·013096 | 30 16 | 9·986904 | 0 | 0 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

76° — $5^h\ 4^m$

## LOG. SINES, COSINES, &c.

0h 56m — 14°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 9·383675 | | 10·616325 | 9·396771 | | 10·603229 | 10·013096 | | 9·986904 | 4 | 60 |
| 30 | 2 | 9·383928 | 1″ 8 | 10·616072 | 9·397040 | 1″ 9 | 10·602960 | 10·013112 | 1″ 1 | 9·986888 | 58 | 30 |
| 1 | 4 | 9·384182 | 2 17 | 10·615818 | 9·397309 | 2 18 | 10·602691 | 10·013127 | 2 1 | 9·986873 | 56 | 59 |
| 30 | 6 | 9·384435 | 3 25 | 10·615565 | 9·397578 | 3 27 | 10·602422 | 10·013143 | 3 2 | 9·986857 | 54 | 30 |
| 2 | 8 | 9·384687 | 4 33 | 10·615313 | 9·397846 | 4 36 | 10·602154 | 10·013159 | 4 2 | 9·986841 | 52 | 58 |
| 30 | 10 | 9·384940 | 5 42 | 10·615060 | 9·398115 | 5 44 | 10·601885 | 10·013175 | 5 3 | 9·986825 | 50 | 30 |
| 3 | 12 | 9·385192 | 6 50 | 10·614808 | 9·398383 | 6 53 | 10·601617 | 10·013191 | 6 3 | 9·986809 | 48 | 57 |
| 30 | 14 | 9·385445 | 7 59 | 10·614555 | 9·398651 | 7 62 | 10·601349 | 10·013206 | 7 4 | 9·986794 | 46 | 30 |
| 4 | 16 | 9·385697 | 8 67 | 10·614303 | 9·398919 | 8 71 | 10·601081 | 10·013222 | 8 4 | 9·986778 | 44 | 56 |
| 30 | 18 | 9·385949 | 9 75 | 10·614051 | 9·399187 | 9 80 | 10·600813 | 10·013238 | 9 5 | 9·986762 | 42 | 30 |
| 5 | 20 | 9·386201 | 10 84 | 10·613799 | 9·399455 | 10 89 | 10·600545 | 10·013254 | 10 5 | 9·986746 | 40 | 55 |
| 30 | 22 | 9·386452 | 11 92 | 10·613548 | 9·399722 | 11 98 | 10·600278 | 10·013270 | 11 6 | 9·986730 | 38 | 30 |
| 6 | 24 | 9·386704 | 12 100 | 10·613296 | 9·399990 | 12 107 | 10·600010 | 10·013286 | 12 6 | 9·986714 | 36 | 54 |
| 30 | 26 | 9·386955 | 13 109 | 10·613045 | 9·400257 | 13 116 | 10·599743 | 10·013301 | 13 7 | 9·986699 | 34 | 30 |
| 7 | 28 | 9·387207 | 14 118 | 10·612793 | 9·400524 | 14 125 | 10·599476 | 10·013317 | 14 7 | 9·986683 | 32 | 53 |
| 30 | 30 | 9·387458 | 15 126 | 10·612542 | 9·400791 | 15 133 | 10·599209 | 10·013333 | 15 8 | 9·986667 | 30 | 30 |
| 8 | 32 | 9·387709 | 16 134 | 10·612291 | 9·401058 | 16 142 | 10·598942 | 10·013349 | 16 8 | 9·986651 | 28 | 52 |
| 30 | 34 | 9·387959 | 17 142 | 10·612041 | 9·401325 | 17 151 | 10·598675 | 10·013365 | 17 9 | 9·986635 | 26 | 30 |
| 9 | 36 | 9·388210 | 18 150 | 10·611790 | 9·401591 | 18 160 | 10·598409 | 10·013381 | 18 10 | 9·986619 | 24 | 51 |
| 30 | 38 | 9·388461 | 19 159 | 10·611539 | 9·401857 | 19 169 | 10·598143 | 10·013397 | 19 10 | 9·986603 | 22 | 30 |
| 10 | 40 | 9·388711 | 20 167 | 10·611289 | 9·402124 | 20 178 | 10·597876 | 10·013413 | 20 11 | 9·986587 | 20 | 50 |
| 30 | 42 | 9·388961 | 21 176 | 10·611039 | 9·402390 | 21 187 | 10·597610 | 10·013429 | 21 11 | 9·986571 | 18 | 30 |
| 11 | 44 | 9·389211 | 22 184 | 10·610789 | 9·402656 | 22 196 | 10·597344 | 10·013445 | 22 12 | 9·986555 | 16 | 49 |
| 30 | 46 | 9·389461 | 23 192 | 10·610539 | 9·402922 | 23 205 | 10·597078 | 10·013461 | 23 12 | 9·986539 | 14 | 30 |
| 12 | 48 | 9·389711 | 24 201 | 10·610289 | 9·403187 | 24 214 | 10·596813 | 10·013477 | 24 13 | 9·986523 | 12 | 48 |
| 30 | 50 | 9·389960 | 25 209 | 10·610040 | 9·403453 | 25 222 | 10·596547 | 10·013493 | 25 13 | 9·986507 | 10 | 30 |
| 13 | 52 | 9·390210 | 26 218 | 10·609790 | 9·403718 | 26 231 | 10·596282 | 10·013509 | 26 14 | 9·986491 | 8 | 47 |
| 30 | 54 | 9·390459 | 27 227 | 10·609541 | 9·403983 | 27 240 | 10·596017 | 10·013525 | 27 14 | 9·986475 | 6 | 30 |
| 14 | 56 | 9·390708 | 28 236 | 10·609292 | 9·404249 | 28 249 | 10·595751 | 10·013541 | 28 15 | 9·986459 | 4 | 46 |
| 30 | 58 | 9·390957 | 29 244 | 10·609043 | 9·404514 | 29 258 | 10·595486 | 10·013557 | 29 15 | 9·986443 | 2 | 30 |
| 15 | 57 | 9·391206 | 30 251 | 10·608794 | 9·404778 | 30 267 | 10·595222 | 10·013573 | 30 16 | 9·986427 | 3 | 45 |
| 30 | 2 | 9·391454 | 1 8 | 10·608546 | 9·405043 | 1 9 | 10·594957 | 10·013589 | 1 1 | 9·986411 | 58 | 30 |
| 16 | 4 | 9·391703 | 2 16 | 10·608297 | 9·405308 | 2 17 | 10·594692 | 10·013605 | 2 1 | 9·986395 | 56 | 44 |
| 30 | 6 | 9·391951 | 3 25 | 10·608049 | 9·405572 | 3 26 | 10·594428 | 10·013621 | 3 2 | 9·986379 | 54 | 30 |
| 17 | 8 | 9·392199 | 4 33 | 10·607801 | 9·405836 | 4 35 | 10·594164 | 10·013637 | 4 2 | 9·986363 | 52 | 43 |
| 30 | 10 | 9·392447 | 5 41 | 10·607553 | 9·406100 | 5 44 | 10·593900 | 10·013653 | 5 3 | 9·986347 | 50 | 30 |
| 18 | 12 | 9·392695 | 6 49 | 10·607305 | 9·406364 | 6 52 | 10·593636 | 10·013669 | 6 3 | 9·986331 | 48 | 42 |
| 30 | 14 | 9·392943 | 7 57 | 10·607057 | 9·406628 | 7 61 | 10·593372 | 10·013685 | 7 4 | 9·986315 | 46 | 30 |
| 19 | 16 | 9·393191 | 8 66 | 10·606809 | 9·406892 | 8 70 | 10·593108 | 10·013701 | 8 4 | 9·986299 | 44 | 41 |
| 30 | 18 | 9·393438 | 9 74 | 10·606562 | 9·407155 | 9 79 | 10·592845 | 10·013718 | 9 5 | 9·986282 | 42 | 30 |
| 20 | 20 | 9·393685 | 10 82 | 10·606315 | 9·407419 | 10 87 | 10·592581 | 10·013734 | 10 5 | 9·986266 | 40 | 40 |
| 30 | 22 | 9·393932 | 11 90 | 10·606058 | 9·407682 | 11 96 | 10·592318 | 10·013750 | 11 6 | 9·986250 | 38 | 30 |
| 21 | 24 | 9·394179 | 12 98 | 10·605821 | 9·407945 | 12 105 | 10·592055 | 10·013766 | 12 6 | 9·986234 | 36 | 39 |
| 30 | 26 | 9·394426 | 13 106 | 10·605574 | 9·408208 | 13 114 | 10·591792 | 10·013782 | 13 7 | 9·986218 | 34 | 30 |
| 22 | 28 | 9·394673 | 14 114 | 10·605327 | 9·408471 | 14 122 | 10·591529 | 10·013798 | 14 8 | 9·986202 | 32 | 38 |
| 30 | 30 | 9·394919 | 15 123 | 10·605081 | 9·408734 | 15 131 | 10·591266 | 10·013814 | 15 8 | 9·986186 | 30 | 30 |
| 23 | 32 | 9·395166 | 16 132 | 10·604834 | 9·408996 | 16 140 | 10·591004 | 10·013831 | 16 9 | 9·986169 | 28 | 37 |
| 30 | 34 | 9·395412 | 17 140 | 10·604588 | 9·409259 | 17 149 | 10·590741 | 10·013847 | 17 9 | 9·986153 | 26 | 30 |
| 24 | 36 | 9·395658 | 18 148 | 10·604342 | 9·409521 | 18 157 | 10·590479 | 10·013863 | 18 10 | 9·986137 | 24 | 36 |
| 30 | 38 | 9·395904 | 19 156 | 10·604096 | 9·409783 | 19 166 | 10·590217 | 10·013879 | 19 10 | 9·986121 | 22 | 30 |
| 25 | 40 | 9·396150 | 20 164 | 10·603850 | 9·410045 | 20 175 | 10·589955 | 10·013896 | 20 11 | 9·986104 | 20 | 35 |
| 30 | 42 | 9·396395 | 21 172 | 10·603605 | 9·410307 | 21 184 | 10·589693 | 10·013912 | 21 11 | 9·986088 | 18 | 30 |
| 26 | 44 | 9·396641 | 22 180 | 10·603359 | 9·410569 | 22 192 | 10·589431 | 10·013928 | 22 12 | 9·986072 | 16 | 34 |
| 30 | 46 | 9·396886 | 23 189 | 10·603114 | 9·410831 | 23 201 | 10·589169 | 10·013944 | 23 12 | 9·986056 | 14 | 30 |
| 27 | 48 | 9·397132 | 24 197 | 10·602868 | 9·411092 | 24 210 | 10·588908 | 10·013961 | 24 13 | 9·986039 | 12 | 33 |
| 30 | 50 | 9·397377 | 25 205 | 10·602623 | 9·411353 | 25 219 | 10·588647 | 10·013977 | 25 13 | 9·986023 | 10 | 30 |
| 28 | 52 | 9·397621 | 26 213 | 10·602379 | 9·411615 | 26 227 | 10·588385 | 10·013993 | 26 14 | 9·986007 | 8 | 32 |
| 30 | 54 | 9·397866 | 27 221 | 10·602134 | 9·411876 | 27 236 | 10·588124 | 10·014009 | 27 15 | 9·985991 | 6 | 30 |
| 29 | 56 | 9·398111 | 28 229 | 10·601889 | 9·412137 | 28 245 | 10·587863 | 10·014026 | 28 15 | 9·985974 | 4 | 31 |
| 30 | 58 | 9·398355 | 29 237 | 10·601645 | 9·412397 | 29 254 | 10·587603 | 10·014042 | 29 16 | 9·985958 | 2 | 30 |
| 30 | 58 | 9·398600 | 30 246 | 10·601400 | 9·412658 | 30 262 | 10·587342 | 10·014058 | 30 16 | 9·985942 | 0 | 30 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

75° — 5h 3m

## LOG. SINES, COSINES, &c.

$0^h\ 58^m$ 14°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 9·398600 | | 10·601400 | 9·412658 | | 10·587342 | 10·014658 | | 9·985942 | 2 | 30 |
| 30 | 2 | 9·398844 | 1″ 8 | 10·601156 | 9·412919 | 1″ 9 | 10·587081 | 10·014075 | 1″ 1 | 9·985925 | 58 | 30 |
| 31 | 4 | 9·399088 | 2 16 | 10·600912 | 9·413179 | 2 17 | 10·586821 | 10·014091 | 2 1 | 9·985909 | 56 | 29 |
| 30 | 6 | 9·399332 | 3 24 | 10·600668 | 9·413439 | 3 26 | 10·586561 | 10·014107 | 3 2 | 9·985893 | 54 | 30 |
| 32 | 8 | 9·399575 | 4 32 | 10·600425 | 9·413699 | 4 34 | 10·586301 | 10·014124 | 4 2 | 9·985876 | 52 | 28 |
| 30 | 10 | 9·399819 | 5 40 | 10·600181 | 9·413959 | 5 43 | 10·586041 | 10·014140 | 5 3 | 9·985860 | 50 | 30 |
| 33 | 12 | 9·400062 | 6 48 | 10·599938 | 9·414219 | 6 52 | 10·585781 | 10·014157 | 6 3 | 9·985843 | 48 | 27 |
| 30 | 14 | 9·400306 | 7 56 | 10·599694 | 9·414479 | 7 60 | 10·585521 | 10·014173 | 7 4 | 9·985827 | 46 | 30 |
| 34 | 16 | 9·400549 | 8 65 | 10·599451 | 9·414738 | 8 69 | 10·585262 | 10·014189 | 8 4 | 9·985811 | 44 | 26 |
| 30 | 18 | 9·400792 | 9 73 | 10·599208 | 9·414998 | 9 78 | 10·585002 | 10·014206 | 9 5 | 9·985794 | 42 | 30 |
| 35 | 20 | 9·401035 | 10 81 | 10·598965 | 9·415257 | 10 86 | 10·584743 | 10·014222 | 10 5 | 9·985778 | 40 | 25 |
| 30 | 22 | 9·401277 | 11 89 | 10·598723 | 9·415516 | 11 95 | 10·584484 | 10·014239 | 11 6 | 9·985761 | 38 | 30 |
| 36 | 24 | 9·401520 | 12 96 | 10·598480 | 9·415775 | 12 103 | 10·584225 | 10·014255 | 12 7 | 9·985745 | 36 | 24 |
| 30 | 26 | 9·401762 | 13 104 | 10·598238 | 9·416034 | 13 112 | 10·583966 | 10·014272 | 13 7 | 9·985728 | 34 | 30 |
| 37 | 28 | 9·402005 | 14 112 | 10·597995 | 9·416293 | 14 121 | 10·583707 | 10·014288 | 14 8 | 9·985712 | 32 | 23 |
| 30 | 30 | 9·402247 | 15 120 | 10·597753 | 9·416551 | 15 129 | 10·583449 | 10·014305 | 15 8 | 9·985695 | 30 | 30 |
| 38 | 32 | 9·402489 | 16 129 | 10·597511 | 9·416810 | 16 138 | 10·583190 | 10·014321 | 16 9 | 9·985679 | 28 | 22 |
| 30 | 34 | 9·402731 | 17 137 | 10·597269 | 9·417068 | 17 147 | 10·582932 | 10·014338 | 17 9 | 9·985662 | 26 | 30 |
| 39 | 36 | 9·402972 | 18 145 | 10·597028 | 9·417326 | 18 155 | 10·582674 | 10·014354 | 18 10 | 9·985646 | 24 | 21 |
| 30 | 38 | 9·403214 | 19 153 | 10·596786 | 9·417585 | 19 164 | 10·582415 | 10·014371 | 19 10 | 9·985629 | 22 | 30 |
| 40 | 40 | 9·403455 | 20 161 | 10·596545 | 9·417842 | 20 172 | 10·582158 | 10·014387 | 20 11 | 9·985613 | 20 | 20 |
| 30 | 42 | 9·403697 | 21 169 | 10·596303 | 9·418100 | 21 181 | 10·581900 | 10·014404 | 21 12 | 9·985596 | 18 | 30 |
| 41 | 44 | 9·403938 | 22 178 | 10·596062 | 9·418358 | 22 190 | 10·581642 | 10·014420 | 22 12 | 9·985580 | 16 | 19 |
| 30 | 46 | 9·404179 | 23 186 | 10·595821 | 9·418616 | 23 198 | 10·581384 | 10·014437 | 23 13 | 9·985563 | 14 | 30 |
| 42 | 48 | 9·404420 | 24 194 | 10·595580 | 9·418873 | 24 207 | 10·581127 | 10·014453 | 24 13 | 9·985547 | 12 | 18 |
| 30 | 50 | 9·404660 | 25 202 | 10·595340 | 9·419130 | 25 215 | 10·580870 | 10·014470 | 25 14 | 9·985530 | 10 | 30 |
| 43 | 52 | 9·404901 | 26 210 | 10·595099 | 9·419387 | 26 224 | 10·580613 | 10·014486 | 26 14 | 9·985514 | 8 | 17 |
| 30 | 54 | 9·405141 | 27 218 | 10·594859 | 9·419644 | 27 233 | 10·580356 | 10·014503 | 27 15 | 9·985497 | 6 | 30 |
| 44 | 56 | 9·405382 | 28 226 | 10·594618 | 9·419901 | 28 241 | 10·580099 | 10·014520 | 28 15 | 9·985480 | 4 | 16 |
| 30 | 58 | 9·405622 | 29 234 | 10·594378 | 9·420158 | 29 250 | 10·579842 | 10·014536 | 29 16 | 9·985464 | 2 | 30 |
| 45 | 60 | 9·405862 | 30 242 | 10·594138 | 9·420415 | 30 259 | 10·579585 | 10·014553 | 30 16 | 9·985447 | 0 | 15 |
| 30 | 2 | 9·406102 | 1 8 | 10·593898 | 9·420671 | 1 8 | 10·579329 | 10·014570 | 1 1 | 9·985430 | 58 | 30 |
| 46 | 4 | 9·406341 | 2 16 | 10·593659 | 9·420927 | 2 17 | 10·579073 | 10·014586 | 2 1 | 9·985414 | 56 | 14 |
| 30 | 6 | 9·406581 | 3 24 | 10·593419 | 9·421184 | 3 25 | 10·578816 | 10·014603 | 3 2 | 9·985397 | 54 | 30 |
| 47 | 8 | 9·406820 | 4 32 | 10·593180 | 9·421440 | 4 34 | 10·578560 | 10·014619 | 4 2 | 9·985381 | 52 | 13 |
| 30 | 10 | 9·407060 | 5 40 | 10·592940 | 9·421696 | 5 42 | 10·578304 | 10·014636 | 5 3 | 9·985364 | 50 | 30 |
| 48 | 12 | 9·407299 | 6 48 | 10·592701 | 9·421952 | 6 51 | 10·578048 | 10·014653 | 6 3 | 9·985347 | 48 | 12 |
| 30 | 14 | 9·407538 | 7 55 | 10·592462 | 9·422207 | 7 59 | 10·577793 | 10·014670 | 7 4 | 9·985330 | 46 | 30 |
| 49 | 16 | 9·407777 | 8 63 | 10·592223 | 9·422463 | 8 68 | 10·577537 | 10·014686 | 8 4 | 9·985314 | 44 | 11 |
| 30 | 18 | 9·408015 | 9 71 | 10·591985 | 9·422718 | 9 76 | 10·577282 | 10·014703 | 9 5 | 9·985297 | 42 | 30 |
| 50 | 20 | 9·408254 | 10 79 | 10·591746 | 9·422974 | 10 85 | 10·577026 | 10·014720 | 10 6 | 9·985280 | 40 | 10 |
| 30 | 22 | 9·408492 | 11 87 | 10·591508 | 9·423229 | 11 93 | 10·576771 | 10·014736 | 11 6 | 9·985264 | 38 | 30 |
| 51 | 24 | 9·408731 | 12 95 | 10·591269 | 9·423484 | 12 102 | 10·576516 | 10·014753 | 12 7 | 9·985247 | 36 | 9 |
| 30 | 26 | 9·408969 | 13 103 | 10·591031 | 9·423739 | 13 110 | 10·576261 | 10·014770 | 13 7 | 9·985230 | 34 | 30 |
| 52 | 28 | 9·409207 | 14 111 | 10·590793 | 9·423993 | 14 119 | 10·576007 | 10·014787 | 14 8 | 9·985213 | 32 | 8 |
| 30 | 30 | 9·409445 | 15 118 | 10·590555 | 9·424248 | 15 127 | 10·575752 | 10·014803 | 15 8 | 9·985197 | 30 | 30 |
| 53 | 32 | 9·409682 | 16 126 | 10·590318 | 9·424503 | 16 136 | 10·575497 | 10·014820 | 16 9 | 9·985180 | 28 | 7 |
| 30 | 34 | 9·409920 | 17 134 | 10·590080 | 9·424757 | 17 144 | 10·575243 | 10·014837 | 17 10 | 9·985163 | 26 | 30 |
| 54 | 36 | 9·410157 | 18 142 | 10·589843 | 9·425011 | 18 153 | 10·574989 | 10·014854 | 18 10 | 9·985146 | 24 | 6 |
| 30 | 38 | 9·410395 | 19 150 | 10·589605 | 9·425265 | 19 161 | 10·574735 | 10·014871 | 19 11 | 9·985129 | 22 | 30 |
| 55 | 40 | 9·410632 | 20 158 | 10·589368 | 9·425519 | 20 170 | 10·574481 | 10·014887 | 20 11 | 9·985113 | 20 | 5 |
| 30 | 42 | 9·410869 | 21 166 | 10·589131 | 9·425773 | 21 178 | 10·574227 | 10·014904 | 21 12 | 9·985096 | 18 | 30 |
| 56 | 44 | 9·411106 | 22 174 | 10·588894 | 9·426027 | 22 187 | 10·573973 | 10·014921 | 22 12 | 9·985079 | 16 | 4 |
| 30 | 46 | 9·411343 | 23 182 | 10·588657 | 9·426281 | 23 195 | 10·573719 | 10·014938 | 23 13 | 9·985062 | 14 | 30 |
| 57 | 48 | 9·411579 | 24 190 | 10·588421 | 9·426534 | 24 204 | 10·573466 | 10·014955 | 24 13 | 9·985045 | 12 | 3 |
| 30 | 50 | 9·411816 | 25 198 | 10·588184 | 9·426787 | 25 212 | 10·573212 | 10·014972 | 25 14 | 9·985028 | 10 | 30 |
| 58 | 52 | 9·412052 | 26 206 | 10·587948 | 9·427041 | 26 220 | 10·572959 | 10·014989 | 26 15 | 9·985011 | 8 | 2 |
| 30 | 54 | 9·412288 | 27 214 | 10·587712 | 9·427294 | 27 229 | 10·572706 | 10·015005 | 27 15 | 9·984995 | 6 | 30 |
| 59 | 56 | 9·412524 | 28 222 | 10·587476 | 9·427547 | 28 237 | 10·572453 | 10·015022 | 28 16 | 9·984978 | 4 | 1 |
| 30 | 58 | 9·412760 | 29 230 | 10·587240 | 9·427800 | 29 246 | 10·572200 | 10·015039 | 29 16 | 9·984961 | 2 | 30 |
| 60 | 60 | 9·412996 | 30 238 | 10·587004 | 9·428052 | 30 254 | 10·571948 | 10·015056 | 30 17 | 9·984944 | 0 | 0 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

75° $5^h\ 0^m$

## LOG. SINES, COSINES, &c.

1h 0m — 15°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 9·412996 | | 10·587004 | 9·428052 | | 10·571948 | 10·015056 | | 9·984944 | 60 | 60 |
| 30 | 2 | 9·413232 | 1″ 8 | 10·586768 | 9·428305 | 1″ 8 | 10·571695 | 10·015073 | 1″ 1 | 9·984927 | 58 | 30 |
| 1 | 4 | 9·413467 | 2 16 | 10·586533 | 9·428558 | 2 17 | 10·571442 | 10·015090 | 2 1 | 9·984910 | 56 | 59 |
| 30 | 6 | 9·413703 | 3 23 | 10·586297 | 9·428810 | 3 25 | 10·571190 | 10·015107 | 3 2 | 9·984893 | 54 | 30 |
| 2 | 8 | 9·413938 | 4 31 | 10·586062 | 9·429062 | 4 33 | 10·570938 | 10·015124 | 4 2 | 9·984876 | 52 | 58 |
| 30 | 10 | 9·414173 | 5 39 | 10·585827 | 9·429314 | 5 42 | 10·570686 | 10·015141 | 5 3 | 9·984859 | 50 | 30 |
| 3 | 12 | 9·414408 | 6 47 | 10·585592 | 9·429566 | 6 50 | 10·570434 | 10·015158 | 6 3 | 9·984842 | 48 | 57 |
| 30 | 14 | 9·414643 | 7 55 | 10·585357 | 9·429818 | 7 59 | 10·570182 | 10·015175 | 7 4 | 9·984825 | 46 | 30 |
| 4 | 16 | 9·414878 | 8 62 | 10·585122 | 9·430070 | 8 67 | 10·569930 | 10·015192 | 8 5 | 9·984808 | 44 | 56 |
| 30 | 18 | 9·415112 | 9 70 | 10·584888 | 9·430321 | 9 75 | 10·569679 | 10·015209 | 9 5 | 9·984791 | 42 | 30 |
| 5 | 20 | 9·415347 | 10 78 | 10·584653 | 9·430573 | 10 84 | 10·569427 | 10·015226 | 10 6 | 9·984774 | 40 | 55 |
| 30 | 22 | 9·415581 | 11 86 | 10·584419 | 9·430824 | 11 92 | 10·569176 | 10·015243 | 11 6 | 9·984757 | 38 | 30 |
| 6 | 24 | 9·415815 | 12 94 | 10·584185 | 9·431075 | 12 100 | 10·568925 | 10·015260 | 12 7 | 9·984740 | 36 | 54 |
| 30 | 26 | 9·416049 | 13 101 | 10·583951 | 9·431326 | 13 109 | 10·568674 | 10·015277 | 13 7 | 9·984723 | 34 | 30 |
| 7 | 28 | 9·416283 | 14 109 | 10·583717 | 9·431577 | 14 117 | 10·568423 | 10·015294 | 14 8 | 9·984706 | 32 | 53 |
| 30 | 30 | 9·416517 | 15 117 | 10·583483 | 9·431828 | 15 125 | 10·568172 | 10·015311 | 15 9 | 9·984689 | 30 | 30 |
| 8 | 32 | 9·416751 | 16 125 | 10·583249 | 9·432079 | 16 134 | 10·567921 | 10·015328 | 16 9 | 9·984672 | 28 | 52 |
| 30 | 34 | 9·416984 | 17 133 | 10·583016 | 9·432329 | 17 142 | 10·567671 | 10·015345 | 17 10 | 9·984655 | 26 | 30 |
| 9 | 36 | 9·417217 | 18 140 | 10·582783 | 9·432580 | 18 150 | 10·567420 | 10·015362 | 18 10 | 9·984638 | 24 | 51 |
| 30 | 38 | 9·417451 | 19 148 | 10·582549 | 9·432830 | 19 159 | 10·567170 | 10·015380 | 19 11 | 9·984620 | 22 | 30 |
| 10 | 40 | 9·417684 | 20 156 | 10·582316 | 9·433080 | 20 167 | 10·566920 | 10·015397 | 20 11 | 9·984603 | 20 | 50 |
| 30 | 42 | 9·417917 | 21 164 | 10·582083 | 9·433331 | 21 176 | 10·566669 | 10·015414 | 21 12 | 9·984586 | 18 | 30 |
| 11 | 44 | 9·418150 | 22 171 | 10·581850 | 9·433580 | 22 184 | 10·566420 | 10·015431 | 22 13 | 9·984569 | 16 | 49 |
| 30 | 46 | 9·418382 | 23 179 | 10·581618 | 9·433830 | 23 192 | 10·566170 | 10·015448 | 23 13 | 9·984552 | 14 | 30 |
| 12 | 48 | 9·418615 | 24 187 | 10·581385 | 9·434080 | 24 201 | 10·565920 | 10·015465 | 24 14 | 9·984535 | 12 | 48 |
| 30 | 50 | 9·418847 | 25 195 | 10·581153 | 9·434330 | 25 209 | 10·565670 | 10·015482 | 25 14 | 9·984518 | 10 | 30 |
| 13 | 52 | 9·419079 | 26 203 | 10·580921 | 9·434579 | 26 217 | 10·565421 | 10·015500 | 26 15 | 9·984500 | 8 | 47 |
| 30 | 54 | 9·419312 | 27 210 | 10·580688 | 9·434828 | 27 226 | 10·565172 | 10·015517 | 27 15 | 9·984483 | 6 | 30 |
| 14 | 56 | 9·419544 | 28 218 | 10·580456 | 9·435078 | 28 234 | 10·564922 | 10·015534 | 28 16 | 9·984466 | 4 | 46 |
| 30 | 58 | 9·419776 | 29 226 | 10·580224 | 9·435327 | 29 242 | 10·564673 | 10·015551 | 29 17 | 9·984449 | 2 | 30 |
| 15 | 1 | 9·420007 | 30 234 | 10·579993 | 9·435576 | 30 251 | 10·564424 | 10·015568 | 30 17 | 9·984432 | 59 | 45 |
| 30 | 2 | 9·420239 | 1 8 | 10·579761 | 9·435825 | 1 8 | 10·564175 | 10·015586 | 1 1 | 9·984414 | 58 | 30 |
| 16 | 4 | 9·420470 | 2 15 | 10·579530 | 9·436073 | 2 16 | 10·563927 | 10·015603 | 2 1 | 9·984397 | 56 | 44 |
| 30 | 6 | 9·420702 | 3 23 | 10·579298 | 9·436322 | 3 25 | 10·563678 | 10·015620 | 3 2 | 9·984380 | 54 | 30 |
| 17 | 8 | 9·420933 | 4 31 | 10·579067 | 9·436570 | 4 33 | 10·563430 | 10·015637 | 4 2 | 9·984363 | 52 | 43 |
| 30 | 10 | 9·421164 | 5 38 | 10·578836 | 9·436819 | 5 41 | 10·563181 | 10·015655 | 5 3 | 9·984345 | 50 | 30 |
| 18 | 12 | 9·421395 | 6 46 | 10·578605 | 9·437067 | 6 49 | 10·562933 | 10·015672 | 6 3 | 9·984328 | 48 | 42 |
| 30 | 14 | 9·421626 | 7 54 | 10·578374 | 9·437315 | 7 58 | 10·562685 | 10·015689 | 7 4 | 9·984311 | 46 | 30 |
| 19 | 16 | 9·421857 | 8 61 | 10·578143 | 9·437563 | 8 66 | 10·562437 | 10·015706 | 8 5 | 9·984294 | 44 | 41 |
| 30 | 18 | 9·422087 | 9 69 | 10·577913 | 9·437811 | 9 74 | 10·562189 | 10·015724 | 9 5 | 9·984276 | 42 | 30 |
| 20 | 20 | 9·422318 | 10 77 | 10·577682 | 9·438059 | 10 82 | 10·561941 | 10·015741 | 10 6 | 9·984259 | 40 | 40 |
| 30 | 22 | 9·422548 | 11 85 | 10·577452 | 9·438306 | 11 91 | 10·561694 | 10·015758 | 11 6 | 9·984242 | 38 | 30 |
| 21 | 24 | 9·422778 | 12 92 | 10·577222 | 9·438554 | 12 99 | 10·561446 | 10·015776 | 12 7 | 9·984224 | 36 | 39 |
| 30 | 26 | 9·423008 | 13 100 | 10·576992 | 9·438801 | 13 107 | 10·561199 | 10·015793 | 13 8 | 9·984207 | 34 | 30 |
| 22 | 28 | 9·423238 | 14 108 | 10·576762 | 9·439048 | 14 115 | 10·560952 | 10·015810 | 14 8 | 9·984190 | 32 | 38 |
| 30 | 30 | 9·423468 | 15 115 | 10·576532 | 9·439296 | 15 123 | 10·560704 | 10·015828 | 15 9 | 9·984172 | 30 | 30 |
| 23 | 32 | 9·423697 | 16 123 | 10·576303 | 9·439543 | 16 132 | 10·560457 | 10·015845 | 16 9 | 9·984155 | 28 | 37 |
| 30 | 34 | 9·423927 | 17 131 | 10·576073 | 9·439790 | 17 140 | 10·560210 | 10·015863 | 17 10 | 9·984137 | 26 | 30 |
| 24 | 36 | 9·424156 | 18 138 | 10·575844 | 9·440036 | 18 148 | 10·559964 | 10·015880 | 18 10 | 9·984120 | 24 | 36 |
| 30 | 38 | 9·424386 | 19 146 | 10·575614 | 9·440283 | 19 156 | 10·559717 | 10·015897 | 19 11 | 9·984103 | 22 | 30 |
| 25 | 40 | 9·424615 | 20 153 | 10·575385 | 9·440529 | 20 165 | 10·559471 | 10·015915 | 20 12 | 9·984085 | 20 | 35 |
| 30 | 42 | 9·424844 | 21 161 | 10·575156 | 9·440776 | 21 173 | 10·559224 | 10·015932 | 21 12 | 9·984068 | 18 | 30 |
| 26 | 44 | 9·425073 | 22 169 | 10·574927 | 9·441022 | 22 181 | 10·558978 | 10·015950 | 22 13 | 9·984050 | 16 | 34 |
| 30 | 46 | 9·425301 | 23 176 | 10·574699 | 9·441268 | 23 189 | 10·558732 | 10·015967 | 23 13 | 9·984033 | 14 | 30 |
| 27 | 48 | 9·425530 | 24 184 | 10·574470 | 9·441514 | 24 198 | 10·558486 | 10·015985 | 24 14 | 9·984015 | 12 | 33 |
| 30 | 50 | 9·425758 | 25 192 | 10·574242 | 9·441760 | 25 206 | 10·558240 | 10·016002 | 25 14 | 9·983998 | 10 | 30 |
| 28 | 52 | 9·425987 | 26 199 | 10·574013 | 9·442006 | 26 214 | 10·557994 | 10·016019 | 26 15 | 9·983981 | 8 | 32 |
| 30 | 54 | 9·426215 | 27 207 | 10·573785 | 9·442252 | 27 222 | 10·557748 | 10·016037 | 27 16 | 9·983963 | 6 | 30 |
| 29 | 56 | 9·426443 | 28 215 | 10·573557 | 9·442497 | 28 230 | 10·557503 | 10·016054 | 28 16 | 9·983946 | 4 | 31 |
| 30 | 58 | 9·426671 | 29 222 | 10·573329 | 9·442743 | 29 239 | 10·557257 | 10·016072 | 29 17 | 9·983928 | 2 | 30 |
| 30 | 2 | 9·426899 | 30 230 | 10·573101 | 9·442988 | 30 247 | 10·557012 | 10·016089 | 30 17 | 9·983911 | 0 | 30 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

74° — 4h 58m

## LOG. SINES, COSINES, &c.

1ʰ 2ᵐ — 15°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 9·426899 | | 10·573101 | 9·442988 | | 10·557012 | 10·016089 | | 9·983911 | 58 | 30 |
| 30 | 2 | 9·427127 | 1″ 8 | 10·572873 | 9·443234 | 1″ 8 | 10·556766 | 10·016107 | 1″ 1 | 9·983893 | 58 | 30 |
| 31 | 4 | 9·427354 | 2 15 | 10·572646 | 9·443479 | 2 16 | 10·556521 | 10·016125 | 2 1 | 9·983875 | 56 | 29 |
| 30 | 6 | 9·427582 | 3 23 | 10·572418 | 9·443724 | 3 24 | 10·556276 | 10·016142 | 3 2 | 9·983858 | 54 | 30 |
| 32 | 8 | 9·427809 | 4 30 | 10·572191 | 9·443968 | 4 32 | 10·556032 | 10·016160 | 4 2 | 9·983840 | 52 | 28 |
| 30 | 10 | 9·428036 | 5 38 | 10·571964 | 9·444213 | 5 41 | 10·555787 | 10·016177 | 5 3 | 9·983823 | 50 | 30 |
| 33 | 12 | 9·428263 | 6 45 | 10·571737 | 9·444458 | 6 49 | 10·555542 | 10·016195 | 6 4 | 9·983805 | 48 | 27 |
| 30 | 14 | 9·428490 | 7 53 | 10·571510 | 9·444702 | 7 57 | 10·555298 | 10·016212 | 7 4 | 9·983788 | 46 | 30 |
| 34 | 16 | 9·428717 | 8 60 | 10·571283 | 9·444947 | 8 65 | 10·555053 | 10·016230 | 8 5 | 9·983770 | 44 | 26 |
| 30 | 18 | 9·428944 | 9 68 | 10·571056 | 9·445191 | 9 73 | 10·554809 | 10·016248 | 9 5 | 9·983752 | 42 | 30 |
| 35 | 20 | 9·429170 | 10 75 | 10·570830 | 9·445435 | 10 81 | 10·554565 | 10·016265 | 10 6 | 9·983735 | 40 | 25 |
| 30 | 22 | 9·429397 | 11 83 | 10·570603 | 9·445679 | 11 89 | 10·554321 | 10·016283 | 11 6 | 9·983717 | 38 | 30 |
| 36 | 24 | 9·429623 | 12 90 | 10·570377 | 9·445923 | 12 97 | 10·554077 | 10·016300 | 12 7 | 9·983700 | 36 | 24 |
| 30 | 26 | 9·429849 | 13 98 | 10·570151 | 9·446167 | 13 106 | 10·553833 | 10·016318 | 13 8 | 9·983682 | 34 | 30 |
| 37 | 28 | 9·430075 | 14 105 | 10·569925 | 9·446411 | 14 114 | 10·553589 | 10·016336 | 14 8 | 9·983664 | 32 | 23 |
| 30 | 30 | 9·430301 | 15 113 | 10·569699 | 9·446654 | 15 122 | 10·553346 | 10·016353 | 15 9 | 9·983647 | 30 | 30 |
| 38 | 32 | 9·430527 | 16 120 | 10·569473 | 9·446898 | 16 130 | 10·553102 | 10·016371 | 16 9 | 9·983629 | 28 | 22 |
| 30 | 34 | 9·430752 | 17 128 | 10·569248 | 9·447141 | 17 138 | 10·552859 | 10·016389 | 17 10 | 9·983611 | 26 | 30 |
| 39 | 36 | 9·430978 | 18 135 | 10·569022 | 9·447384 | 18 146 | 10·552616 | 10·016406 | 18 11 | 9·983594 | 24 | 21 |
| 30 | 38 | 9·431203 | 19 143 | 10·568797 | 9·447627 | 19 154 | 10·552373 | 10·016424 | 19 11 | 9·983576 | 22 | 30 |
| 40 | 40 | 9·431429 | 20 151 | 10·568571 | 9·447870 | 20 162 | 10·552130 | 10·016442 | 20 12 | 9·983558 | 20 | 20 |
| 30 | 42 | 9·431654 | 21 158 | 10·568346 | 9·448113 | 21 171 | 10·551887 | 10·016460 | 21 12 | 9·983540 | 18 | 30 |
| 41 | 44 | 9·431879 | 22 166 | 10·568121 | 9·448356 | 22 179 | 10·551644 | 10·016477 | 22 13 | 9·983523 | 16 | 19 |
| 30 | 46 | 9·432104 | 23 173 | 10·567896 | 9·448599 | 23 187 | 10·551401 | 10·016495 | 23 14 | 9·983505 | 14 | 30 |
| 42 | 48 | 9·432329 | 24 181 | 10·567671 | 9·448841 | 24 195 | 10·551159 | 10·016513 | 24 14 | 9·983487 | 12 | 18 |
| 30 | 50 | 9·432553 | 25 188 | 10·567447 | 9·449084 | 25 203 | 10·550916 | 10·016531 | 25 15 | 9·983469 | 10 | 30 |
| 43 | 52 | 9·432778 | 26 196 | 10·567222 | 9·449326 | 26 211 | 10·550674 | 10·016548 | 26 15 | 9·983452 | 8 | 17 |
| 30 | 54 | 9·433002 | 27 203 | 10·566998 | 9·449568 | 27 219 | 10·550432 | 10·016566 | 27 16 | 9·983434 | 6 | 30 |
| 44 | 56 | 9·433226 | 28 210 | 10·566774 | 9·449810 | 28 227 | 10·550190 | 10·016584 | 28 17 | 9·983416 | 4 | 16 |
| 30 | 58 | 9·433451 | 29 217 | 10·566549 | 9·450052 | 29 235 | 10·549948 | 10·016602 | 29 17 | 9·983398 | 2 | 30 |
| 45 | 3 | 9·433675 | 30 226 | 10·566325 | 9·450294 | 30 244 | 10·549706 | 10·016619 | 30 18 | 9·983381 | 57 | 15 |
| 30 | 2 | 9·433898 | 1 7 | 10·566102 | 9·450536 | 1 8 | 10·549464 | 10·016637 | 1 1 | 9·983363 | 58 | 30 |
| 46 | 4 | 9·434122 | 2 15 | 10·565878 | 9·450777 | 2 16 | 10·549223 | 10·016655 | 2 1 | 9·983345 | 56 | 14 |
| 30 | 6 | 9·434346 | 3 22 | 10·565654 | 9·451019 | 3 24 | 10·548981 | 10·016673 | 3 2 | 9·983327 | 54 | 30 |
| 47 | 8 | 9·434569 | 4 30 | 10·565431 | 9·451260 | 4 32 | 10·548740 | 10·016691 | 4 2 | 9·983309 | 52 | 13 |
| 30 | 10 | 9·434793 | 5 37 | 10·565207 | 9·451502 | 5 40 | 10·548498 | 10·016709 | 5 3 | 9·983291 | 50 | 30 |
| 48 | 12 | 9·435016 | 6 44 | 10·564984 | 9·451743 | 6 48 | 10·548257 | 10·016727 | 6 4 | 9·983273 | 48 | 12 |
| 30 | 14 | 9·435239 | 7 52 | 10·564761 | 9·451984 | 7 56 | 10·548016 | 10·016744 | 7 4 | 9·983256 | 46 | 30 |
| 49 | 16 | 9·435462 | 8 59 | 10·564538 | 9·452225 | 8 64 | 10·547775 | 10·016762 | 8 5 | 9·983238 | 44 | 11 |
| 30 | 18 | 9·435685 | 9 67 | 10·564315 | 9·452465 | 9 72 | 10·547535 | 10·016780 | 9 5 | 9·983220 | 42 | 30 |
| 50 | 20 | 9·435908 | 10 74 | 10·564092 | 9·452706 | 10 80 | 10·547294 | 10·016798 | 10 6 | 9·983202 | 40 | 10 |
| 30 | 22 | 9·436131 | 11 82 | 10·563869 | 9·452947 | 11 88 | 10·547053 | 10·016816 | 11 7 | 9·983184 | 38 | 30 |
| 51 | 24 | 9·436353 | 12 89 | 10·563647 | 9·453187 | 12 96 | 10·546813 | 10·016834 | 12 7 | 9·983166 | 36 | 9 |
| 30 | 26 | 9·436576 | 13 97 | 10·563424 | 9·453428 | 13 104 | 10·546572 | 10·016852 | 13 8 | 9·983148 | 34 | 30 |
| 52 | 28 | 9·436798 | 14 104 | 10·563202 | 9·453668 | 14 112 | 10·546332 | 10·016870 | 14 8 | 9·983130 | 32 | 8 |
| 30 | 30 | 9·437020 | 15 111 | 10·562980 | 9·453908 | 15 120 | 10·546092 | 10·016888 | 15 9 | 9·983112 | 30 | 30 |
| 53 | 32 | 9·437242 | 16 118 | 10·562758 | 9·454148 | 16 128 | 10·545852 | 10·016906 | 16 10 | 9·983094 | 28 | 7 |
| 30 | 34 | 9·437464 | 17 126 | 10·562536 | 9·454388 | 17 136 | 10·545612 | 10·016924 | 17 10 | 9·983076 | 26 | 30 |
| 54 | 36 | 9·437686 | 18 133 | 10·562314 | 9·454628 | 18 144 | 10·545372 | 10·016942 | 18 11 | 9·983058 | 24 | 6 |
| 30 | 38 | 9·437908 | 19 141 | 10·562092 | 9·454867 | 19 152 | 10·545133 | 10·016960 | 19 11 | 9·983040 | 22 | 30 |
| 55 | 40 | 9·438129 | 20 148 | 10·561871 | 9·455107 | 20 160 | 10·544893 | 10·016978 | 20 12 | 9·983022 | 20 | 5 |
| 30 | 42 | 9·438351 | 21 156 | 10·561649 | 9·455346 | 21 168 | 10·544654 | 10·016996 | 21 13 | 9·983004 | 18 | 30 |
| 56 | 44 | 9·438572 | 22 163 | 10·561428 | 9·455586 | 22 176 | 10·544414 | 10·017014 | 22 13 | 9·982986 | 16 | 4 |
| 30 | 46 | 9·438793 | 23 171 | 10·561207 | 9·455825 | 23 184 | 10·544175 | 10·017032 | 23 14 | 9·982968 | 14 | 30 |
| 57 | 48 | 9·439014 | 24 178 | 10·560986 | 9·456064 | 24 192 | 10·543936 | 10·017050 | 24 14 | 9·982950 | 12 | 3 |
| 30 | 50 | 9·439235 | 25 185 | 10·560765 | 9·456303 | 25 200 | 10·543697 | 10·017068 | 25 15 | 9·982932 | 10 | 30 |
| 58 | 52 | 9·439456 | 26 192 | 10·560544 | 9·456542 | 26 208 | 10·543458 | 10·017086 | 26 16 | 9·982914 | 8 | 2 |
| 30 | 54 | 9·439677 | 27 200 | 10·560323 | 9·456781 | 27 216 | 10·543219 | 10·017104 | 27 16 | 9·982896 | 6 | 30 |
| 59 | 56 | 9·439897 | 28 207 | 10·560103 | 9·457019 | 28 224 | 10·542981 | 10·017122 | 28 17 | 9·982878 | 4 | 1 |
| 30 | 58 | 9·440118 | 29 215 | 10·559882 | 9·457258 | 29 232 | 10·542742 | 10·017140 | 29 17 | 9·982860 | 2 | 30 |
| 60 | 4 | 9·440338 | 30 222 | 10·559662 | 9·457496 | 30 240 | 10·542504 | 10·017158 | 30 18 | 9·982842 | 0 | 0 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

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## LOG. SINES. COSINES, &c.

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| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 9·440338 | | 10·559662 | 9·457496 | | 10·542504 | 10·017158 | | 9·982842 | 56 | 60 |
| 30 | 2 | 9·440558 | 1″ 7 | 10·559441 | 9·457735 | 1″ 8 | 10·542265 | 10·017176 | 1″ 1 | 9·982824 | 58 | 30 |
| 1 | 4 | 9·440778 | 2 15 | 10·559222 | 9·457973 | 2 16 | 10·542027 | 10·017195 | 2 1 | 9·982805 | 56 | 59 |
| 30 | 6 | 9·440998 | 3 22 | 10·559002 | 9·458211 | 3 24 | 10·541789 | 10·017213 | 3 2 | 9·982787 | 54 | 30 |
| 2 | 8 | 9·441218 | 4 29 | 10·558782 | 9·458449 | 4 32 | 10·541551 | 10·017231 | 4 2 | 9·982769 | 52 | 58 |
| 30 | 10 | 9·441438 | 5 36 | 10·558562 | 9·458687 | 5 39 | 10·541313 | 10·017249 | 5 3 | 9·982751 | 50 | 30 |
| 3 | 12 | 9·441658 | 6 44 | 10·558342 | 9·458925 | 6 47 | 10·541075 | 10·017267 | 6 4 | 9·982733 | 48 | 57 |
| 30 | 14 | 9·441877 | 7 51 | 10·558123 | 9·459163 | 7 55 | 10·540837 | 10·017285 | 7 4 | 9·982715 | 46 | 30 |
| 4 | 16 | 9·442096 | 8 58 | 10·557904 | 9·459400 | 8 63 | 10·540600 | 10·017304 | 8 5 | 9·982696 | 44 | 56 |
| 30 | 18 | 9·442316 | 9 65 | 10·557684 | 9·459638 | 9 71 | 10·540362 | 10·017322 | 9 5 | 9·982678 | 42 | 30 |
| 5 | 20 | 9·442535 | 10 73 | 10·557465 | 9·459875 | 10 79 | 10·540125 | 10·017340 | 10 6 | 9·982660 | 40 | 55 |
| 30 | 22 | 9·442754 | 11 80 | 10·557246 | 9·460112 | 11 87 | 10·539888 | 10·017358 | 11 7 | 9·982642 | 38 | 30 |
| 6 | 24 | 9·442973 | 12 87 | 10·557027 | 9·460349 | 12 95 | 10·539651 | 10·017376 | 12 7 | 9·982624 | 36 | 54 |
| 30 | 26 | 9·443192 | 13 95 | 10·556808 | 9·460586 | 13 103 | 10·539414 | 10·017395 | 13 8 | 9·982605 | 34 | 30 |
| 7 | 28 | 9·443410 | 14 102 | 10·556590 | 9·460823 | 14 110 | 10·539177 | 10·017413 | 14 9 | 9·982587 | 32 | 53 |
| 30 | 30 | 9·443629 | 15 109 | 10·556371 | 9·461060 | 15 118 | 10·538940 | 10·017431 | 15 9 | 9·982569 | 30 | 30 |
| 8 | 32 | 9·443847 | 16 116 | 10·556153 | 9·461297 | 16 126 | 10·538703 | 10·017449 | 16 10 | 9·982551 | 28 | 52 |
| 30 | 34 | 9·444066 | 17 124 | 10·555934 | 9·461533 | 17 134 | 10·538467 | 10·017468 | 17 10 | 9·982532 | 26 | 30 |
| 9 | 36 | 9·444284 | 18 131 | 10·555716 | 9·461770 | 18 142 | 10·538230 | 10·017486 | 18 11 | 9·982514 | 24 | 51 |
| 30 | 38 | 9·444502 | 19 138 | 10·555498 | 9·462006 | 19 150 | 10·537994 | 10·017504 | 19 12 | 9·982496 | 22 | 30 |
| 10 | 40 | 9·444720 | 20 146 | 10·555280 | 9·462242 | 20 158 | 10·537758 | 10·017523 | 20 12 | 9·982477 | 20 | 50 |
| 30 | 42 | 9·444938 | 21 153 | 10·555062 | 9·462478 | 21 166 | 10·537522 | 10·017541 | 21 13 | 9·982459 | 18 | 30 |
| 11 | 44 | 9·445155 | 22 160 | 10·554845 | 9·462715 | 22 174 | 10·537286 | 10·017559 | 22 13 | 9·982441 | 16 | 49 |
| 30 | 46 | 9·445373 | 23 167 | 10·554627 | 9·462950 | 23 181 | 10·537050 | 10·017578 | 23 14 | 9·982422 | 14 | 30 |
| 12 | 48 | 9·445590 | 24 175 | 10·554410 | 9·463186 | 24 189 | 10·536814 | 10·017596 | 24 15 | 9·982404 | 12 | 48 |
| 30 | 50 | 9·445808 | 25 182 | 10·554192 | 9·463422 | 25 197 | 10·536578 | 10·017614 | 25 15 | 9·982386 | 10 | 30 |
| 13 | 52 | 9·446025 | 26 189 | 10·553975 | 9·463658 | 26 205 | 10·536342 | 10·017633 | 26 16 | 9·982367 | 8 | 47 |
| 30 | 54 | 9·446242 | 27 196 | 10·553758 | 9·463893 | 27 213 | 10·536107 | 10·017651 | 27 16 | 9·982349 | 6 | 30 |
| 14 | 56 | 9·446459 | 28 204 | 10·553541 | 9·464128 | 28 221 | 10·535872 | 10·017669 | 28 17 | 9·982331 | 4 | 46 |
| 30 | 58 | 9·446676 | 29 211 | 10·553324 | 9·464364 | 29 229 | 10·535636 | 10·017688 | 29 18 | 9·982312 | 2 | 30 |
| 15 | 5 | 9·446893 | 30 218 | 10·553107 | 9·464599 | 30 237 | 10·535401 | 10·017706 | 30 18 | 9·982294 | 55 | 45 |
| 30 | 2 | 9·447109 | 1 7 | 10·552891 | 9·464834 | 1 8 | 10·535166 | 10·017725 | 1 1 | 9·982275 | 58 | 30 |
| 16 | 4 | 9·447326 | 2 14 | 10·552674 | 9·465069 | 2 16 | 10·534931 | 10·017743 | 2 1 | 9·982257 | 56 | 44 |
| 30 | 6 | 9·447542 | 3 22 | 10·552458 | 9·465304 | 3 23 | 10·534696 | 10·017761 | 3 2 | 9·982239 | 54 | 30 |
| 17 | 8 | 9·447759 | 4 29 | 10·552241 | 9·465539 | 4 31 | 10·534461 | 10·017780 | 4 2 | 9·982220 | 52 | 43 |
| 30 | 10 | 9·447975 | 5 36 | 10·552025 | 9·465773 | 5 39 | 10·534227 | 10·017798 | 5 3 | 9·982202 | 50 | 30 |
| 18 | 12 | 9·448191 | 6 43 | 10·551809 | 9·466008 | 6 47 | 10·533992 | 10·017817 | 6 4 | 9·982183 | 48 | 42 |
| 30 | 14 | 9·448407 | 7 50 | 10·551593 | 9·466242 | 7 54 | 10·533758 | 10·017835 | 7 4 | 9·982165 | 46 | 30 |
| 19 | 16 | 9·448623 | 8 57 | 10·551377 | 9·466477 | 8 62 | 10·533523 | 10·017854 | 8 5 | 9·982146 | 44 | 41 |
| 30 | 18 | 9·448838 | 9 64 | 10·551162 | 9·466711 | 9 70 | 10·533289 | 10·017872 | 9 6 | 9·982128 | 42 | 30 |
| 20 | 20 | 9·449054 | 10 72 | 10·550946 | 9·466945 | 10 78 | 10·533055 | 10·017891 | 10 6 | 9·982109 | 40 | 40 |
| 30 | 22 | 9·449269 | 11 79 | 10·550731 | 9·467179 | 11 86 | 10·532821 | 10·017909 | 11 7 | 9·982091 | 38 | 30 |
| 21 | 24 | 9·449485 | 12 86 | 10·550515 | 9·467413 | 12 93 | 10·532587 | 10·017928 | 12 7 | 9·982072 | 36 | 39 |
| 30 | 26 | 9·449700 | 13 93 | 10·550300 | 9·467647 | 13 101 | 10·532353 | 10·017946 | 13 8 | 9·982054 | 34 | 30 |
| 22 | 28 | 9·449915 | 14 100 | 10·550085 | 9·467880 | 14 109 | 10·532120 | 10·017965 | 14 9 | 9·982035 | 32 | 38 |
| 30 | 30 | 9·450130 | 15 107 | 10·549870 | 9·468114 | 15 117 | 10·531886 | 10·017984 | 15 9 | 9·982016 | 30 | 30 |
| 23 | 32 | 9·450345 | 16 114 | 10·549655 | 9·468347 | 16 124 | 10·531653 | 10·018002 | 16 10 | 9·981998 | 28 | 37 |
| 30 | 34 | 9·450560 | 17 122 | 10·549440 | 9·468581 | 17 132 | 10·531419 | 10·018021 | 17 11 | 9·981979 | 26 | 30 |
| 24 | 36 | 9·450775 | 18 129 | 10·549225 | 9·468814 | 18 140 | 10·531186 | 10·018039 | 18 11 | 9·981961 | 24 | 36 |
| 30 | 38 | 9·450989 | 19 136 | 10·549011 | 9·469047 | 19 148 | 10·530953 | 10·018058 | 19 12 | 9·981942 | 22 | 30 |
| 25 | 40 | 9·451204 | 20 143 | 10·548796 | 9·469280 | 20 156 | 10·530720 | 10·018076 | 20 12 | 9·981924 | 20 | 35 |
| 30 | 42 | 9·451418 | 21 150 | 10·548582 | 9·469513 | 21 163 | 10·530487 | 10·018095 | 21 13 | 9·981905 | 18 | 30 |
| 26 | 44 | 9·451632 | 22 157 | 10·548368 | 9·469746 | 22 171 | 10·530254 | 10·018114 | 22 14 | 9·981886 | 16 | 34 |
| 30 | 46 | 9·451846 | 23 165 | 10·548154 | 9·469979 | 23 179 | 10·530021 | 10·018132 | 23 14 | 9·981868 | 14 | 30 |
| 27 | 48 | 9·452060 | 24 172 | 10·547940 | 9·470211 | 24 187 | 10·529789 | 10·018151 | 24 15 | 9·981849 | 12 | 33 |
| 30 | 50 | 9·452274 | 25 179 | 10·547726 | 9·470444 | 25 194 | 10·529556 | 10·018170 | 25 16 | 9·981830 | 10 | 30 |
| 28 | 52 | 9·452488 | 26 186 | 10·547512 | 9·470676 | 26 202 | 10·529324 | 10·018188 | 26 16 | 9·981812 | 8 | 32 |
| 30 | 54 | 9·452702 | 27 193 | 10·547298 | 9·470909 | 27 210 | 10·529091 | 10·018207 | 27 17 | 9·981793 | 6 | 30 |
| 29 | 56 | 9·452915 | 28 200 | 10·547085 | 9·471141 | 28 218 | 10·528859 | 10·018226 | 28 17 | 9·981774 | 4 | 31 |
| 30 | 58 | 9·453129 | 29 208 | 10·546871 | 9·471373 | 29 226 | 10·528627 | 10·018244 | 29 18 | 9·981756 | 2 | 30 |
| 30 | 6 | 9·453342 | 30 215 | 10·546658 | 9·471605 | 30 233 | 10·528395 | 10·018263 | 30 19 | 9·981737 | 0 | 30 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

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| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 9·453342 | | 10·546658 | 9·471605 | | 10·528395 | 10·018263 | | 9·981737 | 54 | 30 |
| 30 | 2 | 9·453555 | 1″ 7 | 10·546445 | 9·471837 | 1″ 8 | 10·528163 | 10·018282 | 1″ 1 | 9·981718 | 58 | 30 |
| 31 | 4 | 9·453768 | 2 14 | 10·546232 | 9·472069 | 2 15 | 10·527931 | 10·018300 | 2 1 | 9·981700 | 56 | 29 |
| 30 | 6 | 9·453981 | 3 21 | 10·546019 | 9·472300 | 3 23 | 10·527700 | 10·018319 | 3 2 | 9·981681 | 54 | 30 |
| 32 | 8 | 9·454194 | 4 28 | 10·545806 | 9·472532 | 4 31 | 10·527468 | 10·018338 | 4 3 | 9·981662 | 52 | 28 |
| 30 | 10 | 9·454407 | 5 35 | 10·545593 | 9·472763 | 5 38 | 10·527237 | 10·018357 | 5 3 | 9·981643 | 50 | 30 |
| 33 | 12 | 9·454619 | 6 42 | 10·545381 | 9·472995 | 6 46 | 10·527005 | 10·018375 | 6 4 | 9·981625 | 48 | 27 |
| 30 | 14 | 9·454832 | 7 49 | 10·545168 | 9·473226 | 7 54 | 10·526774 | 10·018394 | 7 4 | 9·981606 | 46 | 30 |
| 34 | 16 | 9·455044 | 8 56 | 10·544956 | 9·473457 | 8 61 | 10·526543 | 10·018413 | 8 5 | 9·981587 | 44 | 26 |
| 30 | 18 | 9·455256 | 9 63 | 10·544744 | 9·473688 | 9 69 | 10·526312 | 10·018432 | 9 6 | 9·981568 | 42 | 30 |
| 35 | 20 | 9·455469 | 10 70 | 10·544531 | 9·473919 | 10 77 | 10·526081 | 10·018451 | 10 6 | 9·981549 | 40 | 25 |
| 30 | 22 | 9·455681 | 11 78 | 10·544319 | 9·474150 | 11 84 | 10·525850 | 10·018469 | 11 7 | 9·981531 | 38 | 30 |
| 36 | 24 | 9·455893 | 12 85 | 10·544107 | 9·474381 | 12 92 | 10·525619 | 10·018488 | 12 8 | 9·981512 | 36 | 24 |
| 30 | 26 | 9·456104 | 13 92 | 10·543896 | 9·474612 | 13 100 | 10·525388 | 10·018507 | 13 8 | 9·981493 | 34 | 30 |
| 37 | 28 | 9·456316 | 14 99 | 10·543684 | 9·474842 | 14 108 | 10·525158 | 10·018526 | 14 9 | 9·981474 | 32 | 23 |
| 30 | 30 | 9·456528 | 15 106 | 10·543472 | 9·475073 | 15 115 | 10·524927 | 10·018545 | 15 9 | 9·981455 | 30 | 30 |
| 38 | 32 | 9·456739 | 16 113 | 10·543261 | 9·475303 | 16 123 | 10·524697 | 10·018564 | 16 10 | 9·981436 | 28 | 22 |
| 30 | 34 | 9·456951 | 17 120 | 10·543049 | 9·475533 | 17 131 | 10·524467 | 10·018583 | 17 11 | 9·981417 | 26 | 30 |
| 39 | 36 | 9·457162 | 18 127 | 10·542838 | 9·475763 | 18 138 | 10·524237 | 10·018601 | 18 11 | 9·981399 | 24 | 21 |
| 30 | 38 | 9·457373 | 19 134 | 10·542627 | 9·475993 | 19 146 | 10·524007 | 10·018620 | 19 12 | 9·981380 | 22 | 30 |
| 40 | 40 | 9·457584 | 20 141 | 10·542416 | 9·476223 | 20 154 | 10·523777 | 10·018639 | 20 13 | 9·981361 | 20 | 20 |
| 30 | 42 | 9·457795 | 21 148 | 10·542205 | 9·476453 | 21 161 | 10·523547 | 10·018658 | 21 13 | 9·981342 | 18 | 30 |
| 41 | 44 | 9·458006 | 22 155 | 10·541994 | 9·476683 | 22 169 | 10·523317 | 10·018677 | 22 14 | 9·981323 | 16 | 19 |
| 30 | 46 | 9·458217 | 23 162 | 10·541783 | 9·476913 | 23 177 | 10·523087 | 10·018696 | 23 14 | 9·981304 | 14 | 30 |
| 42 | 48 | 9·458427 | 24 169 | 10·541573 | 9·477142 | 24 184 | 10·522858 | 10·018715 | 24 15 | 9·981285 | 12 | 18 |
| 30 | 50 | 9·458638 | 25 176 | 10·541362 | 9·477372 | 25 192 | 10·522628 | 10·018734 | 25 16 | 9·981266 | 10 | 30 |
| 43 | 52 | 9·458848 | 26 183 | 10·541152 | 9·477601 | 26 200 | 10·522399 | 10·018753 | 26 16 | 9·981247 | 8 | 17 |
| 30 | 54 | 9·459058 | 27 190 | 10·540942 | 9·477830 | 27 207 | 10·522170 | 10·018772 | 27 17 | 9·981228 | 6 | 30 |
| 44 | 56 | 9·459268 | 28 197 | 10·540732 | 9·478059 | 28 215 | 10·521941 | 10·018791 | 28 18 | 9·981209 | 4 | 16 |
| 30 | 58 | 9·459478 | 29 204 | 10·540522 | 9·478288 | 29 223 | 10·521712 | 10·018810 | 29 18 | 9·981190 | 2 | 30 |
| 45 | 7 | 9·459688 | 30 211 | 10·540312 | 9·478517 | 30 230 | 10·521483 | 10·018829 | 30 19 | 9·981171 | 53 | 15 |
| 30 | 2 | 9·459898 | 1 7 | 10·540102 | 9·478746 | 1 8 | 10·521254 | 10·018848 | 1 1 | 9·981152 | 58 | 30 |
| 46 | 4 | 9·460108 | 2 14 | 10·539892 | 9·478975 | 2 15 | 10·521025 | 10·018867 | 2 1 | 9·981133 | 56 | 14 |
| 30 | 6 | 9·460317 | 3 21 | 10·539683 | 9·479203 | 3 23 | 10·520797 | 10·018886 | 3 2 | 9·981114 | 54 | 30 |
| 47 | 8 | 9·460527 | 4 28 | 10·539473 | 9·479432 | 4 30 | 10·520568 | 10·018905 | 4 3 | 9·981095 | 52 | 13 |
| 30 | 10 | 9·460736 | 5 35 | 10·539264 | 9·479660 | 5 38 | 10·520340 | 10·018924 | 5 3 | 9·981076 | 50 | 30 |
| 48 | 12 | 9·460946 | 6 42 | 10·539054 | 9·479889 | 6 45 | 10·520111 | 10·018943 | 6 4 | 9·981057 | 48 | 12 |
| 30 | 14 | 9·461155 | 7 49 | 10·538845 | 9·480117 | 7 53 | 10·519883 | 10·018962 | 7 4 | 9·981038 | 46 | 30 |
| 49 | 16 | 9·461364 | 8 56 | 10·538636 | 9·480345 | 8 61 | 10·519655 | 10·018981 | 8 5 | 9·981019 | 44 | 11 |
| 30 | 18 | 9·461573 | 9 62 | 10·538427 | 9·480573 | 9 68 | 10·519427 | 10·019000 | 9 6 | 9·981000 | 42 | 30 |
| 50 | 20 | 9·461782 | 10 69 | 10·538218 | 9·480801 | 10 76 | 10·519199 | 10·019019 | 10 6 | 9·980981 | 40 | 10 |
| 30 | 22 | 9·461990 | 11 76 | 10·538010 | 9·481029 | 11 83 | 10·518971 | 10·019039 | 11 7 | 9·980961 | 38 | 30 |
| 51 | 24 | 9·462199 | 12 83 | 10·537801 | 9·481257 | 12 91 | 10·518743 | 10·019058 | 12 8 | 9·980942 | 36 | 9 |
| 30 | 26 | 9·462407 | 13 90 | 10·537593 | 9·481484 | 13 99 | 10·518516 | 10·019077 | 13 8 | 9·980923 | 34 | 30 |
| 52 | 28 | 9·462616 | 14 97 | 10·537384 | 9·481712 | 14 106 | 10·518288 | 10·019096 | 14 9 | 9·980904 | 32 | 8 |
| 30 | 30 | 9·462824 | 15 104 | 10·537176 | 9·481939 | 15 114 | 10·518061 | 10·019115 | 15 10 | 9·980885 | 30 | 30 |
| 53 | 32 | 9·463032 | 16 111 | 10·536968 | 9·482167 | 16 121 | 10·517833 | 10·019134 | 16 10 | 9·980866 | 28 | 7 |
| 30 | 34 | 9·463240 | 17 118 | 10·536760 | 9·482394 | 17 129 | 10·517606 | 10·019153 | 17 11 | 9·980847 | 26 | 30 |
| 54 | 36 | 9·463448 | 18 125 | 10·536552 | 9·482621 | 18 136 | 10·517379 | 10·019173 | 18 12 | 9·980827 | 24 | 6 |
| 30 | 38 | 9·463656 | 19 132 | 10·536344 | 9·482848 | 19 144 | 10·517152 | 10·019192 | 19 12 | 9·980808 | 22 | 30 |
| 55 | 40 | 9·463864 | 20 139 | 10·536136 | 9·483075 | 20 152 | 10·516925 | 10·019211 | 20 13 | 9·980789 | 20 | 5 |
| 30 | 42 | 9·464072 | 21 146 | 10·535928 | 9·483302 | 21 159 | 10·516698 | 10·019230 | 21 13 | 9·980770 | 18 | 30 |
| 56 | 44 | 9·464279 | 22 153 | 10·535721 | 9·483529 | 22 167 | 10·516471 | 10·019250 | 22 14 | 9·980750 | 16 | 4 |
| 30 | 46 | 9·464486 | 23 160 | 10·535514 | 9·483755 | 23 174 | 10·516245 | 10·019269 | 23 15 | 9·980731 | 14 | 30 |
| 57 | 48 | 9·464694 | 24 167 | 10·535306 | 9·483982 | 24 182 | 10·516018 | 10·019288 | 24 15 | 9·980712 | 12 | 3 |
| 30 | 50 | 9·464901 | 25 174 | 10·535099 | 9·484208 | 25 189 | 10·515792 | 10·019307 | 25 16 | 9·980693 | 10 | 30 |
| 58 | 52 | 9·465108 | 26 180 | 10·534892 | 9·484435 | 26 197 | 10·515565 | 10·019327 | 26 17 | 9·980673 | 8 | 2 |
| 30 | 54 | 9·465315 | 27 187 | 10·534685 | 9·484661 | 27 205 | 10·515339 | 10·019346 | 27 17 | 9·980654 | 6 | 30 |
| 59 | 56 | 9·465522 | 28 194 | 10·534478 | 9·484887 | 28 212 | 10·515113 | 10·019365 | 28 18 | 9·980635 | 4 | 1 |
| 30 | 58 | 9·465729 | 29 201 | 10·534271 | 9·485113 | 29 220 | 10·514887 | 10·019384 | 29 19 | 9·980616 | 2 | 30 |
| 60 | 8 | 9·465935 | 30 208 | 10·534065 | 9·485339 | 30 227 | 10·514661 | 10·019404 | 30 19 | 9·980596 | 0 | 0 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

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## LOG. SINES, COSINES, &c.

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| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 9·465935 | | 10·534065 | 9·485339 | | 10·514661 | 10·019404 | | 9·980596 | 52 | 60 |
| 30 | 2 | 9·466142 | 1″ 7 | 10·533858 | 9·485565 | 1″ 7 | 10·514435 | 10·019423 | 1″ 1 | 9·980577 | 58 | 30 |
| 1 | 4 | 9·466348 | 2 14 | 10·533652 | 9·485791 | 2 15 | 10·514209 | 10·019442 | 2 1 | 9·980558 | 56 | 59 |
| 30 | 6 | 9·466555 | 3 20 | 10·533445 | 9·486016 | 3 22 | 10·513984 | 10·019462 | 3 2 | 9·980538 | 54 | 30 |
| 2 | 8 | 9·466761 | 4 27 | 10·533239 | 9·486242 | 4 30 | 10·513758 | 10·019481 | 4 3 | 9·980519 | 52 | 58 |
| 30 | 10 | 9·466967 | 5 34 | 10·533033 | 9·486467 | 5 37 | 10·513533 | 10·019500 | 5 3 | 9·980500 | 50 | 30 |
| 3 | 12 | 9·467173 | 6 41 | 10·532827 | 9·486693 | 6 45 | 10·513307 | 10·019520 | 6 4 | 9·980480 | 48 | 57 |
| 30 | 14 | 9·467379 | 7 48 | 10·532621 | 9·486918 | 7 52 | 10·513082 | 10·019539 | 7 5 | 9·980461 | 46 | 30 |
| 4 | 16 | 9·467585 | 8 55 | 10·532415 | 9·487143 | 8 60 | 10·512857 | 10·019558 | 8 5 | 9·980442 | 44 | 56 |
| 30 | 18 | 9·467790 | 9 61 | 10·532210 | 9·487368 | 9 67 | 10·512632 | 10·019578 | 9 6 | 9·980422 | 42 | 30 |
| 5 | 20 | 9·467996 | 10 68 | 10·532004 | 9·487593 | 10 7[illegible] | 10·512407 | 10·019597 | 10 6 | 9·980403 | 40 | 55 |
| 30 | 22 | 9·468202 | 11 75 | 10·531798 | 9·487818 | 11 82 | 10·512182 | 10·019617 | 11 7 | 9·980383 | 38 | 30 |
| 6 | 24 | 9·468407 | 12 82 | 10·531593 | 9·488043 | 12 90 | 10·511957 | 10·019636 | 12 8 | 9·980364 | 36 | 54 |
| 30 | 26 | 9·468612 | 13 89 | 10·531388 | 9·488268 | 13 97 | 10·511732 | 10·019656 | 13 8 | 9·980344 | 34 | 30 |
| 7 | 28 | 9·468817 | 14 96 | 10·531183 | 9·488492 | 14 105 | 10·511508 | 10·019675 | 14 9 | 9·980325 | 32 | 53 |
| 30 | 30 | 9·469022 | 15 102 | 10·530978 | 9·488717 | 15 112 | 10·511283 | 10·019694 | 15 10 | 9·980306 | 30 | 30 |
| 8 | 32 | 9·469227 | 16 109 | 10·530773 | 9·488941 | 16 120 | 10·511059 | 10·019714 | 16 10 | 9·980286 | 28 | 52 |
| 30 | 34 | 9·469432 | 17 116 | 10·530568 | 9·489166 | 17 127 | 10·510834 | 10·019733 | 17 11 | 9·980267 | 26 | 30 |
| 9 | 36 | 9·469637 | 18 123 | 10·530363 | 9·489390 | 18 135 | 10·510610 | 10·019753 | 18 12 | 9·980247 | 24 | 51 |
| 30 | 38 | 9·469842 | 19 130 | 10·530158 | 9·489614 | 19 142 | 10·510386 | 10·019772 | 19 12 | 9·980228 | 22 | 30 |
| 10 | 40 | 9·470046 | 20 137 | 10·529954 | 9·489838 | 20 150 | 10·510162 | 10·019792 | 20 13 | 9·980208 | 20 | 50 |
| 30 | 42 | 9·470251 | 21 143 | 10·529749 | 9·490062 | 21 157 | 10·509938 | 10·019811 | 21 14 | 9·980189 | 18 | 30 |
| 11 | 44 | 9·470455 | 22 150 | 10·529545 | 9·490286 | 22 165 | 10·509714 | 10·019831 | 22 14 | 9·980169 | 16 | 49 |
| 30 | 46 | 9·470659 | 23 157 | 10·529341 | 9·490510 | 23 172 | 10·509490 | 10·019851 | 23 15 | 9·980149 | 14 | 30 |
| 12 | 48 | 9·470863 | 24 164 | 10·529137 | 9·490733 | 24 180 | 10·509267 | 10·019870 | 24 16 | 9·980130 | 12 | 48 |
| 30 | 50 | 9·471067 | 25 171 | 10·528933 | 9·490957 | 25 187 | 10·509043 | 10·019890 | 25 16 | 9·980110 | 10 | 30 |
| 13 | 52 | 9·471271 | 26 178 | 10·528729 | 9·491180 | 26 194 | 10·508820 | 10·019909 | 26 17 | 9·980091 | 8 | 47 |
| 30 | 54 | 9·471475 | 27 184 | 10·528525 | 9·491404 | 27 202 | 10·508596 | 10·019929 | 27 18 | 9·980071 | 6 | 30 |
| 14 | 56 | 9·471679 | 28 191 | 10·528321 | 9·491627 | 28 209 | 10·508373 | 10·019948 | 28 18 | 9·980052 | 4 | 46 |
| 30 | 58 | 9·471882 | 29 198 | 10·528118 | 9·491850 | 29 217 | 10·508150 | 10·019968 | 29 19 | 9·980032 | 2 | 30 |
| 15 | 9 | 9·472086 | 30 205 | 10·527914 | 9·492073 | 30 224 | 10·507927 | 10·019988 | 30 19 | 9·980012 | 52 | 45 |
| 30 | 2 | 9·472289 | 1 7 | 10·527-11 | 9·492296 | 1 7 | 10·507704 | 10·020007 | 1 1 | 9·979993 | 58 | 30 |
| 16 | 4 | 9·472492 | 2 13 | 10·527508 | 9·492519 | 2 15 | 10·507481 | 10·020027 | 2 1 | 9·979973 | 56 | 44 |
| 30 | 6 | 9·472695 | 3 20 | 10·527305 | 9·492742 | 3 22 | 10·507258 | 10·020046 | 3 2 | 9·979954 | 54 | 30 |
| 17 | 8 | 9·472898 | 4 27 | 10·527102 | 9·492965 | 4 30 | 10·507035 | 10·020066 | 4 3 | 9·979934 | 52 | 43 |
| 30 | 10 | 9·473101 | 5 34 | 10·526899 | 9·493187 | 5 37 | 10·506813 | 10·020086 | 5 3 | 9·979914 | 50 | 30 |
| 18 | 12 | 9·473304 | 6 40 | 10·526696 | 9·493410 | 6 44 | 10·506590 | 10·020105 | 6 4 | 9·979895 | 48 | 42 |
| 30 | 14 | 9·473507 | 7 47 | 10·526493 | 9·493632 | 7 52 | 10·506368 | 10·020125 | 7 5 | 9·979875 | 46 | 30 |
| 19 | 16 | 9·473710 | 8 54 | 10·526290 | 9·493854 | 8 59 | 10·506146 | 10·020145 | 8 5 | 9·979855 | 44 | 41 |
| 30 | 18 | 9·473912 | 9 61 | 10·526088 | 9·4940[illegible] | 9 66 | 10·505923 | 10·020164 | 9 6 | 9·979836 | 42 | 30 |
| 20 | 20 | 9·474115 | 10 67 | 10·525885 | 9·494299 | 10 74 | 10·505701 | 10·020184 | 10 7 | 9·979816 | 40 | 40 |
| 30 | 22 | 9·474317 | 11 74 | 10·525683 | 9·494521 | 11 81 | 10·505479 | 10·020204 | 11 7 | 9·979796 | 38 | 30 |
| 21 | 24 | 9·474519 | 12 81 | 10·525481 | 9·494743 | 12 89 | 10·505257 | 10·020224 | 12 8 | 9·979776 | 36 | 39 |
| 30 | 26 | 9·474721 | 13 88 | 10·525279 | 9·494965 | 13 96 | 10·505035 | 10·020243 | 13 9 | 9·979757 | 34 | 30 |
| 22 | 28 | 9·474923 | 14 94 | 10·525077 | 9·495186 | 14 103 | 10·504814 | 10·020263 | 14 9 | 9·979737 | 32 | 38 |
| 30 | 30 | 9·475125 | 15 101 | 10·524875 | 9·495408 | 15 111 | 10·504592 | 10·020283 | 15 10 | 9·979717 | 30 | 30 |
| 23 | 32 | 9·475327 | 16 108 | 10·524673 | 9·495630 | 16 118 | 10·504370 | 10·020303 | 16 11 | 9·979697 | 28 | 37 |
| 30 | 34 | 9·475529 | 17 115 | 10·524471 | 9·495851 | 17 126 | 10·504149 | 10·020322 | 17 11 | 9·979678 | 26 | 30 |
| 24 | 36 | 9·475730 | 18 122 | 10·524270 | 9·496073 | 18 133 | 10·503927 | 10·020342 | 18 12 | 9·979658 | 24 | 36 |
| 30 | 38 | 9·475932 | 19 128 | 10·524068 | 9·496294 | 19 140 | 10·503706 | 10·020362 | 19 13 | 9·979638 | 22 | 30 |
| 25 | 40 | 9·476133 | 20 135 | 10·523867 | 9·496515 | 20 148 | 10·503485 | 10·020382 | 20 13 | 9·979618 | 20 | 35 |
| 30 | 42 | 9·476335 | 21 142 | 10·523665 | 9·496736 | 21 155 | 10·503264 | 10·020402 | 21 14 | 9·979598 | 18 | 30 |
| 26 | 44 | 9·476536 | 22 149 | 10·523464 | 9·496957 | 22 163 | 10·503043 | 10·020421 | 22 15 | 9·979579 | 16 | 34 |
| 30 | 46 | 9·476737 | 23 155 | 10·523263 | 9·497178 | 23 170 | 10·502822 | 10·020441 | 23 15 | 9·979559 | 14 | 30 |
| 27 | 48 | 9·476938 | 24 161 | 10·523062 | 9·497399 | 24 177 | 10·502601 | 10·020461 | 24 16 | 9·979539 | 12 | 33 |
| 30 | 50 | 9·477139 | 25 168 | 10·522861 | 9·497620 | 25 185 | 10·502380 | 10·020481 | 25 16 | 9·979519 | 10 | 30 |
| 28 | 52 | 9·477340 | 26 175 | 10·522660 | 9·497841 | 26 192 | 10·502159 | 10·020501 | 26 17 | 9·979499 | 8 | 32 |
| 30 | 54 | 9·477540 | 27 181 | 10·522460 | 9·498061 | 27 200 | 10·501939 | 10·020521 | 27 18 | 9·979479 | 6 | 30 |
| 29 | 56 | 9·477741 | 28 188 | 10·522259 | 9·498282 | 28 207 | 10·501718 | 10·020541 | 28 18 | 9·979459 | 4 | 31 |
| 30 | 58 | 9·477941 | 29 195 | 10·522059 | 9·498502 | 29 214 | 10·501498 | 10·020561 | 29 19 | 9·979439 | 2 | 30 |
| 30 | 10 | 9·478142 | 30 202 | 10·521858 | 9·498722 | 30 222 | 10·501278 | 10·020580 | 30 20 | 9·979420 | 0 | 30 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

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LOG. SINES, COSINES, &c.

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| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 9·478142 | | 10·521858 | 9·498722 | | 10·501278 | 10·020580 | | 9·979420 | 50 | 30 |
| 30 | 2 | 9·478342 | 1″ 7 | 10·521658 | 9·498943 | 1″ 7 | 10·501057 | 10·020600 | 1″ 1 | 9·979400 | 58 | 30 |
| 31 | 4 | 9·478542 | 2 13 | 10·521458 | 9·499163 | 2 15 | 10·500837 | 10·020620 | 2 1 | 9·979380 | 56 | 29 |
| 30 | 6 | 9·478742 | 3 20 | 10·521258 | 9·499383 | 3 22 | 10·500617 | 10·020640 | 3 2 | 9·979360 | 54 | 30 |
| 32 | 8 | 9·478942 | 4 26 | 10·521058 | 9·499603 | 4 29 | 10·500397 | 10·020660 | 4 3 | 9·979340 | 52 | 28 |
| 30 | 10 | 9·479142 | 5 33 | 10·520858 | 9·499822 | 5 36 | 10·500178 | 10·020680 | 5 3 | 9·979320 | 50 | 30 |
| 33 | 12 | 9·479342 | 6 40 | 10·520658 | 9·500042 | 6 44 | 10·499958 | 10·020700 | 6 4 | 9·979300 | 48 | 27 |
| 30 | 14 | 9·479541 | 7 46 | 10·520458 | 9·500262 | 7 51 | 10·499738 | 10·020720 | 7 5 | 9·979280 | 46 | 30 |
| 34 | 16 | 9·479741 | 8 53 | 10·520259 | 9·500481 | 8 58 | 10·499519 | 10·020740 | 8 5 | 9·979260 | 44 | 26 |
| 30 | 18 | 9·479941 | 9 60 | 10·520059 | 9·500701 | 9 66 | 10·499299 | 10·020760 | 9 6 | 9·979240 | 42 | 30 |
| 35 | 20 | 9·480140 | 10 66 | 10·519860 | 9·500920 | 10 73 | 10·499080 | 10·020780 | 10 7 | 9·979220 | 40 | 25 |
| 30 | 22 | 9·480339 | 11 73 | 10·519661 | 9·501140 | 11 80 | 10·498860 | 10·020800 | 11 7 | 9·979200 | 38 | 30 |
| 36 | 24 | 9·480539 | 12 80 | 10·519461 | 9·501359 | 12 88 | 10·498641 | 10·020820 | 12 8 | 9·979180 | 36 | 24 |
| 30 | 26 | 9·480738 | 13 86 | 10·519262 | 9·501578 | 13 95 | 10·498422 | 10·020840 | 13 9 | 9·979160 | 34 | 30 |
| 37 | 28 | 9·480937 | 14 93 | 10·519063 | 9·501797 | 14 102 | 10·498203 | 10·020860 | 14 9 | 9·979140 | 32 | 23 |
| 30 | 30 | 9·481135 | 15 99 | 10·518865 | 9·502016 | 15 109 | 10·497984 | 10·020880 | 15 10 | 9·979120 | 30 | 30 |
| 38 | 32 | 9·481334 | 16 106 | 10·518666 | 9·502235 | 16 117 | 10·497765 | 10·020900 | 16 11 | 9·979100 | 28 | 22 |
| 30 | 34 | 9·481533 | 17 113 | 10·518467 | 9·502453 | 17 124 | 10·497547 | 10·020921 | 17 11 | 9·979079 | 26 | 30 |
| 39 | 36 | 9·481731 | 18 119 | 10·518269 | 9·502672 | 18 131 | 10·497328 | 10·020941 | 18 12 | 9·979059 | 24 | 21 |
| 30 | 38 | 9·481930 | 19 126 | 10·518070 | 9·502891 | 19 139 | 10·497109 | 10·020961 | 19 13 | 9·979039 | 22 | 30 |
| 40 | 40 | 9·482128 | 20 132 | 10·517872 | 9·503109 | 20 146 | 10·496891 | 10·020981 | 20 13 | 9·979019 | 20 | 20 |
| 30 | 42 | 9·482327 | 21 139 | 10·517673 | 9·503328 | 21 153 | 10·496672 | 10·021001 | 21 14 | 9·978999 | 18 | 30 |
| 41 | 44 | 9·482525 | 22 146 | 10·517475 | 9·503546 | 22 161 | 10·496454 | 10·021021 | 22 15 | 9·978979 | 16 | 19 |
| 30 | 46 | 9·482723 | 23 152 | 10·517277 | 9·503764 | 23 168 | 10·496236 | 10·021041 | 23 15 | 9·978959 | 14 | 30 |
| 42 | 48 | 9·482921 | 24 159 | 10·517079 | 9·503982 | 24 175 | 10·496018 | 10·021061 | 24 16 | 9·978939 | 12 | 18 |
| 30 | 50 | 9·483119 | 25 166 | 10·516881 | 9·504200 | 25 182 | 10·495800 | 10·021082 | 25 17 | 9·978918 | 10 | 30 |
| 43 | 52 | 9·483316 | 26 172 | 10·516684 | 9·504418 | 26 190 | 10·495582 | 10·021102 | 26 17 | 9·978898 | 8 | 17 |
| 30 | 54 | 9·483514 | 27 179 | 10·516486 | 9·504636 | 27 197 | 10·495364 | 10·021122 | 27 18 | 9·978878 | 6 | 30 |
| 44 | 56 | 9·483712 | 28 186 | 10·516288 | 9·504854 | 28 204 | 10·495146 | 10·021142 | 28 19 | 9·978858 | 4 | 16 |
| 30 | 58 | 9·483909 | 29 192 | 10·516091 | 9·505072 | 29 212 | 10·494928 | 10·021162 | 29 19 | 9·978838 | 2 | 30 |
| 45 | 11 | 9·484107 | 30 199 | 10·515893 | 9·505289 | 30 219 | 10·494711 | 10·021183 | 30 20 | 9·978817 | 49 | 15 |
| 30 | 2 | 9·484304 | 1 7 | 10·515696 | 9·505507 | 1 7 | 10·494493 | 10·021203 | 1 1 | 9·978797 | 58 | 30 |
| 46 | 4 | 9·484501 | 2 13 | 10·515499 | 9·505724 | 2 14 | 10·494276 | 10·021223 | 2 1 | 9·978777 | 56 | 14 |
| 30 | 6 | 9·484698 | 3 20 | 10·515302 | 9·505941 | 3 22 | 10·494059 | 10·021243 | 3 2 | 9·978757 | 54 | 30 |
| 47 | 8 | 9·484895 | 4 26 | 10·515105 | 9·506159 | 4 29 | 10·493841 | 10·021263 | 4 3 | 9·978737 | 52 | 13 |
| 30 | 10 | 9·485092 | 5 33 | 10·514908 | 9·506376 | 5 36 | 10·493624 | 10·021284 | 5 3 | 9·978716 | 50 | 30 |
| 48 | 12 | 9·485289 | 6 39 | 10·514711 | 9·506593 | 6 43 | 10·493407 | 10·021304 | 6 4 | 9·978696 | 48 | 12 |
| 30 | 14 | 9·485485 | 7 46 | 10·514515 | 9·506810 | 7 50 | 10·493190 | 10·021324 | 7 5 | 9·978676 | 46 | 30 |
| 49 | 16 | 9·485682 | 8 52 | 10·514318 | 9·507027 | 8 58 | 10·492973 | 10·021345 | 8 5 | 9·978655 | 44 | 11 |
| 30 | 18 | 9·485879 | 9 59 | 10·514121 | 9·507243 | 9 65 | 10·492757 | 10·021365 | 9 6 | 9·978635 | 42 | 30 |
| 50 | 20 | 9·486075 | 10 65 | 10·513925 | 9·507460 | 10 72 | 10·492540 | 10·021385 | 10 7 | 9·978615 | 40 | 10 |
| 30 | 22 | 9·486271 | 11 72 | 10·513729 | 9·507677 | 11 79 | 10·492323 | 10·021406 | 11 7 | 9·978594 | 38 | 30 |
| 51 | 24 | 9·486467 | 12 78 | 10·513533 | 9·507893 | 12 87 | 10·492107 | 10·021426 | 12 8 | 9·978574 | 36 | 9 |
| 30 | 26 | 9·486664 | 13 85 | 10·513336 | 9·508110 | 13 94 | 10·491890 | 10·021446 | 13 9 | 9·978554 | 34 | 30 |
| 52 | 28 | 9·486860 | 14 91 | 10·513140 | 9·508326 | 14 101 | 10·491674 | 10·021467 | 14 10 | 9·978533 | 32 | 8 |
| 30 | 30 | 9·487055 | 15 98 | 10·512945 | 9·508542 | 15 108 | 10·491458 | 10·021487 | 15 10 | 9·978513 | 30 | 30 |
| 53 | 32 | 9·487251 | 16 104 | 10·512749 | 9·508759 | 16 115 | 10·491241 | 10·021507 | 16 11 | 9·978493 | 28 | 7 |
| 30 | 34 | 9·487447 | 17 111 | 10·512553 | 9·508975 | 17 123 | 10·491025 | 10·021528 | 17 12 | 9·978472 | 26 | 30 |
| 54 | 36 | 9·487643 | 18 117 | 10·512357 | 9·509191 | 18 130 | 10·490809 | 10·021548 | 18 12 | 9·978452 | 24 | 6 |
| 30 | 38 | 9·487838 | 19 124 | 10·512162 | 9·509407 | 19 137 | 10·490593 | 10·021569 | 19 13 | 9·978431 | 22 | 30 |
| 55 | 40 | 9·488034 | 20 131 | 10·511966 | 9·509622 | 20 144 | 10·490378 | 10·021589 | 20 14 | 9·978411 | 20 | 5 |
| 30 | 42 | 9·488229 | 21 137 | 10·511771 | 9·509838 | 21 151 | 10·490162 | 10·021609 | 21 14 | 9·978391 | 18 | 30 |
| 56 | 44 | 9·488424 | 22 144 | 10·511576 | 9·510054 | 22 159 | 10·489946 | 10·021630 | 22 15 | 9·978370 | 16 | 4 |
| 30 | 46 | 9·488619 | 23 150 | 10·511381 | 9·510269 | 23 166 | 10·489731 | 10·021650 | 23 16 | 9·978350 | 14 | 30 |
| 57 | 48 | 9·488814 | 24 157 | 10·511186 | 9·510485 | 24 173 | 10·489515 | 10·021671 | 24 16 | 9·978329 | 12 | 3 |
| 30 | 50 | 9·489009 | 25 163 | 10·510991 | 9·510700 | 25 180 | 10·489300 | 10·021691 | 25 17 | 9·978309 | 10 | 30 |
| 58 | 52 | 9·489204 | 26 170 | 10·510796 | 9·510916 | 26 187 | 10·489084 | 10·021712 | 26 18 | 9·978288 | 8 | 2 |
| 30 | 54 | 9·489399 | 27 176 | 10·510601 | 9·511131 | 27 195 | 10·488869 | 10·021732 | 27 18 | 9·978268 | 6 | 30 |
| 59 | 56 | 9·489593 | 28 183 | 10·510407 | 9·511346 | 28 202 | 10·488654 | 10·021753 | 28 19 | 9·978247 | 4 | 1 |
| 30 | 58 | 9·489788 | 29 189 | 10·510212 | 9·511561 | 29 209 | 10·488439 | 10·021773 | 29 20 | 9·978227 | 2 | 30 |
| 60 | 12 | 9·489982 | 30 196 | 10·510018 | 9·511776 | 30 216 | 10·488224 | 10·021794 | 30 20 | 9·978206 | 0 | 0 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

72° 4ʰ 48ᵐ

## LOG. SINES, COSINES, &c.

1h 12m — 18°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 9·489982 | | 10·510018 | 9·511776 | | 10·488224 | 10·021794 | | 9·978206 | 48 | 60 |
| 30 | 2 | 9·490177 | 1″ 6 | 10·509823 | 9·511991 | 1″ 7 | 10·488009 | 10·021814 | 1″ 1 | 9·978186 | 58 | 30 |
| 1 | 4 | 9·490371 | 2 13 | 10·509629 | 9·512206 | 2 14 | 10·487794 | 10·021835 | 2 1 | 9·978165 | 56 | 59 |
| 30 | 6 | 9·490565 | 3 19 | 10·509435 | 9·512420 | 3 21 | 10·487580 | 10·021855 | 3 2 | 9·978145 | 54 | 30 |
| 2 | 8 | 9·490759 | 4 26 | 10·509241 | 9·512635 | 4 28 | 10·487365 | 10·021876 | 4 3 | 9·978124 | 52 | 58 |
| 30 | 10 | 9·490953 | 5 32 | 10·509047 | 9·512850 | 5 36 | 10·487150 | 10·021896 | 5 3 | 9·978104 | 50 | 30 |
| 3 | 12 | 9·491147 | 6 39 | 10·508853 | 9·513064 | 6 43 | 10·486936 | 10·021917 | 6 4 | 9·978083 | 48 | 57 |
| 30 | 14 | 9·491341 | 7 45 | 10·508659 | 9·513278 | 7 50 | 10·486722 | 10·021938 | 7 5 | 9·978062 | 46 | 30 |
| 4 | 16 | 9·491535 | 8 51 | 10·508465 | 9·513493 | 8 57 | 10·486507 | 10·021958 | 8 6 | 9·978042 | 44 | 56 |
| 30 | 18 | 9·491728 | 9 58 | 10·508272 | 9·513707 | 9 64 | 10·486293 | 10·021979 | 9 6 | 9·978021 | 42 | 30 |
| 5 | 20 | 9·491922 | 10 64 | 10·508078 | 9·513921 | 10 71 | 10·486079 | 10·021999 | 10 7 | 9·978001 | 40 | 55 |
| 30 | 22 | 9·492115 | 11 71 | 10·507885 | 9·514135 | 11 78 | 10·485865 | 10·022020 | 11 8 | 9·977980 | 38 | 30 |
| 6 | 24 | 9·492308 | 12 77 | 10·507692 | 9·514349 | 12 85 | 10·485651 | 10·022041 | 12 8 | 9·977959 | 36 | 54 |
| 30 | 26 | 9·492502 | 13 84 | 10·507498 | 9·514563 | 13 93 | 10·485437 | 10·022061 | 13 9 | 9·977939 | 34 | 30 |
| 7 | 28 | 9·492695 | 14 90 | 10·507305 | 9·514777 | 14 100 | 10·485223 | 10·022082 | 14 10 | 9·977918 | 32 | 53 |
| 30 | 30 | 9·492888 | 15 96 | 10·507112 | 9·514990 | 15 107 | 10·485010 | 10·022103 | 15 10 | 9·977897 | 30 | 30 |
| 8 | 32 | 9·493081 | 16 103 | 10·506919 | 9·515204 | 16 114 | 10·484796 | 10·022123 | 16 11 | 9·977877 | 28 | 52 |
| 30 | 34 | 9·493273 | 17 109 | 10·506727 | 9·515417 | 17 121 | 10·484583 | 10·022144 | 17 12 | 9·977856 | 26 | 30 |
| 9 | 36 | 9·493466 | 18 116 | 10·506534 | 9·515631 | 18 128 | 10·484369 | 10·022165 | 18 12 | 9·977835 | 24 | 51 |
| 30 | 38 | 9·493659 | 19 122 | 10·506341 | 9·515844 | 19 135 | 10·484156 | 10·022185 | 19 13 | 9·977815 | 22 | 30 |
| 10 | 40 | 9·493851 | 20 129 | 10·506149 | 9·516057 | 20 142 | 10·483943 | 10·022206 | 20 14 | 9·977794 | 20 | 50 |
| 30 | 42 | 9·494044 | 21 135 | 10·505956 | 9·516271 | 21 150 | 10·483729 | 10·022227 | 21 14 | 9·977773 | 18 | 30 |
| 11 | 44 | 9·494236 | 22 142 | 10·505764 | 9·516484 | 22 157 | 10·483516 | 10·022248 | 22 15 | 9·977752 | 16 | 49 |
| 30 | 46 | 9·494428 | 23 148 | 10·505572 | 9·516697 | 23 164 | 10·483303 | 10·022268 | 23 16 | 9·977732 | 14 | 30 |
| 12 | 48 | 9·494621 | 24 155 | 10·505379 | 9·516910 | 24 171 | 10·483090 | 10·022289 | 24 17 | 9·977711 | 12 | 48 |
| 30 | 50 | 9·494813 | 25 161 | 10·505187 | 9·517123 | 25 178 | 10·482877 | 10·022310 | 25 17 | 9·977690 | 10 | 30 |
| 13 | 52 | 9·495005 | 26 168 | 10·504995 | 9·517335 | 26 185 | 10·482665 | 10·022331 | 26 18 | 9·977669 | 8 | 47 |
| 30 | 54 | 9·495196 | 27 174 | 10·504804 | 9·517548 | 27 192 | 10·482452 | 10·022352 | 27 19 | 9·977648 | 6 | 30 |
| 14 | 56 | 9·495388 | 28 180 | 10·504612 | 9·517761 | 28 199 | 10·482239 | 10·022372 | 28 19 | 9·977628 | 4 | 46 |
| 30 | 58 | 9·495580 | 29 186 | 10·504420 | 9·517973 | 29 206 | 10·482027 | 10·022393 | 29 20 | 9·977607 | 2 | 30 |
| 15 | 13 | 9·495772 | 30 193 | 10·504228 | 9·518186 | 30 214 | 10·481814 | 10·022414 | 30 21 | 9·977586 | 47 | 45 |
| 30 | 2 | 9·495963 | 1 6 | 10·504037 | 9·518398 | 1 7 | 10·481602 | 10·022435 | 1 1 | 9·977565 | 58 | 30 |
| 16 | 4 | 9·496154 | 2 13 | 10·503846 | 9·518610 | 2 14 | 10·481390 | 10·022456 | 2 1 | 9·977544 | 56 | 44 |
| 30 | 6 | 9·496346 | 3 19 | 10·503654 | 9·518822 | 3 21 | 10·481178 | 10·022476 | 3 2 | 9·977524 | 54 | 30 |
| 17 | 8 | 9·496537 | 4 25 | 10·503463 | 9·519034 | 4 28 | 10·480966 | 10·022497 | 4 3 | 9·977503 | 52 | 43 |
| 30 | 10 | 9·496728 | 5 32 | 10·503272 | 9·519246 | 5 35 | 10·480754 | 10·022518 | 5 3 | 9·977482 | 50 | 30 |
| 18 | 12 | 9·496919 | 6 38 | 10·503081 | 9·519458 | 6 42 | 10·480542 | 10·022539 | 6 4 | 9·977461 | 48 | 42 |
| 30 | 14 | 9·497110 | 7 44 | 10·502890 | 9·519670 | 7 49 | 10·480330 | 10·022560 | 7 5 | 9·977440 | 46 | 30 |
| 19 | 16 | 9·497301 | 8 51 | 10·502699 | 9·519882 | 8 56 | 10·480118 | 10·022581 | 8 6 | 9·977419 | 44 | 41 |
| 30 | 18 | 9·497492 | 9 57 | 10·502508 | 9·520094 | 9 63 | 10·479906 | 10·022602 | 9 6 | 9·977398 | 42 | 30 |
| 20 | 20 | 9·497682 | 10 63 | 10·502318 | 9·520305 | 10 70 | 10·479695 | 10·022623 | 10 7 | 9·977377 | 40 | 40 |
| 30 | 22 | 9·497873 | 11 70 | 10·502127 | 9·520517 | 11 77 | 10·479483 | 10·022644 | 11 8 | 9·977356 | 38 | 30 |
| 21 | 24 | 9·498064 | 12 76 | 10·501936 | 9·520728 | 12 84 | 10·479272 | 10·022665 | 12 8 | 9·977335 | 36 | 39 |
| 30 | 26 | 9·498254 | 13 82 | 10·501746 | 9·520939 | 13 91 | 10·479061 | 10·022686 | 13 9 | 9·977314 | 34 | 30 |
| 22 | 28 | 9·498444 | 14 89 | 10·501556 | 9·521151 | 14 98 | 10·478849 | 10·022707 | 14 10 | 9·977293 | 32 | 38 |
| 30 | 30 | 9·498634 | 15 95 | 10·501366 | 9·521362 | 15 105 | 10·478638 | 10·022728 | 15 10 | 9·977272 | 30 | 30 |
| 23 | 32 | 9·498825 | 16 101 | 10·501175 | 9·521573 | 16 112 | 10·478427 | 10·022749 | 16 11 | 9·977251 | 28 | 37 |
| 30 | 34 | 9·499015 | 17 108 | 10·500985 | 9·521784 | 17 120 | 10·478216 | 10·022770 | 17 12 | 9·977230 | 26 | 30 |
| 24 | 36 | 9·499204 | 18 114 | 10·500796 | 9·521995 | 18 127 | 10·478005 | 10·022791 | 18 13 | 9·977209 | 24 | 36 |
| 30 | 38 | 9·499394 | 19 121 | 10·500606 | 9·522206 | 19 134 | 10·477794 | 10·022812 | 19 13 | 9·977188 | 22 | 30 |
| 25 | 40 | 9·499584 | 20 127 | 10·500416 | 9·522417 | 20 141 | 10·477583 | 10·022833 | 20 14 | 9·977167 | 20 | 35 |
| 30 | 42 | 9·499774 | 21 133 | 10·500226 | 9·522627 | 21 148 | 10·477373 | 10·022854 | 21 15 | 9·977146 | 18 | 30 |
| 26 | 44 | 9·499963 | 22 140 | 10·500037 | 9·522838 | 22 155 | 10·477162 | 10·022875 | 22 15 | 9·977125 | 16 | 34 |
| 30 | 46 | 9·500153 | 23 146 | 10·499847 | 9·523048 | 23 162 | 10·476952 | 10·022896 | 23 16 | 9·977104 | 14 | 30 |
| 27 | 48 | 9·500342 | 24 152 | 10·499658 | 9·523259 | 24 169 | 10·476741 | 10·022917 | 24 17 | 9·977083 | 12 | 33 |
| 30 | 50 | 9·500531 | 25 159 | 10·499469 | 9·523469 | 25 176 | 10·476531 | 10·022938 | 25 17 | 9·977062 | 10 | 30 |
| 28 | 52 | 9·500721 | 26 165 | 10·499279 | 9·523680 | 26 183 | 10·476320 | 10·022959 | 26 18 | 9·977041 | 8 | 32 |
| 30 | 54 | 9·500910 | 27 171 | 10·499090 | 9·523890 | 27 190 | 10·476110 | 10·022980 | 27 19 | 9·977020 | 6 | 30 |
| 29 | 56 | 9·501099 | 28 178 | 10·498901 | 9·524100 | 28 197 | 10·475900 | 10·023001 | 28 20 | 9·976999 | 4 | 31 |
| 30 | 58 | 9·501288 | 29 184 | 10·498712 | 9·524310 | 29 204 | 10·475690 | 10·023022 | 29 20 | 9·976978 | 2 | 30 |
| 30 | 14 | 9·501476 | 30 190 | 10·498524 | 9·524520 | 30 211 | 10·475480 | 10·023043 | 30 21 | 9·976957 | 0 | 30 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

71° — 4h 46m

## LOG. SINES, COSINES, &c.

1h 14m — 18°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 9·501476 | | 10·498524 | 9·524520 | | 10·475480 | 10·023043 | | 9·976957 | 46 | 30 |
| 30 | 2 | 9·501665 | 1″ 6 | 10·498335 | 9·524730 | 1″ 7 | 10·475270 | 10·023065 | 1″ 1 | 9·976935 | 58 | 30 |
| 31 | 4 | 9·501854 | 2 12 | 10·498146 | 9·524940 | 2 14 | 10·475060 | 10·023086 | 2 1 | 9·976914 | 56 | 29 |
| 30 | 6 | 9·502042 | 3 19 | 10·497958 | 9·525149 | 3 21 | 10·474851 | 10·023107 | 3 2 | 9·976893 | 54 | 30 |
| 32 | 8 | 9·502231 | 4 25 | 10·497769 | 9·525359 | 4 28 | 10·474641 | 10·023128 | 4 3 | 9·976872 | 52 | 28 |
| 30 | 10 | 9·502419 | 5 31 | 10·497581 | 9·525568 | 5 35 | 10·474432 | 10·023149 | 5 4 | 9·976851 | 50 | 30 |
| 33 | 12 | 9·502607 | 6 37 | 10·497393 | 9·525778 | 6 42 | 10·474222 | 10·023170 | 6 4 | 9·976830 | 48 | 27 |
| 30 | 14 | 9·502796 | 7 44 | 10·497204 | 9·525987 | 7 49 | 10·474013 | 10·023192 | 7 5 | 9·976808 | 46 | 30 |
| 34 | 16 | 9·502984 | 8 50 | 10·497016 | 9·526197 | 8 56 | 10·473803 | 10·023213 | 8 6 | 9·976787 | 44 | 26 |
| 30 | 18 | 9·503172 | 9 56 | 10·496828 | 9·526406 | 9 63 | 10·473594 | 10·023234 | 9 6 | 9·976766 | 42 | 30 |
| 35 | 20 | 9·503360 | 10 62 | 10·496640 | 9·526615 | 10 70 | 10·473385 | 10·023255 | 10 7 | 9·976745 | 40 | 25 |
| 30 | 22 | 9·503548 | 11 69 | 10·496452 | 9·526824 | 11 77 | 10·473176 | 10·023277 | 11 8 | 9·976723 | 38 | 30 |
| 36 | 24 | 9·503735 | 12 75 | 10·496265 | 9·527033 | 12 84 | 10·472967 | 10·023298 | 12 9 | 9·976702 | 36 | 24 |
| 30 | 26 | 9·503923 | 13 81 | 10·496077 | 9·527242 | 13 90 | 10·472758 | 10·023319 | 13 9 | 9·976681 | 34 | 30 |
| 37 | 28 | 9·504110 | 14 87 | 10·495890 | 9·527451 | 14 97 | 10·472549 | 10·023340 | 14 10 | 9·976660 | 32 | 23 |
| 30 | 30 | 9·504298 | 15 94 | 10·495702 | 9·527660 | 15 104 | 10·472340 | 10·023362 | 15 11 | 9·976638 | 30 | 30 |
| 38 | 32 | 9·504485 | 16 100 | 10·495515 | 9·527868 | 16 111 | 10·472132 | 10·023383 | 16 11 | 9·976617 | 28 | 22 |
| 30 | 34 | 9·504673 | 17 106 | 10·495327 | 9·528077 | 17 118 | 10·471923 | 10·023404 | 17 12 | 9·976596 | 26 | 30 |
| 39 | 36 | 9·504860 | 18 112 | 10·495140 | 9·528285 | 18 125 | 10·471715 | 10·023426 | 18 13 | 9·976574 | 24 | 21 |
| 30 | 38 | 9·505047 | 19 119 | 10·494953 | 9·528494 | 19 132 | 10·471506 | 10·023447 | 19 13 | 9·976553 | 22 | 30 |
| 40 | 40 | 9·505234 | 20 125 | 10·494766 | 9·528702 | 20 139 | 10·471298 | 10·023468 | 20 14 | 9·976532 | 20 | 20 |
| 30 | 42 | 9·505421 | 21 131 | 10·494579 | 9·528910 | 21 146 | 10·471090 | 10·023490 | 21 15 | 9·976510 | 18 | 30 |
| 41 | 44 | 9·505608 | 22 137 | 10·494392 | 9·529119 | 22 153 | 10·470881 | 10·023511 | 22 16 | 9·976489 | 16 | 19 |
| 30 | 46 | 9·505794 | 23 144 | 10·494206 | 9·529327 | 23 160 | 10·470673 | 10·023532 | 23 16 | 9·976468 | 14 | 30 |
| 42 | 48 | 9·505981 | 24 150 | 10·494019 | 9·529535 | 24 167 | 10·470465 | 10·023554 | 24 17 | 9·976446 | 12 | 18 |
| 30 | 50 | 9·506168 | 25 156 | 10·493832 | 9·529743 | 25 174 | 10·470257 | 10·023575 | 25 18 | 9·976425 | 10 | 30 |
| 43 | 52 | 9·506354 | 26 162 | 10·493646 | 9·529951 | 26 181 | 10·470049 | 10·023596 | 26 18 | 9·976404 | 8 | 17 |
| 30 | 54 | 9·506541 | 27 169 | 10·493459 | 9·530158 | 27 188 | 10·469842 | 10·023618 | 27 19 | 9·976382 | 6 | 30 |
| 44 | 56 | 9·506727 | 28 175 | 10·493273 | 9·530366 | 28 195 | 10·469634 | 10·023639 | 28 20 | 9·976361 | 4 | 16 |
| 30 | 58 | 9·506913 | 29 181 | 10·493087 | 9·530574 | 29 202 | 10·469426 | 10·023661 | 29 21 | 9·976339 | 2 | 30 |
| 45 | 15 | 9·507099 | 30 187 | 10·492901 | 9·530781 | 30 209 | 10·469219 | 10·023682 | 30 21 | 9·976318 | 45 | 15 |
| 30 | 2 | 9·507285 | 1 6 | 10·492715 | 9·530989 | 1 7 | 10·469011 | 10·023704 | 1 1 | 9·976296 | 58 | 30 |
| 46 | 4 | 9·507471 | 2 12 | 10·492529 | 9·531196 | 2 14 | 10·468804 | 10·023725 | 2 1 | 9·976275 | 56 | 14 |
| 30 | 6 | 9·507657 | 3 18 | 10·492343 | 9·531403 | 3 21 | 10·468597 | 10·023746 | 3 2 | 9·976254 | 54 | 30 |
| 47 | 8 | 9·507843 | 4 25 | 10·492157 | 9·531611 | 4 28 | 10·468389 | 10·023768 | 4 3 | 9·976232 | 52 | 13 |
| 30 | 10 | 9·508028 | 5 31 | 10·491972 | 9·531818 | 5 34 | 10·468182 | 10·023789 | 5 4 | 9·976211 | 50 | 30 |
| 48 | 12 | 9·508214 | 6 37 | 10·491786 | 9·532025 | 6 41 | 10·467975 | 10·023811 | 6 4 | 9·976189 | 48 | 12 |
| 30 | 14 | 9·508400 | 7 43 | 10·491600 | 9·532232 | 7 48 | 10·467768 | 10·023832 | 7 5 | 9·976168 | 46 | 30 |
| 49 | 16 | 9·508585 | 8 49 | 10·491415 | 9·532439 | 8 55 | 10·467561 | 10·023854 | 8 6 | 9·976146 | 44 | 11 |
| 30 | 18 | 9·508770 | 9 55 | 10·491230 | 9·532646 | 9 62 | 10·467354 | 10·023875 | 9 6 | 9·976125 | 42 | 30 |
| 50 | 20 | 9·508956 | 10 62 | 10·491044 | 9·532853 | 10 69 | 10·467147 | 10·023897 | 10 7 | 9·976103 | 40 | 10 |
| 30 | 22 | 9·509141 | 11 68 | 10·490859 | 9·533059 | 11 76 | 10·466941 | 10·023919 | 11 8 | 9·976081 | 38 | 30 |
| 51 | 24 | 9·509326 | 12 74 | 10·490674 | 9·533266 | 12 83 | 10·466734 | 10·023940 | 12 9 | 9·976060 | 36 | 9 |
| 30 | 26 | 9·509511 | 13 80 | 10·490489 | 9·533472 | 13 89 | 10·466528 | 10·023962 | 13 9 | 9·976038 | 34 | 30 |
| 52 | 28 | 9·509696 | 14 86 | 10·490304 | 9·533679 | 14 96 | 10·466321 | 10·023983 | 14 10 | 9·976017 | 32 | 8 |
| 30 | 30 | 9·509880 | 15 92 | 10·490120 | 9·533885 | 15 103 | 10·466115 | 10·024005 | 15 11 | 9·975995 | 30 | 30 |
| 53 | 32 | 9·510065 | 16 99 | 10·489935 | 9·534092 | 16 110 | 10·465908 | 10·024026 | 16 12 | 9·975974 | 28 | 7 |
| 30 | 34 | 9·510250 | 17 105 | 10·489750 | 9·534298 | 17 117 | 10·465702 | 10·024048 | 17 12 | 9·975952 | 26 | 30 |
| 54 | 36 | 9·510434 | 18 111 | 10·489566 | 9·534504 | 18 124 | 10·465496 | 10·024070 | 18 13 | 9·975930 | 24 | 6 |
| 30 | 38 | 9·510619 | 19 117 | 10·489381 | 9·534710 | 19 131 | 10·465290 | 10·024091 | 19 14 | 9·975909 | 22 | 30 |
| 55 | 40 | 9·510803 | 20 123 | 10·489197 | 9·534916 | 20 138 | 10·465084 | 10·024113 | 20 14 | 9·975887 | 20 | 5 |
| 30 | 42 | 9·510987 | 21 129 | 10·489013 | 9·535122 | 21 144 | 10·464878 | 10·024135 | 21 15 | 9·975865 | 18 | 30 |
| 56 | 44 | 9·511172 | 22 135 | 10·488828 | 9·535328 | 22 151 | 10·464672 | 10·024156 | 22 16 | 9·975844 | 16 | 4 |
| 30 | 46 | 9·511356 | 23 142 | 10·488644 | 9·535534 | 23 158 | 10·464466 | 10·024178 | 23 17 | 9·975822 | 14 | 30 |
| 57 | 48 | 9·511540 | 24 148 | 10·488460 | 9·535739 | 24 165 | 10·464261 | 10·024200 | 24 17 | 9·975800 | 12 | 3 |
| 30 | 50 | 9·511724 | 25 154 | 10·488276 | 9·535945 | 25 172 | 10·464055 | 10·024221 | 25 18 | 9·975779 | 10 | 30 |
| 58 | 52 | 9·511907 | 26 160 | 10·488093 | 9·536150 | 26 178 | 10·463850 | 10·024243 | 26 19 | 9·975757 | 8 | 2 |
| 30 | 54 | 9·512091 | 27 166 | 10·487909 | 9·536356 | 27 186 | 10·463644 | 10·024265 | 27 19 | 9·975735 | 6 | 30 |
| 59 | 56 | 9·512275 | 28 172 | 10·487725 | 9·536561 | 28 193 | 10·463439 | 10·024286 | 28 20 | 9·975714 | 4 | 1 |
| 30 | 58 | 9·512458 | 29 179 | 10·487542 | 9·536767 | 29 200 | 10·463233 | 10·024308 | 29 21 | 9·975692 | 2 | 30 |
| 60 | 16 | 9·512642 | 30 185 | 10·487358 | 9·536972 | 30 206 | 10·463028 | 10·024330 | 30 22 | 9·975670 | 0 | 0 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

71° — 4h 44m

## LOG. SINES, COSINES, &c.

1h 16m — 19°

| ′ ″ | m. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 9·512642 | | 10·487358 | 9·536972 | | 10·463028 | 10·024330 | | 9·975670 | 44 | 60 |
| 30 | 2 | 9·512825 | 1″ 6 | 10·487175 | 9·537177 | 1″ 7 | 10·462823 | 10·024352 | 1″ 1 | 9·975648 | 58 | 30 |
| 1 | 4 | 9·513009 | 2 12 | 10·486991 | 9·537382 | 2 14 | 10·462618 | 10·024373 | 2 1 | 9·975627 | 56 | 59 |
| 30 | 6 | 9·513192 | 3 18 | 10·486808 | 9·537587 | 3 20 | 10·462413 | 10·024395 | 3 2 | 9·975605 | 54 | 30 |
| 2 | 8 | 9·513375 | 4 24 | 10·486625 | 9·537792 | 4 27 | 10·462208 | 10·024417 | 4 3 | 9·975583 | 52 | 58 |
| 30 | 10 | 9·513558 | 5 30 | 10·486442 | 9·537997 | 5 34 | 10·462003 | 10·024439 | 5 4 | 9·975561 | 50 | 30 |
| 3 | 12 | 9·513741 | 6 36 | 10·486259 | 9·538202 | 6 41 | 10·461798 | 10·024461 | 6 4 | 9·975539 | 48 | 57 |
| 30 | 14 | 9·513924 | 7 43 | 10·486076 | 9·538406 | 7 48 | 10·461594 | 10·024482 | 7 5 | 9·975518 | 46 | 30 |
| 4 | 16 | 9·514107 | 8 49 | 10·485893 | 9·538611 | 8 54 | 10·461389 | 10·024504 | 8 6 | 9·975496 | 44 | 56 |
| 30 | 18 | 9·514289 | 9 55 | 10·485711 | 9·538816 | 9 61 | 10·461184 | 10·024526 | 9 7 | 9·975474 | 42 | 30 |
| 5 | 20 | 9·514472 | 10 61 | 10·485528 | 9·539020 | 10 68 | 10·460980 | 10·024548 | 10 7 | 9·975452 | 40 | 55 |
| 30 | 22 | 9·514655 | 11 67 | 10·485345 | 9·539224 | 11 75 | 10·460776 | 10·024570 | 11 8 | 9·975430 | 38 | 30 |
| 6 | 24 | 9·514837 | 12 73 | 10·485163 | 9·539429 | 12 82 | 10·460571 | 10·024592 | 12 9 | 9·975408 | 36 | 54 |
| 30 | 26 | 9·515019 | 13 79 | 10·484981 | 9·539633 | 13 88 | 10·460367 | 10·024614 | 13 9 | 9·975386 | 34 | 30 |
| 7 | 28 | 9·515202 | 14 85 | 10·484798 | 9·539837 | 14 95 | 10·460163 | 10·024635 | 14 10 | 9·975365 | 32 | 53 |
| 30 | 30 | 9·515384 | 15 91 | 10·484616 | 9·540041 | 15 102 | 10·459959 | 10·024657 | 15 11 | 9·975343 | 30 | 30 |
| 8 | 32 | 9·515566 | 16 97 | 10·484434 | 9·540245 | 16 109 | 10·459755 | 10·024679 | 16 12 | 9·975321 | 28 | 52 |
| 30 | 34 | 9·515748 | 17 103 | 10·484252 | 9·540449 | 17 116 | 10·459551 | 10·024701 | 17 12 | 9·975299 | 26 | 30 |
| 9 | 36 | 9·515930 | 18 109 | 10·484070 | 9·540653 | 18 122 | 10·459347 | 10·024723 | 18 13 | 9·975277 | 24 | 51 |
| 30 | 38 | 9·516112 | 19 115 | 10·483888 | 9·540857 | 19 129 | 10·459143 | 10·024745 | 19 14 | 9·975255 | 22 | 30 |
| 10 | 40 | 9·516294 | 20 121 | 10·483706 | 9·541061 | 20 136 | 10·458939 | 10·024767 | 20 15 | 9·975233 | 20 | 50 |
| 30 | 42 | 9·516475 | 21 127 | 10·483525 | 9·541264 | 21 143 | 10·458736 | 10·024789 | 21 15 | 9·975211 | 18 | 30 |
| 11 | 44 | 9·516657 | 22 134 | 10·483343 | 9·541468 | 22 150 | 10·458532 | 10·024811 | 22 16 | 9·975189 | 16 | 49 |
| 30 | 46 | 9·516838 | 23 140 | 10·483162 | 9·541671 | 23 156 | 10·458329 | 10·024833 | 23 17 | 9·975167 | 14 | 30 |
| 12 | 48 | 9·517020 | 24 146 | 10·482980 | 9·541875 | 24 163 | 10·458125 | 10·024855 | 24 18 | 9·975145 | 12 | 48 |
| 30 | 50 | 9·517201 | 25 152 | 10·482799 | 9·542078 | 25 170 | 10·457922 | 10·024877 | 25 18 | 9·975123 | 10 | 30 |
| 13 | 52 | 9·517382 | 26 158 | 10·482618 | 9·542281 | 26 177 | 10·457719 | 10·024899 | 26 19 | 9·975101 | 8 | 47 |
| 30 | 54 | 9·517564 | 27 164 | 10·482436 | 9·542485 | 27 184 | 10·457515 | 10·024921 | 27 20 | 9·975079 | 6 | 30 |
| 14 | 56 | 9·517745 | 28 170 | 10·482255 | 9·542688 | 28 190 | 10·457312 | 10·024943 | 28 20 | 9·975057 | 4 | 46 |
| 30 | 58 | 9·517926 | 29 176 | 10·482074 | 9·542891 | 29 197 | 10·457109 | 10·024965 | 29 21 | 9·975035 | 2 | 30 |
| 15 | 17 | 9·518107 | 30 182 | 10·481893 | 9·543094 | 30 204 | 10·456906 | 10·024987 | 30 22 | 9·975013 | 43 | 45 |
| 30 | 2 | 9·518287 | 1 6 | 10·481713 | 9·543297 | 1 7 | 10·456703 | 10·025009 | 1 1 | 9·974991 | 58 | 30 |
| 16 | 4 | 9·518468 | 2 12 | 10·481532 | 9·543499 | 2 13 | 10·456501 | 10·025031 | 2 1 | 9·974969 | 56 | 44 |
| 30 | 6 | 9·518649 | 3 18 | 10·481351 | 9·543702 | 3 20 | 10·456298 | 10·025053 | 3 2 | 9·974947 | 54 | 30 |
| 17 | 8 | 9·518829 | 4 24 | 10·481171 | 9·543905 | 4 27 | 10·456095 | 10·025075 | 4 3 | 9·974925 | 52 | 43 |
| 30 | 10 | 9·519010 | 5 30 | 10·480990 | 9·544107 | 5 34 | 10·455893 | 10·025098 | 5 4 | 9·974903 | 50 | 30 |
| 18 | 12 | 9·519190 | 6 36 | 10·480810 | 9·544310 | 6 40 | 10·455690 | 10·025120 | 6 4 | 9·974880 | 48 | 42 |
| 30 | 14 | 9·519371 | 7 42 | 10·480629 | 9·544512 | 7 47 | 10·455488 | 10·025142 | 7 5 | 9·974858 | 46 | 30 |
| 19 | 16 | 9·519551 | 8 48 | 10·480449 | 9·544715 | 8 54 | 10·455285 | 10·025164 | 8 6 | 9·974836 | 44 | 41 |
| 30 | 18 | 9·519731 | 9 54 | 10·480269 | 9·544917 | 9 61 | 10·455083 | 10·025186 | 9 7 | 9·974814 | 42 | 30 |
| 20 | 20 | 9·519911 | 10 60 | 10·480089 | 9·545119 | 10 67 | 10·454881 | 10·025208 | 10 7 | 9·974792 | 40 | 40 |
| 30 | 22 | 9·520091 | 11 66 | 10·479909 | 9·545322 | 11 74 | 10·454678 | 10·025230 | 11 8 | 9·974770 | 38 | 30 |
| 21 | 24 | 9·520271 | 12 72 | 10·479729 | 9·545524 | 12 81 | 10·454476 | 10·025252 | 12 9 | 9·974748 | 36 | 39 |
| 30 | 26 | 9·520451 | 13 78 | 10·479549 | 9·545726 | 13 87 | 10·454274 | 10·025275 | 13 10 | 9·974725 | 34 | 30 |
| 22 | 28 | 9·520631 | 14 84 | 10·479369 | 9·545928 | 14 94 | 10·454072 | 10·025297 | 14 10 | 9·974703 | 32 | 38 |
| 30 | 30 | 9·520810 | 15 90 | 10·479190 | 9·546129 | 15 101 | 10·453871 | 10·025319 | 15 11 | 9·974681 | 30 | 30 |
| 23 | 32 | 9·520990 | 16 96 | 10·479010 | 9·546331 | 16 108 | 10·453669 | 10·025341 | 16 12 | 9·974659 | 28 | 37 |
| 30 | 34 | 9·521169 | 17 102 | 10·478831 | 9·546533 | 17 114 | 10·453467 | 10·025364 | 17 13 | 9·974636 | 26 | 30 |
| 24 | 36 | 9·521349 | 18 108 | 10·478651 | 9·546735 | 18 121 | 10·453265 | 10·025386 | 18 13 | 9·974614 | 24 | 36 |
| 30 | 38 | 9·521528 | 19 114 | 10·478472 | 9·546936 | 19 128 | 10·453064 | 10·025408 | 19 14 | 9·974592 | 22 | 30 |
| 25 | 40 | 9·521707 | 20 120 | 10·478293 | 9·547138 | 20 135 | 10·452862 | 10·025430 | 20 15 | 9·974570 | 20 | 35 |
| 30 | 42 | 9·521887 | 21 126 | 10·478113 | 9·547339 | 21 141 | 10·452661 | 10·025453 | 21 16 | 9·974547 | 18 | 30 |
| 26 | 44 | 9·522066 | 22 132 | 10·477934 | 9·547540 | 22 148 | 10·452460 | 10·025475 | 22 16 | 9·974525 | 16 | 34 |
| 30 | 46 | 9·522245 | 23 138 | 10·477755 | 9·547742 | 23 155 | 10·452258 | 10·025497 | 23 17 | 9·974503 | 14 | 30 |
| 27 | 48 | 9·522424 | 24 144 | 10·477576 | 9·547943 | 24 162 | 10·452057 | 10·025519 | 24 18 | 9·974481 | 12 | 33 |
| 30 | 50 | 9·522602 | 25 150 | 10·477398 | 9·548144 | 25 168 | 10·451856 | 10·025542 | 25 18 | 9·974458 | 10 | 30 |
| 28 | 52 | 9·522781 | 26 156 | 10·477219 | 9·548345 | 26 175 | 10·451655 | 10·025564 | 26 19 | 9·974436 | 8 | 32 |
| 30 | 54 | 9·522960 | 27 162 | 10·477040 | 9·548546 | 27 182 | 10·451454 | 10·025586 | 27 20 | 9·974414 | 6 | 30 |
| 29 | 56 | 9·523138 | 28 168 | 10·476862 | 9·548747 | 28 188 | 10·451253 | 10·025609 | 28 21 | 9·974391 | 4 | 31 |
| 30 | 58 | 9·523317 | 29 174 | 10·476683 | 9·548948 | 29 195 | 10·451052 | 10·025631 | 29 21 | 9·974369 | 2 | 30 |
| 30 | 18 | 9·523495 | 30 180 | 10·476505 | 9·549149 | 30 202 | 10·450851 | 10·025653 | 30 22 | 9·974347 | 0 | 30 |
| ′ ″ | m. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. | ′ ″ |

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## LOG. SINES, COSINES, &c.

1ʰ 18ᵐ — 19°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 9·523495 | | 10·476505 | 9·549149 | | 10·450851 | 10·025653 | | 9·974347 | 42 | 30 |
| 30 | 2 | 9·523674 | 1″ 6 | 10·476326 | 9·549349 | 1″ 7 | 10·450651 | 10·025676 | 1″ 1 | 9·974324 | 58 | 30 |
| 31 | 4 | 9·523852 | 2 12 | 10·476148 | 9·549550 | 2 13 | 10·450450 | 10·025698 | 2 1 | 9·974302 | 56 | 29 |
| 30 | 6 | 9·524030 | 3 18 | 10·475970 | 9·549751 | 3 20 | 10·450249 | 10·025721 | 3 2 | 9·974279 | 54 | 30 |
| 32 | 8 | 9·524208 | 4 24 | 10·475792 | 9·549951 | 4 27 | 10·450049 | 10·025743 | 4 3 | 9·974257 | 52 | 28 |
| 30 | 10 | 9·524386 | 5 30 | 10·475614 | 9·550152 | 5 33 | 10·449848 | 10·025765 | 5 4 | 9·974235 | 50 | 30 |
| 33 | 12 | 9·524564 | 6 35 | 10·475436 | 9·550352 | 6 40 | 10·449648 | 10·025788 | 6 4 | 9·974212 | 48 | 27 |
| 30 | 14 | 9·524742 | 7 41 | 10·475258 | 9·550552 | 7 47 | 10·449448 | 10·025810 | 7 5 | 9·974190 | 46 | 30 |
| 34 | 16 | 9·524920 | 8 47 | 10·475080 | 9·550752 | 8 53 | 10·449248 | 10·025833 | 8 6 | 9·974167 | 44 | 26 |
| 30 | 18 | 9·525097 | 9 53 | 10·474903 | 9·550952 | 9 60 | 10·449048 | 10·025855 | 9 7 | 9·974145 | 42 | 30 |
| 35 | 20 | 9·525275 | 10 59 | 10·474725 | 9·551153 | 10 66 | 10·448847 | 10·025878 | 10 7 | 9·974122 | 40 | 25 |
| 30 | 22 | 9·525452 | 11 65 | 10·474548 | 9·551353 | 11 73 | 10·448647 | 10·025900 | 11 8 | 9·974100 | 38 | 30 |
| 36 | 24 | 9·525630 | 12 71 | 10·474370 | 9·551552 | 12 80 | 10·448448 | 10·025923 | 12 9 | 9·974077 | 36 | 24 |
| 30 | 26 | 9·525807 | 13 77 | 10·474193 | 9·551752 | 13 86 | 10·448248 | 10·025945 | 13 10 | 9·974055 | 34 | 30 |
| 37 | 28 | 9·525984 | 14 83 | 10·474016 | 9·551952 | 14 93 | 10·448048 | 10·025968 | 14 10 | 9·974032 | 32 | 23 |
| 30 | 30 | 9·526162 | 15 89 | 10·473838 | 9·552152 | 15 98 | 10·447848 | 10·025990 | 15 11 | 9·974010 | 30 | 30 |
| 38 | 32 | 9·526339 | 16 94 | 10·473661 | 9·552351 | 16 106 | 10·447649 | 10·026013 | 16 12 | 9·973987 | 28 | 22 |
| 30 | 34 | 9·526516 | 17 100 | 10·473484 | 9·552551 | 17 113 | 10·447449 | 10·026035 | 17 13 | 9·973965 | 26 | 30 |
| 39 | 36 | 9·526693 | 18 106 | 10·473307 | 9·552750 | 18 120 | 10·447250 | 10·026058 | 18 13 | 9·973942 | 24 | 21 |
| 30 | 38 | 9·526870 | 19 112 | 10·473130 | 9·552950 | 19 126 | 10·447050 | 10·026080 | 19 14 | 9·973920 | 22 | 30 |
| 40 | 40 | 9·527046 | 20 118 | 10·472954 | 9·553149 | 20 133 | 10·446851 | 10·026103 | 20 15 | 9·973897 | 20 | 20 |
| 30 | 42 | 9·527223 | 21 124 | 10·472777 | 9·553348 | 21 140 | 10·446652 | 10·026126 | 21 16 | 9·973875 | 18 | 30 |
| 41 | 44 | 9·527400 | 22 130 | 10·472600 | 9·553548 | 22 146 | 10·446452 | 10·026148 | 22 16 | 9·973852 | 16 | 19 |
| 30 | 46 | 9·527576 | 23 136 | 10·472424 | 9·553747 | 23 153 | 10·446253 | 10·026171 | 23 17 | 9·973829 | 14 | 30 |
| 42 | 48 | 9·527753 | 24 142 | 10·472247 | 9·553946 | 24 160 | 10·446054 | 10·026193 | 24 18 | 9·973807 | 12 | 18 |
| 30 | 50 | 9·527929 | 25 148 | 10·472071 | 9·554145 | 25 166 | 10·445855 | 10·026216 | 25 19 | 9·973784 | 10 | 30 |
| 43 | 52 | 9·528105 | 26 153 | 10·471895 | 9·554344 | 26 173 | 10·445656 | 10·026239 | 26 19 | 9·973761 | 8 | 17 |
| 30 | 54 | 9·528282 | 27 159 | 10·471718 | 9·554543 | 27 180 | 10·445457 | 10·026261 | 27 20 | 9·973739 | 6 | 30 |
| 44 | 56 | 9·528458 | 28 165 | 10·471542 | 9·554741 | 28 186 | 10·445259 | 10·026284 | 28 21 | 9·973716 | 4 | 16 |
| 30 | 58 | 9·528634 | 29 171 | 10·471366 | 9·554940 | 29 193 | 10·445060 | 10·026307 | 29 22 | 9·973694 | 2 | 30 |
| 45 | 19 | 9·528810 | 30 177 | 10·471190 | 9·555139 | 30 199 | 10·444861 | 10·026329 | 30 22 | 9·973671 | 41 | 15 |
| 30 | 2 | 9·528986 | 1 6 | 10·471014 | 9·555337 | 1 7 | 10·444663 | 10·026352 | 1 1 | 9·973648 | 58 | 30 |
| 46 | 4 | 9·529161 | 2 12 | 10·470839 | 9·555536 | 2 13 | 10·444464 | 10·026375 | 2 2 | 9·973625 | 56 | 14 |
| 30 | 6 | 9·529337 | 3 17 | 10·470663 | 9·555734 | 3 20 | 10·444266 | 10·026397 | 3 2 | 9·973603 | 54 | 30 |
| 47 | 8 | 9·529513 | 4 23 | 10·470487 | 9·555933 | 4 26 | 10·444067 | 10·026420 | 4 3 | 9·973580 | 52 | 13 |
| 30 | 10 | 9·529688 | 5 29 | 10·470312 | 9·556131 | 5 33 | 10·443869 | 10·026443 | 5 4 | 9·973557 | 50 | 30 |
| 48 | 12 | 9·529864 | 6 35 | 10·470136 | 9·556329 | 6 40 | 10·443671 | 10·026465 | 6 5 | 9·973535 | 48 | 12 |
| 30 | 14 | 9·530039 | 7 41 | 10·469961 | 9·556527 | 7 46 | 10·443473 | 10·026488 | 7 5 | 9·973512 | 46 | 30 |
| 49 | 16 | 9·530215 | 8 47 | 10·469785 | 9·556725 | 8 53 | 10·443275 | 10·026511 | 8 6 | 9·973489 | 44 | 11 |
| 30 | 18 | 9·530390 | 9 52 | 10·469610 | 9·556923 | 9 59 | 10·443077 | 10·026534 | 9 7 | 9·973466 | 42 | 30 |
| 50 | 20 | 9·530565 | 10 58 | 10·469435 | 9·557121 | 10 66 | 10·442879 | 10·026556 | 10 8 | 9·973444 | 40 | 10 |
| 30 | 22 | 9·530740 | 11 64 | 10·469260 | 9·557319 | 11 72 | 10·442681 | 10·026579 | 11 8 | 9·973421 | 38 | 30 |
| 51 | 24 | 9·530915 | 12 70 | 10·469085 | 9·557517 | 12 79 | 10·442483 | 10·026602 | 12 9 | 9·973398 | 36 | 9 |
| 30 | 26 | 9·531090 | 13 76 | 10·468910 | 9·557715 | 13 86 | 10·442285 | 10·026625 | 13 10 | 9·973375 | 34 | 30 |
| 52 | 28 | 9·531265 | 14 81 | 10·468735 | 9·557913 | 14 92 | 10·442087 | 10·026648 | 14 10 | 9·973352 | 32 | 8 |
| 30 | 30 | 9·531440 | 15 87 | 10·468560 | 9·558110 | 15 99 | 10·441890 | 10·026671 | 15 11 | 9·973330 | 30 | 30 |
| 53 | 32 | 9·531614 | 16 93 | 10·468386 | 9·558308 | 16 105 | 10·441692 | 10·026693 | 16 12 | 9·973307 | 28 | 7 |
| 30 | 34 | 9·531789 | 17 99 | 10·468211 | 9·558505 | 17 112 | 10·441495 | 10·026716 | 17 13 | 9·973284 | 26 | 30 |
| 54 | 36 | 9·531963 | 18 105 | 10·468037 | 9·558703 | 18 119 | 10·441297 | 10·026739 | 18 14 | 9·973261 | 24 | 6 |
| 30 | 38 | 9·532138 | 19 111 | 10·467862 | 9·558900 | 19 125 | 10·441100 | 10·026762 | 19 14 | 9·973238 | 22 | 30 |
| 55 | 40 | 9·532312 | 20 117 | 10·467688 | 9·559097 | 20 132 | 10·440903 | 10·026785 | 20 15 | 9·973215 | 20 | 5 |
| 30 | 42 | 9·532487 | 21 123 | 10·467513 | 9·559294 | 21 138 | 10·440706 | 10·026808 | 21 16 | 9·973192 | 18 | 30 |
| 56 | 44 | 9·532661 | 22 128 | 10·467339 | 9·559491 | 22 145 | 10·440509 | 10·026831 | 22 17 | 9·973169 | 16 | 4 |
| 30 | 46 | 9·532835 | 23 134 | 10·467165 | 9·559688 | 23 152 | 10·440312 | 10·026854 | 23 17 | 9·973146 | 14 | 30 |
| 57 | 48 | 9·533009 | 24 140 | 10·466991 | 9·559885 | 24 158 | 10·440115 | 10·026876 | 24 18 | 9·973124 | 12 | 3 |
| 30 | 50 | 9·533183 | 25 146 | 10·466817 | 9·560082 | 25 165 | 10·439918 | 10·026899 | 25 19 | 9·973101 | 10 | 30 |
| 58 | 52 | 9·533357 | 26 152 | 10·466643 | 9·560279 | 26 171 | 10·439721 | 10·026922 | 26 20 | 9·973078 | 8 | 2 |
| 30 | 54 | 9·533531 | 27 158 | 10·466469 | 9·560476 | 27 178 | 10·439524 | 10·026945 | 27 21 | 9·973055 | 6 | 30 |
| 59 | 56 | 9·533704 | 28 164 | 10·466296 | 9·560673 | 28 185 | 10·439327 | 10·026968 | 28 21 | 9·973032 | 4 | 1 |
| 30 | 58 | 9·533878 | 29 169 | 10·466122 | 9·560869 | 29 191 | 10·439131 | 10·026991 | 29 22 | 9·973009 | 2 | 30 |
| 60 | 20 | 9·534052 | 30 175 | 10·465948 | 9·561066 | 30 198 | 10·438934 | 10·027014 | 30 23 | 9·972986 | 0 | 0 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

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## LOG. SINES, COSINES, &c.

$1^h\ 20^m$ 20°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 9·534052 | | 10·465948 | 9·561066 | | 10·438934 | 10·027014 | | 9·972986 | 40 | 60 |
| 30 | 2 | 9·534225 | 1″ 6 | 10·465775 | 9·561262 | 1″ 7 | 10·438738 | 10·027037 | 1″ 1 | 9·972963 | 58 | 30 |
| 1 | 4 | 9·534399 | 2 11 | 10·465601 | 9·561459 | 2 13 | 10·438541 | 10·027060 | 2 2 | 9·972940 | 56 | 59 |
| 30 | 6 | 9·534572 | 3 17 | 10·465428 | 9·561655 | 3 20 | 10·438345 | 10·027083 | 3 2 | 9·972917 | 54 | 30 |
| 2 | 8 | 9·534745 | 4 23 | 10·465255 | 9·561851 | 4 26 | 10·438149 | 10·027106 | 4 3 | 9·972894 | 52 | 58 |
| 30 | 10 | 9·534918 | 5 29 | 10·465082 | 9·562048 | 5 33 | 10·437952 | 10·027129 | 5 4 | 9·972871 | 50 | 30 |
| 3 | 12 | 9·535092 | 6 34 | 10·464908 | 9·562244 | 6 39 | 10·437756 | 10·027152 | 6 5 | 9·972848 | 48 | 57 |
| 30 | 14 | 9·535265 | 7 40 | 10·464735 | 9·562440 | 7 46 | 10·437560 | 10·027175 | 7 5 | 9·972825 | 46 | 30 |
| 4 | 16 | 9·535438 | 8 46 | 10·464562 | 9·562636 | 8 52 | 10·437364 | 10·027198 | 8 6 | 9·972802 | 44 | 56 |
| 30 | 18 | 9·535610 | 9 52 | 10·464390 | 9·562832 | 9 59 | 10·437168 | 10·027222 | 9 7 | 9·972778 | 42 | 30 |
| 5 | 20 | 9·535783 | 10 57 | 10·464217 | 9·563028 | 10 65 | 10·436972 | 10·027245 | 10 8 | 9·972755 | 40 | 55 |
| 30 | 22 | 9·535956 | 11 63 | 10·464044 | 9·563224 | 11 72 | 10·436776 | 10·027268 | 11 8 | 9·972732 | 38 | 30 |
| 6 | 24 | 9·536129 | 12 69 | 10·463871 | 9·563419 | 12 78 | 10·436581 | 10·027291 | 12 9 | 9·972709 | 36 | 54 |
| 30 | 26 | 9·536301 | 13 75 | 10·463699 | 9·563615 | 13 85 | 10·436385 | 10·027314 | 13 10 | 9·972686 | 34 | 30 |
| 7 | 28 | 9·536474 | 14 80 | 10·463526 | 9·563811 | 14 91 | 10·436189 | 10·027337 | 14 11 | 9·972663 | 32 | 53 |
| 30 | 30 | 9·536646 | 15 86 | 10·463354 | 9·564006 | 15 98 | 10·435994 | 10·027360 | 15 12 | 9·972640 | 30 | 30 |
| 8 | 32 | 9·536818 | 16 92 | 10·463182 | 9·564202 | 16 104 | 10·435798 | 10·027383 | 16 12 | 9·972617 | 28 | 52 |
| 30 | 34 | 9·536991 | 17 98 | 10·463009 | 9·564397 | 17 111 | 10·435603 | 10·027407 | 17 13 | 9·972593 | 26 | 30 |
| 9 | 36 | 9·537163 | 18 103 | 10·462837 | 9·564593 | 18 117 | 10·435407 | 10·027430 | 18 14 | 9·972570 | 24 | 51 |
| 30 | 38 | 9·537335 | 19 109 | 10·462665 | 9·564788 | 19 124 | 10·435212 | 10·027453 | 19 15 | 9·972547 | 22 | 30 |
| 10 | 40 | 9·537507 | 20 115 | 10·462493 | 9·564983 | 20 130 | 10·435017 | 10·027476 | 20 15 | 9·972524 | 20 | 50 |
| 30 | 42 | 9·537679 | 21 121 | 10·462321 | 9·565178 | 21 137 | 10·434822 | 10·027499 | 21 16 | 9·972501 | 18 | 30 |
| 11 | 44 | 9·537851 | 22 126 | 10·462149 | 9·565373 | 22 143 | 10·434627 | 10·027522 | 22 17 | 9·972478 | 16 | 49 |
| 30 | 46 | 9·538023 | 23 132 | 10·461977 | 9·565568 | 23 150 | 10·434432 | 10·027546 | 23 18 | 9·972454 | 14 | 30 |
| 12 | 48 | 9·538194 | 24 138 | 10·461806 | 9·565763 | 24 156 | 10·434237 | 10·027569 | 24 18 | 9·972431 | 12 | 48 |
| 30 | 50 | 9·538366 | 25 144 | 10·461634 | 9·565958 | 25 163 | 10·434042 | 10·027592 | 25 19 | 9·972408 | 10 | 30 |
| 13 | 52 | 9·538538 | 26 149 | 10·461462 | 9·566153 | 26 170 | 10·433847 | 10·027615 | 26 20 | 9·972385 | 8 | 47 |
| 30 | 54 | 9·538709 | 27 155 | 10·461291 | 9·566348 | 27 176 | 10·433652 | 10·027639 | 27 21 | 9·972361 | 6 | 30 |
| 14 | 56 | 9·538880 | 28 161 | 10·461120 | 9·566542 | 28 183 | 10·433458 | 10·027662 | 28 22 | 9·972338 | 4 | 46 |
| 30 | 58 | 9·539052 | 29 167 | 10·460948 | 9·566737 | 29 189 | 10·433263 | 10·027685 | 29 22 | 9·972315 | 2 | 30 |
| 15 | 21 | 9·539223 | 30 172 | 10·460777 | 9·566932 | 30 196 | 10·433068 | 10·027709 | 30 23 | 9·972291 | 39 | 45 |
| 30 | 2 | 9·539394 | 1 6 | 10·460606 | 9·567126 | 1 6 | 10·432874 | 10·027732 | 1 1 | 9·972268 | 58 | 30 |
| 16 | 4 | 9·539565 | 2 11 | 10·460435 | 9·567320 | 2 13 | 10·432680 | 10·027755 | 2 2 | 9·972245 | 56 | 44 |
| 30 | 6 | 9·539736 | 3 17 | 10·460264 | 9·567515 | 3 19 | 10·432485 | 10·027779 | 3 2 | 9·972221 | 54 | 30 |
| 17 | 8 | 9·539907 | 4 23 | 10·460093 | 9·567709 | 4 26 | 10·432291 | 10·027802 | 4 3 | 9·972198 | 52 | 43 |
| 30 | 10 | 9·540078 | 5 28 | 10·459922 | 9·567903 | 5 32 | 10·432097 | 10·027825 | 5 4 | 9·972175 | 50 | 30 |
| 18 | 12 | 9·540249 | 6 34 | 10·459751 | 9·568098 | 6 39 | 10·431902 | 10·027849 | 6 5 | 9·972151 | 48 | 42 |
| 30 | 14 | 9·540420 | 7 40 | 10·459580 | 9·568292 | 7 45 | 10·431708 | 10·027872 | 7 5 | 9·972128 | 46 | 30 |
| 19 | 16 | 9·540590 | 8 45 | 10·459410 | 9·568486 | 8 52 | 10·431514 | 10·027895 | 8 6 | 9·972105 | 44 | 41 |
| 30 | 18 | 9·540761 | 9 51 | 10·459239 | 9·568680 | 9 58 | 10·431320 | 10·027919 | 9 7 | 9·972081 | 42 | 30 |
| 20 | 20 | 9·540931 | 10 57 | 10·459069 | 9·568873 | 10 64 | 10·431127 | 10·027942 | 10 8 | 9·972058 | 40 | 40 |
| 30 | 22 | 9·541102 | 11 62 | 10·458898 | 9·569067 | 11 71 | 10·430933 | 10·027966 | 11 9 | 9·972034 | 38 | 30 |
| 21 | 24 | 9·541272 | 12 68 | 10·458728 | 9·569261 | 12 77 | 10·430739 | 10·027989 | 12 9 | 9·972011 | 36 | 39 |
| 30 | 26 | 9·541442 | 13 74 | 10·458558 | 9·569455 | 13 84 | 10·430545 | 10·028012 | 13 10 | 9·971988 | 34 | 30 |
| 22 | 28 | 9·541613 | 14 79 | 10·458387 | 9·569648 | 14 90 | 10·430352 | 10·028036 | 14 11 | 9·971964 | 32 | 38 |
| 30 | 30 | 9·541783 | 15 85 | 10·458217 | 9·569842 | 15 97 | 10·430158 | 10·028059 | 15 12 | 9·971941 | 30 | 30 |
| 23 | 32 | 9·541953 | 16 91 | 10·458047 | 9·570035 | 16 103 | 10·429965 | 10·028083 | 16 12 | 9·971917 | 28 | 37 |
| 30 | 34 | 9·542123 | 17 96 | 10·457877 | 9·570229 | 17 110 | 10·429771 | 10·028106 | 17 13 | 9·971894 | 26 | 30 |
| 24 | 36 | 9·542293 | 18 102 | 10·457707 | 9·570422 | 18 116 | 10·429578 | 10·028130 | 18 14 | 9·971870 | 24 | 36 |
| 30 | 38 | 9·542462 | 19 108 | 10·457538 | 9·570616 | 19 123 | 10·429384 | 10·028153 | 19 15 | 9·971847 | 22 | 30 |
| 25 | 40 | 9·542632 | 20 113 | 10·457368 | 9·570809 | 20 129 | 10·429191 | 10·028177 | 20 16 | 9·971823 | 20 | 35 |
| 30 | 42 | 9·542802 | 21 119 | 10·457198 | 9·571002 | 21 135 | 10·428998 | 10·028200 | 21 16 | 9·971800 | 18 | 30 |
| 26 | 44 | 9·542971 | 22 125 | 10·457029 | 9·571195 | 22 142 | 10·428805 | 10·028224 | 22 17 | 9·971776 | 16 | 34 |
| 30 | 46 | 9·543141 | 23 130 | 10·456859 | 9·571388 | 23 148 | 10·428612 | 10·028247 | 23 18 | 9·971753 | 14 | 30 |
| 27 | 48 | 9·543310 | 24 136 | 10·456690 | 9·571581 | 24 155 | 10·428419 | 10·028271 | 24 19 | 9·971729 | 12 | 33 |
| 30 | 50 | 9·543480 | 25 142 | 10·456520 | 9·571774 | 25 161 | 10·428226 | 10·028294 | 25 19 | 9·971706 | 10 | 30 |
| 28 | 52 | 9·543649 | 26 147 | 10·456351 | 9·571967 | 26 168 | 10·428033 | 10·028318 | 26 20 | 9·971682 | 8 | 32 |
| 30 | 54 | 9·543818 | 27 153 | 10·456182 | 9·572160 | 27 174 | 10·427840 | 10·028342 | 27 21 | 9·971658 | 6 | 30 |
| 29 | 56 | 9·543987 | 28 159 | 10·456013 | 9·572352 | 28 181 | 10·427648 | 10·028365 | 28 22 | 9·971635 | 4 | 31 |
| 30 | 58 | 9·544156 | 29 164 | 10·455844 | 9·572545 | 29 187 | 10·427455 | 10·028389 | 29 23 | 9·971611 | 2 | 30 |
| 30 | 22 | 9·544325 | 30 170 | 10·455675 | 9·572738 | 30 193 | 10·427262 | 10·028412 | 30 23 | 9·971588 | 0 | 30 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

69° $4^h\ 38^m$

## LOG. SINES, COSINES, &c.

1ʰ 22ᵐ — 20°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 9·544325 | | 10·455675 | 9·572738 | | 10·427262 | 10·028412 | | 9·971588 | 38 | 30 |
| 30 | 2 | 9·544494 | 1″ 6 | 10·455506 | 9·572930 | 1″ 6 | 10·427070 | 10·028436 | 1″ 1 | 9·971564 | 58 | 30 |
| 31 | 4 | 9·544663 | 2 11 | 10·455337 | 9·573123 | 2 13 | 10·426877 | 10·028460 | 2 1 | 9·971540 | 56 | 29 |
| 30 | 6 | 9·544832 | 3 17 | 10·455168 | 9·573315 | 3 19 | 10·426685 | 10·028483 | 3 2 | 9·971517 | 54 | 30 |
| 32 | 8 | 9·545000 | 4 22 | 10·455000 | 9·573507 | 4 26 | 10·426493 | 10·028507 | 4 3 | 9·971493 | 52 | 28 |
| 30 | 10 | 9·545169 | 5 28 | 10·454831 | 9·573700 | 5 32 | 10·426300 | 10·028531 | 5 4 | 9·971469 | 50 | 30 |
| 33 | 12 | 9·545338 | 6 34 | 10·454662 | 9·573892 | 6 38 | 10·426108 | 10·028554 | 6 5 | 9·971446 | 48 | 27 |
| 30 | 14 | 9·545506 | 7 39 | 10·454494 | 9·574084 | 7 45 | 10·425916 | 10·028578 | 7 6 | 9·971422 | 46 | 30 |
| 34 | 16 | 9·545674 | 8 45 | 10·454326 | 9·574276 | 8 51 | 10·425724 | 10·028602 | 8 6 | 9·971398 | 44 | 26 |
| 30 | 18 | 9·545843 | 9 50 | 10·454157 | 9·574468 | 9 58 | 10·425532 | 10·028625 | 9 7 | 9·971375 | 42 | 30 |
| 35 | 20 | 9·546011 | 10 56 | 10·453989 | 9·574660 | 10 64 | 10·425340 | 10·028649 | 10 8 | 9·971351 | 40 | 25 |
| 30 | 22 | 9·546179 | 11 61 | 10·453821 | 9·574852 | 11 70 | 10·425148 | 10·028673 | 11 9 | 9·971327 | 38 | 30 |
| 36 | 24 | 9·546347 | 12 67 | 10·453653 | 9·575044 | 12 77 | 10·424956 | 10·028697 | 12 9 | 9·971303 | 36 | 24 |
| 30 | 26 | 9·546515 | 13 72 | 10·453485 | 9·575236 | 13 83 | 10·424764 | 10·028720 | 13 10 | 9·971280 | 34 | 30 |
| 37 | 28 | 9·546683 | 14 78 | 10·453317 | 9·575427 | 14 89 | 10·424573 | 10·028744 | 14 11 | 9·971256 | 32 | 23 |
| 30 | 30 | 9·546851 | 15 84 | 10·453149 | 9·575619 | 15 96 | 10·424381 | 10·028768 | 15 12 | 9·971232 | 30 | 30 |
| 38 | 32 | 9·547019 | 16 90 | 10·452981 | 9·575810 | 16 102 | 10·424190 | 10·028792 | 16 13 | 9·971208 | 28 | 22 |
| 30 | 34 | 9·547187 | 17 95 | 10·452813 | 9·576002 | 17 109 | 10·423998 | 10·028815 | 17 13 | 9·971185 | 26 | 30 |
| 39 | 36 | 9·547354 | 18 101 | 10·452646 | 9·576193 | 18 115 | 10·423807 | 10·028839 | 18 14 | 9·971161 | 24 | 21 |
| 30 | 38 | 9·547522 | 19 107 | 10·452478 | 9·576385 | 19 121 | 10·423615 | 10·028863 | 19 15 | 9·971137 | 22 | 30 |
| 40 | 40 | 9·547689 | 20 112 | 10·452311 | 9·576576 | 20 128 | 10·423424 | 10·028887 | 20 16 | 9·971113 | 20 | 20 |
| 30 | 42 | 9·547857 | 21 118 | 10·452143 | 9·576767 | 21 134 | 10·423233 | 10·028911 | 21 17 | 9·971089 | 18 | 30 |
| 41 | 44 | 9·548024 | 22 123 | 10·451976 | 9·576959 | 22 141 | 10·423041 | 10·028934 | 22 17 | 9·971066 | 16 | 19 |
| 30 | 46 | 9·548191 | 23 129 | 10·451809 | 9·577150 | 23 147 | 10·422850 | 10·028958 | 23 18 | 9·971042 | 14 | 30 |
| 42 | 48 | 9·548359 | 24 134 | 10·451641 | 9·577341 | 24 153 | 10·422659 | 10·028982 | 24 19 | 9·971018 | 12 | 18 |
| 30 | 50 | 9·548526 | 25 140 | 10·451474 | 9·577532 | 25 160 | 10·422468 | 10·029006 | 25 20 | 9·970994 | 10 | 30 |
| 43 | 52 | 9·548693 | 26 145 | 10·451307 | 9·577723 | 26 166 | 10·422277 | 10·029030 | 26 21 | 9·970970 | 8 | 17 |
| 30 | 54 | 9·548860 | 27 151 | 10·451140 | 9·577914 | 27 173 | 10·422086 | 10·029054 | 27 21 | 9·970946 | 6 | 30 |
| 44 | 56 | 9·549027 | 28 156 | 10·450973 | 9·578104 | 28 179 | 10·421896 | 10·029078 | 28 22 | 9·970922 | 4 | 16 |
| 30 | 58 | 9·549193 | 29 162 | 10·450807 | 9·578295 | 29 185 | 10·421705 | 10·029102 | 29 23 | 9·970898 | 2 | 30 |
| 45 | 23 | 9·549360 | 30 168 | 10·450640 | 9·578486 | 30 192 | 10·421514 | 10·029126 | 30 24 | 9·970874 | 37 | 15 |
| 30 | 2 | 9·549527 | 1 6 | 10·450473 | 9·578676 | 1 6 | 10·421324 | 10·029150 | 1 1 | 9·970850 | 58 | 30 |
| 46 | 4 | 9·549693 | 2 11 | 10·450307 | 9·578867 | 2 13 | 10·421133 | 10·029173 | 2 2 | 9·970827 | 56 | 14 |
| 30 | 6 | 9·549860 | 3 17 | 10·450140 | 9·579057 | 3 19 | 10·420943 | 10·029197 | 3 2 | 9·970803 | 54 | 30 |
| 47 | 8 | 9·550026 | 4 22 | 10·449974 | 9·579248 | 4 25 | 10·420752 | 10·029221 | 4 3 | 9·970779 | 52 | 13 |
| 30 | 10 | 9·550193 | 5 28 | 10·449807 | 9·579438 | 5 32 | 10·420562 | 10·029245 | 5 4 | 9·970755 | 50 | 30 |
| 48 | 12 | 9·550359 | 6 33 | 10·449641 | 9·579629 | 6 38 | 10·420371 | 10·029269 | 6 5 | 9·970731 | 48 | 12 |
| 30 | 14 | 9·550525 | 7 39 | 10·449475 | 9·579819 | 7 44 | 10·420181 | 10·029293 | 7 6 | 9·970707 | 46 | 30 |
| 49 | 16 | 9·550692 | 8 44 | 10·449308 | 9·580009 | 8 51 | 10·419991 | 10·029317 | 8 6 | 9·970683 | 44 | 11 |
| 30 | 18 | 9·550858 | 9 50 | 10·449142 | 9·580199 | 9 57 | 10·419801 | 10·029341 | 9 7 | 9·970659 | 42 | 30 |
| 50 | 20 | 9·551024 | 10 55 | 10·448976 | 9·580389 | 10 63 | 10·419611 | 10·029365 | 10 8 | 9·970635 | 40 | 10 |
| 30 | 22 | 9·551190 | 11 6 | 10·448810 | 9·580579 | 11 70 | 10·419421 | 10·029389 | 11 9 | 9·970611 | 38 | 30 |
| 51 | 24 | 9·551356 | 12 66 | 10·448644 | 9·580769 | 12 76 | 10·419231 | 10·029414 | 12 10 | 9·970586 | 36 | 9 |
| 30 | 26 | 9·551521 | 13 72 | 10·448479 | 9·580959 | 13 82 | 10·419041 | 10·029438 | 13 10 | 9·970562 | 34 | 30 |
| 52 | 28 | 9·551687 | 14 77 | 10·448313 | 9·581149 | 14 88 | 10·418851 | 10·029462 | 14 11 | 9·970538 | 32 | 8 |
| 30 | 30 | 9·551853 | 15 83 | 10·448147 | 9·581339 | 15 95 | 10·418661 | 10·029486 | 15 12 | 9·970514 | 30 | 30 |
| 53 | 32 | 9·552018 | 16 88 | 10·447982 | 9·581528 | 16 101 | 10·418472 | 10·029510 | 16 13 | 9·970490 | 28 | 7 |
| 30 | 34 | 9·552184 | 17 94 | 10·447816 | 9·581718 | 17 107 | 10·418282 | 10·029534 | 17 14 | 9·970466 | 26 | 30 |
| 54 | 36 | 9·552349 | 18 99 | 10·447651 | 9·581907 | 18 114 | 10·418093 | 10·029558 | 18 14 | 9·970442 | 24 | 6 |
| 30 | 38 | 9·552515 | 19 105 | 10·447485 | 9·582097 | 19 120 | 10·417903 | 10·029582 | 19 15 | 9·970418 | 22 | 30 |
| 55 | 40 | 9·552680 | 20 110 | 10·447320 | 9·582286 | 20 126 | 10·417714 | 10·029606 | 20 16 | 9·970394 | 20 | 5 |
| 30 | 42 | 9·552845 | 21 116 | 10·447155 | 9·582476 | 21 133 | 10·417524 | 10·029630 | 21 17 | 9·970370 | 18 | 30 |
| 56 | 44 | 9·553010 | 22 121 | 10·446990 | 9·582665 | 22 139 | 10·417335 | 10·029655 | 22 18 | 9·970345 | 16 | 4 |
| 30 | 46 | 9·553176 | 23 127 | 10·446824 | 9·582854 | 23 145 | 10·417146 | 10·029679 | 23 18 | 9·970321 | 14 | 30 |
| 57 | 48 | 9·553341 | 24 132 | 10·446659 | 9·583044 | 24 152 | 10·416956 | 10·029703 | 24 19 | 9·970297 | 12 | 3 |
| 30 | 50 | 9·553506 | 25 138 | 10·446494 | 9·583233 | 25 158 | 10·416767 | 10·029727 | 25 20 | 9·970273 | 10 | 30 |
| 58 | 52 | 9·553670 | 26 143 | 10·446330 | 9·583422 | 26 164 | 10·416578 | 10·029751 | 26 21 | 9·970249 | 8 | 2 |
| 30 | 54 | 9·553835 | 27 149 | 10·446165 | 9·583611 | 27 171 | 10·416389 | 10·029776 | 27 22 | 9·970224 | 6 | 30 |
| 59 | 56 | 9·554000 | 28 154 | 10·446000 | 9·583800 | 28 177 | 10·416200 | 10·029800 | 28 22 | 9·970200 | 4 | 1 |
| 30 | 58 | 9·554165 | 29 160 | 10·445835 | 9·583989 | 29 183 | 10·416011 | 10·029824 | 29 23 | 9·970176 | 2 | 30 |
| 60 | 24 | 9·554329 | 30 166 | 10·445671 | 9·584177 | 30 190 | 10·415823 | 10·029848 | 30 24 | 9·970152 | 0 | 0 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

69° — 4ʰ 36ᵐ

## LOG. SINES, COSINES, &c.

$1^h\ 20^m$ — 20°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 9·534052 | | 10·465948 | 9·561066 | | 10·438934 | 10·027014 | | 9·972986 | 40 | 60 |
| 30 | 2 | 9·534225 | 1″ 6 | 10·465775 | 9·561262 | 1″ 7 | 10·438738 | 10·027037 | 1″ 1 | 9·972963 | 58 | 30 |
| 1 | 4 | 9·534399 | 2 12 | 10·465601 | 9·561459 | 2 13 | 10·438541 | 10·027060 | 2 2 | 9·972940 | 56 | 59 |
| 30 | 6 | 9·534572 | 3 17 | 10·465428 | 9·561655 | 3 20 | 10·438345 | 10·027083 | 3 2 | 9·972917 | 54 | 30 |
| 2 | 8 | 9·534745 | 4 23 | 10·465255 | 9·561851 | 4 26 | 10·438149 | 10·027106 | 4 3 | 9·972894 | 52 | 58 |
| 30 | 10 | 9·534918 | 5 29 | 10·465082 | 9·562048 | 5 33 | 10·437952 | 10·027129 | 5 4 | 9·972871 | 50 | 30 |
| 3 | 12 | 9·535092 | 6 34 | 10·464908 | 9·562244 | 6 39 | 10·437756 | 10·027152 | 6 5 | 9·972848 | 48 | 57 |
| 30 | 14 | 9·535265 | 7 40 | 10·464735 | 9·562440 | 7 46 | 10·437560 | 10·027175 | 7 5 | 9·972825 | 46 | 30 |
| 4 | 16 | 9·535438 | 8 46 | 10·464562 | 9·562636 | 8 52 | 10·437364 | 10·027198 | 8 6 | 9·972802 | 44 | 56 |
| 30 | 18 | 9·535610 | 9 52 | 10·464390 | 9·562832 | 9 59 | 10·437168 | 10·027222 | 9 7 | 9·972778 | 42 | 30 |
| 5 | 20 | 9·535783 | 10 57 | 10·464217 | 9·563028 | 10 65 | 10·436972 | 10·027245 | 10 8 | 9·972755 | 40 | 55 |
| 30 | 22 | 9·535956 | 11 63 | 10·464044 | 9·563224 | 11 72 | 10·436776 | 10·027268 | 11 8 | 9·972732 | 38 | 30 |
| 6 | 24 | 9·536129 | 12 69 | 10·463871 | 9·563419 | 12 78 | 10·436581 | 10·027291 | 12 9 | 9·972709 | 36 | 54 |
| 30 | 26 | 9·536301 | 13 75 | 10·463699 | 9·563615 | 13 85 | 10·436385 | 10·027314 | 13 10 | 9·972686 | 34 | 30 |
| 7 | 28 | 9·536474 | 14 80 | 10·463526 | 9·563811 | 14 91 | 10·436189 | 10·027337 | 14 11 | 9·972663 | 32 | 53 |
| 30 | 30 | 9·536646 | 15 86 | 10·463354 | 9·564006 | 15 98 | 10·435994 | 10·027360 | 15 12 | 9·972640 | 30 | 30 |
| 8 | 32 | 9·536818 | 16 92 | 10·463182 | 9·564202 | 16 104 | 10·435798 | 10·027383 | 16 12 | 9·972617 | 28 | 52 |
| 30 | 34 | 9·536991 | 17 98 | 10·463009 | 9·564397 | 17 111 | 10·435603 | 10·027407 | 17 13 | 9·972593 | 26 | 30 |
| 9 | 36 | 9·537163 | 18 103 | 10·462837 | 9·564593 | 18 117 | 10·435407 | 10·027430 | 18 14 | 9·972570 | 24 | 51 |
| 30 | 38 | 9·537335 | 19 109 | 10·462665 | 9·564788 | 19 124 | 10·435212 | 10·027453 | 19 15 | 9·972547 | 22 | 30 |
| 10 | 40 | 9·537507 | 20 115 | 10·462493 | 9·564983 | 20 130 | 10·435017 | 10·027476 | 20 15 | 9·972524 | 20 | 50 |
| 30 | 42 | 9·537679 | 21 121 | 10·462321 | 9·565178 | 21 137 | 10·434822 | 10·027499 | 21 16 | 9·972501 | 18 | 30 |
| 11 | 44 | 9·537851 | 22 126 | 10·462149 | 9·565373 | 22 143 | 10·434627 | 10·027522 | 22 17 | 9·972478 | 16 | 49 |
| 30 | 46 | 9·538023 | 23 132 | 10·461977 | 9·565568 | 23 150 | 10·434432 | 10·027546 | 23 18 | 9·972454 | 14 | 30 |
| 12 | 48 | 9·538194 | 24 138 | 10·461806 | 9·565763 | 24 156 | 10·434237 | 10·027569 | 24 18 | 9·972431 | 12 | 48 |
| 30 | 50 | 9·538366 | 25 144 | 10·461634 | 9·565958 | 25 163 | 10·434042 | 10·027592 | 25 19 | 9·972408 | 10 | 30 |
| 13 | 52 | 9·538538 | 26 149 | 10·461462 | 9·566153 | 26 170 | 10·433847 | 10·027615 | 26 20 | 9·972385 | 8 | 47 |
| 30 | 54 | 9·538709 | 27 155 | 10·461291 | 9·566348 | 27 176 | 10·433652 | 10·027639 | 27 21 | 9·972361 | 6 | 30 |
| 14 | 56 | 9·538880 | 28 161 | 10·461120 | 9·566542 | 28 183 | 10·433458 | 10·027662 | 28 22 | 9·972338 | 4 | 46 |
| 30 | 58 | 9·539052 | 29 167 | 10·460948 | 9·566737 | 29 189 | 10·433263 | 10·027685 | 29 22 | 9·972315 | 2 | 30 |
| 15 | 21 | 9·539223 | 30 172 | 10·460777 | 9·566932 | 30 196 | 10·433068 | 10·027709 | 30 23 | 9·972291 | 39 | 45 |
| 30 | 2 | 9·539394 | 1 6 | 10·460606 | 9·567126 | 1 6 | 10·432874 | 10·027732 | 1 1 | 9·972268 | 58 | 30 |
| 16 | 4 | 9·539565 | 2 11 | 10·460435 | 9·567320 | 2 13 | 10·432680 | 10·027755 | 2 2 | 9·972245 | 56 | 44 |
| 30 | 6 | 9·539736 | 3 17 | 10·460264 | 9·567515 | 3 19 | 10·432485 | 10·027779 | 3 2 | 9·972221 | 54 | 30 |
| 17 | 8 | 9·539907 | 4 23 | 10·460093 | 9·567709 | 4 26 | 10·432291 | 10·027802 | 4 3 | 9·972198 | 52 | 43 |
| 30 | 10 | 9·540078 | 5 28 | 10·459922 | 9·567903 | 5 32 | 10·432097 | 10·027825 | 5 4 | 9·972175 | 50 | 30 |
| 18 | 12 | 9·540249 | 6 34 | 10·459751 | 9·568098 | 6 39 | 10·431902 | 10·027849 | 6 5 | 9·972151 | 48 | 42 |
| 30 | 14 | 9·540420 | 7 40 | 10·459580 | 9·568292 | 7 45 | 10·431708 | 10·027872 | 7 5 | 9·972128 | 46 | 30 |
| 19 | 16 | 9·540590 | 8 45 | 10·459410 | 9·568486 | 8 52 | 10·431514 | 10·027895 | 8 6 | 9·972105 | 44 | 41 |
| 30 | 18 | 9·540761 | 9 51 | 10·459239 | 9·568680 | 9 58 | 10·431320 | 10·027919 | 9 7 | 9·972081 | 42 | 30 |
| 20 | 20 | 9·540931 | 10 57 | 10·459069 | 9·568873 | 10 64 | 10·431127 | 10·027942 | 10 8 | 9·972058 | 40 | 40 |
| 30 | 22 | 9·541102 | 11 62 | 10·458898 | 9·569067 | 11 71 | 10·430933 | 10·027966 | 11 9 | 9·972034 | 38 | 20 |
| 21 | 24 | 9·541272 | 12 68 | 10·458728 | 9·569261 | 12 77 | 10·430739 | 10·027989 | 12 9 | 9·972011 | 36 | 39 |
| 30 | 26 | 9·541442 | 13 74 | 10·458558 | 9·569455 | 13 84 | 10·430545 | 10·028012 | 13 10 | 9·971988 | 34 | 30 |
| 22 | 28 | 9·541613 | 14 79 | 10·458387 | 9·569648 | 14 90 | 10·430352 | 10·028036 | 14 11 | 9·971964 | 32 | 38 |
| 30 | 30 | 9·541783 | 15 85 | 10·458217 | 9·569842 | 15 97 | 10·430158 | 10·028059 | 15 12 | 9·971941 | 30 | 30 |
| 23 | 32 | 9·541953 | 16 91 | 10·458047 | 9·570035 | 16 103 | 10·429965 | 10·028083 | 16 12 | 9·971917 | 28 | 37 |
| 30 | 34 | 9·542123 | 17 96 | 10·457877 | 9·570229 | 17 110 | 10·429771 | 10·028106 | 17 13 | 9·971894 | 26 | 30 |
| 24 | 36 | 9·542293 | 18 102 | 10·457707 | 9·570422 | 18 116 | 10·429578 | 10·028130 | 18 14 | 9·971870 | 24 | 36 |
| 30 | 38 | 9·542462 | 19 108 | 10·457538 | 9·570616 | 19 123 | 10·429384 | 10·028153 | 19 15 | 9·971847 | 22 | 30 |
| 25 | 40 | 9·542632 | 20 113 | 10·457368 | 9·570809 | 20 129 | 10·429191 | 10·028177 | 20 16 | 9·971823 | 20 | 35 |
| 30 | 42 | 9·542802 | 21 119 | 10·457198 | 9·571002 | 21 135 | 10·428998 | 10·028200 | 21 16 | 9·971800 | 18 | 30 |
| 26 | 44 | 9·542971 | 22 125 | 10·457029 | 9·571195 | 22 142 | 10·428805 | 10·028224 | 22 17 | 9·971776 | 16 | 34 |
| 30 | 46 | 9·543141 | 23 130 | 10·456859 | 9·571388 | 23 148 | 10·428612 | 10·028247 | 23 18 | 9·971753 | 14 | 30 |
| 27 | 48 | 9·543310 | 24 136 | 10·456690 | 9·571581 | 24 155 | 10·428419 | 10·028271 | 24 19 | 9·971729 | 12 | 33 |
| 30 | 50 | 9·543480 | 25 142 | 10·456520 | 9·571774 | 25 161 | 10·428226 | 10·028294 | 25 19 | 9·971706 | 10 | 30 |
| 28 | 52 | 9·543649 | 26 147 | 10·456351 | 9·571967 | 26 168 | 10·428033 | 10·028318 | 26 20 | 9·971682 | 8 | 32 |
| 30 | 54 | 9·543818 | 27 153 | 10·456182 | 9·572160 | 27 174 | 10·427840 | 10·028342 | 27 21 | 9·971658 | 6 | 30 |
| 29 | 56 | 9·543987 | 28 159 | 10·456013 | 9·572352 | 28 181 | 10·427648 | 10·028365 | 28 22 | 9·971635 | 4 | 31 |
| 30 | 58 | 9·544156 | 29 164 | 10·455844 | 9·572545 | 29 187 | 10·427455 | 10·028389 | 29 23 | 9·971611 | 2 | 30 |
| 30 | 22 | 9·544325 | 30 170 | 10·455675 | 9·572738 | 30 193 | 10·427262 | 10·028412 | 30 23 | 9·971588 | 0 | 30 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

69° — $4^h\ 38^m$

## LOG. SINES, COSINES, &c.

1h 22m — 20°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 9·544325 | | 10·455675 | 9·572738 | | 10·427262 | 10·028412 | | 9·971588 | 38 | 30 |
| 30 | 2 | 9·544494 | 1″ 6 | 10·455506 | 9·572930 | 1″ 6 | 10·427070 | 10·028436 | 1″ 1 | 9·971564 | 58 | 30 |
| 31 | 4 | 9·544663 | 2 11 | 10·455337 | 9·573123 | 2 13 | 10·426877 | 10·028460 | 2 1 | 9·971540 | 56 | 29 |
| 30 | 6 | 9·544832 | 3 17 | 10·455168 | 9·573315 | 3 19 | 10·426685 | 10·028483 | 3 2 | 9·971517 | 54 | 30 |
| 32 | 8 | 9·545000 | 4 22 | 10·455000 | 9·573507 | 4 26 | 10·426493 | 10·028507 | 4 3 | 9·971493 | 52 | 28 |
| 30 | 10 | 9·545169 | 5 28 | 10·454831 | 9·573700 | 5 32 | 10·426300 | 10·028531 | 5 4 | 9·971469 | 50 | 30 |
| 33 | 12 | 9·545338 | 6 34 | 10·454662 | 9·573892 | 6 38 | 10·426108 | 10·028554 | 6 5 | 9·971446 | 48 | 27 |
| 30 | 14 | 9·545506 | 7 39 | 10·454494 | 9·574084 | 7 45 | 10·425916 | 10·028578 | 7 6 | 9·971422 | 46 | 30 |
| 34 | 16 | 9·545674 | 8 45 | 10·454326 | 9·574276 | 8 51 | 10·425724 | 10·028602 | 8 6 | 9·971398 | 44 | 26 |
| 30 | 18 | 9·545843 | 9 50 | 10·454157 | 9·574468 | 9 58 | 10·425532 | 10·028625 | 9 7 | 9·971375 | 42 | 30 |
| 35 | 20 | 9·546011 | 10 56 | 10·453989 | 9·574660 | 10 64 | 10·425340 | 10·028649 | 10 8 | 9·971351 | 40 | 25 |
| 30 | 22 | 9·546179 | 11 61 | 10·453821 | 9·574852 | 11 70 | 10·425148 | 10·028673 | 11 9 | 9·971327 | 38 | 30 |
| 36 | 24 | 9·546347 | 12 67 | 10·453653 | 9·575044 | 12 77 | 10·424956 | 10·028697 | 12 9 | 9·971303 | 36 | 24 |
| 30 | 26 | 9·546515 | 13 72 | 10·453485 | 9·575236 | 13 83 | 10·424764 | 10·028720 | 13 10 | 9·971280 | 34 | 30 |
| 37 | 28 | 9·546683 | 14 78 | 10·453317 | 9·575427 | 14 89 | 10·424573 | 10·028744 | 14 11 | 9·971256 | 32 | 23 |
| 30 | 30 | 9·546851 | 15 84 | 10·453149 | 9·575619 | 15 96 | 10·424381 | 10·028768 | 15 12 | 9·971232 | 30 | 30 |
| 38 | 32 | 9·547019 | 16 90 | 10·452981 | 9·575810 | 16 102 | 10·424190 | 10·028792 | 16 13 | 9·971208 | 28 | 22 |
| 30 | 34 | 9·547187 | 17 95 | 10·452813 | 9·576002 | 17 109 | 10·423998 | 10·028815 | 17 13 | 9·971185 | 26 | 30 |
| 39 | 36 | 9·547354 | 18 101 | 10·452646 | 9·576193 | 18 115 | 10·423807 | 10·028839 | 18 14 | 9·971161 | 24 | 21 |
| 30 | 38 | 9·547522 | 19 107 | 10·452478 | 9·576385 | 19 121 | 10·423615 | 10·028863 | 19 15 | 9·971137 | 22 | 30 |
| 40 | 40 | 9·547689 | 20 112 | 10·452311 | 9·576576 | 20 128 | 10·423424 | 10·028887 | 20 16 | 9·971113 | 20 | 20 |
| 30 | 42 | 9·547857 | 21 118 | 10·452143 | 9·576767 | 21 134 | 10·423233 | 10·028911 | 21 17 | 9·971089 | 18 | 30 |
| 41 | 44 | 9·548024 | 22 123 | 10·451976 | 9·576959 | 22 141 | 10·423041 | 10·028934 | 22 17 | 9·971066 | 16 | 19 |
| 30 | 46 | 9·548191 | 23 129 | 10·451809 | 9·577150 | 23 147 | 10·422850 | 10·028958 | 23 18 | 9·971042 | 14 | 30 |
| 42 | 48 | 9·548359 | 24 134 | 10·451641 | 9·577341 | 24 153 | 10·422659 | 10·028982 | 24 19 | 9·971018 | 12 | 18 |
| 30 | 50 | 9·548526 | 25 140 | 10·451474 | 9·577532 | 25 160 | 10·422468 | 10·029006 | 25 20 | 9·970994 | 10 | 30 |
| 43 | 52 | 9·548693 | 26 145 | 10·451307 | 9·577723 | 26 166 | 10·422277 | 10·029030 | 26 21 | 9·970970 | 8 | 17 |
| 30 | 54 | 9·548860 | 27 151 | 10·451140 | 9·577914 | 27 173 | 10·422086 | 10·029054 | 27 21 | 9·970946 | 6 | 30 |
| 44 | 56 | 9·549027 | 28 156 | 10·450973 | 9·578104 | 28 179 | 10·421896 | 10·029078 | 28 22 | 9·970922 | 4 | 16 |
| 30 | 58 | 9·549193 | 29 162 | 10·450807 | 9·578295 | 29 185 | 10·421705 | 10·029102 | 29 23 | 9·970898 | 2 | 30 |
| 45 | 23 | 9·549360 | 30 168 | 10·450640 | 9·578486 | 30 192 | 10·421514 | 10·029126 | 30 24 | 9·970874 | 37 | 15 |
| 30 | 2 | 9·549527 | 1 6 | 10·450473 | 9·578676 | 1 6 | 10·421324 | 10·029150 | 1 1 | 9·970850 | 58 | 30 |
| 46 | 4 | 9·549693 | 2 11 | 10·450307 | 9·578867 | 2 13 | 10·421133 | 10·029173 | 2 2 | 9·970827 | 56 | 14 |
| 30 | 6 | 9·549860 | 3 17 | 10·450140 | 9·579057 | 3 19 | 10·420943 | 10·029197 | 3 2 | 9·970803 | 54 | 30 |
| 47 | 8 | 9·550026 | 4 22 | 10·449974 | 9·579248 | 4 25 | 10·420752 | 10·029221 | 4 3 | 9·970779 | 52 | 13 |
| 30 | 10 | 9·550193 | 5 28 | 10·449807 | 9·579438 | 5 32 | 10·420562 | 10·029245 | 5 4 | 9·970755 | 50 | 30 |
| 48 | 12 | 9·550359 | 6 33 | 10·449641 | 9·579629 | 6 38 | 10·420371 | 10·029269 | 6 5 | 9·970731 | 48 | 12 |
| 30 | 14 | 9·550525 | 7 39 | 10·449475 | 9·579819 | 7 44 | 10·420181 | 10·029293 | 7 6 | 9·970707 | 46 | 30 |
| 49 | 16 | 9·550692 | 6 44 | 10·449308 | 9·580009 | 8 51 | 10·419991 | 10·029317 | 8 6 | 9·970683 | 44 | 11 |
| 30 | 18 | 9·550858 | 9 50 | 10·449142 | 9·580199 | 9 57 | 10·419801 | 10·029341 | 9 7 | 9·970659 | 42 | 30 |
| 50 | 20 | 9·551024 | 10 55 | 10·448976 | 9·580389 | 10 63 | 10·419611 | 10·029365 | 10 8 | 9·970635 | 40 | 10 |
| 30 | 22 | 9·551190 | 11 6 | 10·448810 | 9·580579 | 11 70 | 10·419421 | 10·029389 | 11 9 | 9·970611 | 38 | 30 |
| 51 | 24 | 9·551356 | 12 66 | 10·448644 | 9·580769 | 12 76 | 10·419231 | 10·029414 | 12 10 | 9·970586 | 36 | 9 |
| 30 | 26 | 9·551521 | 13 72 | 10·448479 | 9·580959 | 13 82 | 10·419041 | 10·029438 | 13 10 | 9·970562 | 34 | 30 |
| 52 | 28 | 9·551687 | 14 77 | 10·448313 | 9·581149 | 14 88 | 10·418851 | 10·029462 | 14 11 | 9·970538 | 32 | 8 |
| 30 | 30 | 9·551853 | 15 83 | 10·448147 | 9·581339 | 15 95 | 10·418661 | 10·029486 | 15 12 | 9·970514 | 30 | 30 |
| 53 | 32 | 9·552018 | 16 88 | 10·447982 | 9·581528 | 16 101 | 10·418472 | 10·029510 | 16 13 | 9·970490 | 28 | 7 |
| 30 | 34 | 9·552184 | 17 94 | 10·447816 | 9·581718 | 17 107 | 10·418282 | 10·029534 | 17 14 | 9·970466 | 26 | 30 |
| 54 | 36 | 9·552349 | 18 99 | 10·447651 | 9·581907 | 18 114 | 10·418093 | 10·029558 | 18 14 | 9·970442 | 24 | 6 |
| 30 | 38 | 9·552515 | 19 105 | 10·447485 | 9·582097 | 19 120 | 10·417903 | 10·029582 | 19 15 | 9·970418 | 22 | 30 |
| 55 | 40 | 9·552680 | 20 110 | 10·447320 | 9·582286 | 20 126 | 10·417714 | 10·029606 | 20 16 | 9·970394 | 20 | 5 |
| 30 | 42 | 9·552845 | 21 116 | 10·447155 | 9·582476 | 21 133 | 10·417524 | 10·029630 | 21 17 | 9·970370 | 18 | 30 |
| 56 | 44 | 9·553010 | 22 121 | 10·446990 | 9·582665 | 22 139 | 10·417335 | 10·029655 | 22 18 | 9·970345 | 16 | 4 |
| 30 | 46 | 9·553176 | 23 127 | 10·446824 | 9·582854 | 23 145 | 10·417146 | 10·029679 | 23 18 | 9·970321 | 14 | 30 |
| 57 | 48 | 9·553341 | 24 132 | 10·446659 | 9·583044 | 24 152 | 10·416956 | 10·029703 | 24 19 | 9·970297 | 12 | 3 |
| 30 | 50 | 9·553506 | 25 138 | 10·446494 | 9·583233 | 25 158 | 10·416767 | 10·029727 | 25 20 | 9·970273 | 10 | 30 |
| 58 | 52 | 9·553670 | 26 143 | 10·446330 | 9·583422 | 26 164 | 10·416578 | 10·029751 | 26 21 | 9·970249 | 8 | 2 |
| 30 | 54 | 9·553835 | 27 149 | 10·446165 | 9·583611 | 27 171 | 10·416389 | 10·029776 | 27 22 | 9·970224 | 6 | 30 |
| 59 | 56 | 9·554000 | 28 154 | 10·446000 | 9·583800 | 28 177 | 10·416200 | 10·029800 | 28 22 | 9·970200 | 4 | 1 |
| 30 | 58 | 9·554165 | 29 160 | 10·445835 | 9·583989 | 29 183 | 10·416011 | 10·029824 | 29 23 | 9·970176 | 2 | 30 |
| 60 | 24 | 9·554329 | 30 166 | 10·445671 | 9·584177 | 30 190 | 10·415823 | 10·029848 | 30 24 | 9·970152 | 0 | 0 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

69° — 4h 36m

## LOG. SINES, COSINES, &c.

1ʰ 24ᵐ — 21°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 9·554329 | | 10·445671 | 9·584177 | | 10·415823 | 10·029848 | | 9·970152 | 36 | 60 |
| 30 | 2 | 9·554494 | 1″ 5 | 10·445506 | 9·584366 | 1″ 6 | 10·415634 | 10·029873 | 1″ 1 | 9·970128 | 58 | 30 |
| 1 | 4 | 9·554658 | 2 11 | 10·445342 | 9·584555 | 2 13 | 10·415445 | 10·029897 | 2 2 | 9·970103 | 56 | 59 |
| 30 | 6 | 9·554822 | 3 16 | 10·445178 | 9·584744 | 3 19 | 10·415256 | 10·029921 | 3 2 | 9·970079 | 54 | 30 |
| 2 | 8 | 9·554987 | 4 22 | 10·445013 | 9·584932 | 4 25 | 10·415068 | 10·029945 | 4 3 | 9·970055 | 52 | 58 |
| 30 | 10 | 9·555151 | 5 27 | 10·444849 | 9·585121 | 5 31 | 10·414879 | 10·029970 | 5 4 | 9·970030 | 50 | 30 |
| 3 | 12 | 9·555315 | 6 33 | 10·444685 | 9·585309 | 6 38 | 10·414691 | 10·029994 | 6 5 | 9·970006 | 48 | 57 |
| 30 | 14 | 9·555479 | 7 38 | 10·444521 | 9·585498 | 7 44 | 10·414502 | 10·030018 | 7 6 | 9·969982 | 46 | 30 |
| 4 | 16 | 9·555643 | 8 44 | 10·444357 | 9·585686 | 8 50 | 10·414314 | 10·030043 | 8 7 | 9·969957 | 44 | 56 |
| 30 | 18 | 9·555807 | 9 49 | 10·444193 | 9·585874 | 9 56 | 10·414126 | 10·030067 | 9 7 | 9·969933 | 42 | 30 |
| 5 | 20 | 9·555971 | 10 54 | 10·444029 | 9·586062 | 10 63 | 10·413938 | 10·030091 | 10 8 | 9·969909 | 40 | 55 |
| 30 | 22 | 9·556135 | 11 60 | 10·443865 | 9·586251 | 11 69 | 10·413749 | 10·030116 | 11 9 | 9·969884 | 38 | 30 |
| 6 | 24 | 9·556299 | 12 65 | 10·443701 | 9·586439 | 12 75 | 10·413561 | 10·030140 | 12 10 | 9·969860 | 36 | 54 |
| 30 | 26 | 9·556462 | 13 71 | 10·443538 | 9·586627 | 13 81 | 10·413373 | 10·030164 | 13 11 | 9·969836 | 34 | 30 |
| 7 | 28 | 9·556626 | 14 76 | 10·443374 | 9·586815 | 14 88 | 10·413185 | 10·030189 | 14 11 | 9·969811 | 32 | 53 |
| 30 | 30 | 9·556789 | 15 82 | 10·443211 | 9·587003 | 15 94 | 10·412997 | 10·030213 | 15 12 | 9·969787 | 30 | 30 |
| 8 | 32 | 9·556953 | 16 87 | 10·443047 | 9·587190 | 16 100 | 10·412810 | 10·030238 | 16 13 | 9·969762 | 28 | 52 |
| 30 | 34 | 9·557116 | 17 93 | 10·442884 | 9·587378 | 17 106 | 10·412622 | 10·030262 | 17 14 | 9·969738 | 26 | 30 |
| 9 | 36 | 9·557280 | 18 98 | 10·442720 | 9·587566 | 18 113 | 10·412434 | 10·030286 | 18 15 | 9·969714 | 24 | 51 |
| 30 | 38 | 9·557443 | 19 104 | 10·442557 | 9·587754 | 19 119 | 10·412246 | 10·030311 | 19 15 | 9·969689 | 22 | 30 |
| 10 | 40 | 9·557606 | 20 109 | 10·442394 | 9·587941 | 20 125 | 10·412059 | 10·030335 | 20 16 | 9·969665 | 20 | 50 |
| 30 | 42 | 9·557769 | 21 115 | 10·442231 | 9·588129 | 21 131 | 10·411871 | 10·030360 | 21 17 | 9·969640 | 18 | 30 |
| 11 | 44 | 9·557932 | 22 120 | 10·442068 | 9·588316 | 22 138 | 10·411684 | 10·030384 | 22 18 | 9·969616 | 16 | 49 |
| 30 | 46 | 9·558095 | 23 126 | 10·441905 | 9·588504 | 23 144 | 10·411496 | 10·030409 | 23 19 | 9·969591 | 14 | 30 |
| 12 | 48 | 9·558258 | 24 131 | 10·441742 | 9·588691 | 24 150 | 10·411309 | 10·030433 | 24 19 | 9·969567 | 12 | 48 |
| 30 | 50 | 9·558421 | 25 137 | 10·441579 | 9·588878 | 25 156 | 10·411122 | 10·030458 | 25 20 | 9·969542 | 10 | 30 |
| 13 | 52 | 9·558583 | 26 142 | 10·441417 | 9·589066 | 26 163 | 10·410934 | 10·030482 | 26 21 | 9·969518 | 8 | 47 |
| 30 | 54 | 9·558746 | 27 147 | 10·441254 | 9·589253 | 27 169 | 10·410747 | 10·030507 | 27 22 | 9·969493 | 6 | 30 |
| 14 | 56 | 9·558909 | 28 153 | 10·441091 | 9·589440 | 28 175 | 10·410560 | 10·030531 | 28 23 | 9·969469 | 4 | 46 |
| 30 | 58 | 9·559071 | 29 158 | 10·440929 | 9·589627 | 29 182 | 10·410373 | 10·030556 | 29 23 | 9·969444 | 2 | 30 |
| 15 | 25 | 9·559234 | 30 163 | 10·440766 | 9·589814 | 30 188 | 10·410186 | 10·030580 | 30 24 | 9·969420 | 35 | 45 |
| 30 | 2 | 9·559396 | 1 5 | 10·440604 | 9·590001 | 1 6 | 10·409999 | 10·030605 | 1 1 | 9·969395 | 58 | 30 |
| 16 | 4 | 9·559558 | 2 11 | 10·440442 | 9·590188 | 2 12 | 10·409812 | 10·030630 | 2 2 | 9·969370 | 56 | 44 |
| 30 | 6 | 9·559721 | 3 16 | 10·440279 | 9·590375 | 3 19 | 10·409625 | 10·030654 | 3 2 | 9·969346 | 54 | 30 |
| 17 | 8 | 9·559883 | 4 22 | 10·440117 | 9·590562 | 4 25 | 10·409438 | 10·030679 | 4 3 | 9·969321 | 52 | 43 |
| 30 | 10 | 9·560045 | 5 27 | 10·439955 | 9·590748 | 5 31 | 10·409252 | 10·030703 | 5 4 | 9·969297 | 50 | 30 |
| 18 | 12 | 9·560207 | 6 32 | 10·439793 | 9·590935 | 6 37 | 10·409065 | 10·030728 | 6 5 | 9·969272 | 48 | 42 |
| 30 | 14 | 9·560369 | 7 38 | 10·439631 | 9·591122 | 7 43 | 10·408878 | 10·030753 | 7 6 | 9·969247 | 46 | 30 |
| 19 | 16 | 9·560531 | 8 43 | 10·439469 | 9·591308 | 8 50 | 10·408692 | 10·030777 | 8 7 | 9·969223 | 44 | 41 |
| 30 | 18 | 9·560693 | 9 48 | 10·439307 | 9·591495 | 9 56 | 10·408505 | 10·030802 | 9 7 | 9·969198 | 42 | 30 |
| 20 | 20 | 9·560855 | 10 54 | 10·439145 | 9·591681 | 10 62 | 10·408319 | 10·030827 | 10 8 | 9·969173 | 40 | 40 |
| 30 | 22 | 9·561016 | 11 59 | 10·438984 | 9·591867 | 11 68 | 10·408132 | 10·030851 | 11 9 | 9·969149 | 38 | 30 |
| 21 | 24 | 9·561178 | 12 65 | 10·438822 | 9·592054 | 12 74 | 10·407946 | 10·030876 | 12 10 | 9·969124 | 36 | 39 |
| 30 | 26 | 9·561339 | 13 70 | 10·438661 | 9·592240 | 13 81 | 10·407760 | 10·030901 | 13 11 | 9·969099 | 34 | 30 |
| 22 | 28 | 9·561501 | 14 75 | 10·438499 | 9·592426 | 14 87 | 10·407574 | 10·030925 | 14 11 | 9·969075 | 32 | 38 |
| 30 | 30 | 9·561662 | 15 81 | 10·438338 | 9·592612 | 15 93 | 10·407388 | 10·030950 | 15 12 | 9·969050 | 30 | 30 |
| 23 | 32 | 9·561824 | 16 86 | 10·438176 | 9·592799 | 16 99 | 10·407201 | 10·030975 | 16 13 | 9·969025 | 28 | 37 |
| 30 | 34 | 9·561985 | 17 91 | 10·438015 | 9·592985 | 17 105 | 10·407015 | 10·031000 | 17 14 | 9·969000 | 26 | 30 |
| 24 | 36 | 9·562146 | 18 97 | 10·437854 | 9·593171 | 18 112 | 10·406829 | 10·031024 | 18 15 | 9·968976 | 24 | 36 |
| 30 | 38 | 9·562307 | 19 102 | 10·437693 | 9·593356 | 19 118 | 10·406644 | 10·031049 | 19 16 | 9·968951 | 22 | 30 |
| 25 | 40 | 9·562468 | 20 108 | 10·437532 | 9·593542 | 20 124 | 10·406458 | 10·031074 | 20 16 | 9·968926 | 20 | 35 |
| 30 | 42 | 9·562629 | 21 113 | 10·437371 | 9·593728 | 21 130 | 10·406272 | 10·031099 | 21 17 | 9·968901 | 18 | 30 |
| 26 | 44 | 9·562790 | 22 119 | 10·437210 | 9·593914 | 22 136 | 10·406086 | 10·031123 | 22 18 | 9·968877 | 16 | 34 |
| 30 | 46 | 9·562951 | 23 124 | 10·437049 | 9·594099 | 23 143 | 10·405901 | 10·031148 | 23 19 | 9·968852 | 14 | 30 |
| 27 | 48 | 9·563112 | 24 129 | 10·436888 | 9·594285 | 24 149 | 10·405715 | 10·031173 | 24 20 | 9·968827 | 12 | 33 |
| 30 | 50 | 9·563273 | 25 135 | 10·436727 | 9·594471 | 25 155 | 10·405529 | 10·031198 | 25 20 | 9·968802 | 10 | 30 |
| 28 | 52 | 9·563433 | 26 140 | 10·436567 | 9·594656 | 26 161 | 10·405344 | 10·031223 | 26 21 | 9·968777 | 8 | 32 |
| 30 | 54 | 9·563594 | 27 145 | 10·436406 | 9·594842 | 27 167 | 10·405158 | 10·031248 | 27 22 | 9·968752 | 6 | 30 |
| 29 | 56 | 9·563755 | 28 151 | 10·436245 | 9·595027 | 28 174 | 10·404973 | 10·031272 | 28 23 | 9·968728 | 4 | 31 |
| 30 | 58 | 9·563915 | 29 156 | 10·436085 | 9·595212 | 29 180 | 10·404788 | 10·031297 | 29 24 | 9·968703 | 2 | 30 |
| 30 | 26 | 9·564075 | 30 161 | 10·435925 | 9·595398 | 30 186 | 10·404602 | 10·031322 | 30 25 | 9·968678 | 0 | 30 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

68° — 4ʰ 34ᵐ

## LOG. SINES, COSINES, &c.

1h 26m — 21°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 9·564075 | | 10·435925 | 9·595398 | | 10·404602 | 10·031322 | | 9·968678 | 34 | 30 |
| 30 | 2 | 9·564236 | 1″ 5 | 10·435764 | 9·595583 | 1″ 6 | 10·404417 | 10·031347 | 1″ 1 | 9·968653 | 58 | 30 |
| 31 | 4 | 9·564396 | 2 11 | 10·435604 | 9·595768 | 2 12 | 10·404232 | 10·031372 | 2 2 | 9·968628 | 56 | 29 |
| 30 | 6 | 9·564556 | 3 16 | 10·435444 | 9·595953 | 3 18 | 10·404047 | 10·031397 | 3 3 | 9·968603 | 54 | 30 |
| 32 | 8 | 9·564716 | 4 21 | 10·435284 | 9·596138 | 4 25 | 10·403862 | 10·031422 | 4 3 | 9·968578 | 52 | 28 |
| 30 | 10 | 9·564876 | 5 27 | 10·435124 | 9·596323 | 5 31 | 10·403677 | 10·031447 | 5 4 | 9·968553 | 50 | 30 |
| 33 | 12 | 9·565036 | 6 32 | 10·434964 | 9·596508 | 6 37 | 10·403492 | 10·031472 | 6 5 | 9·968528 | 48 | 27 |
| 30 | 14 | 9·565196 | 7 37 | 10·434804 | 9·596693 | 7 43 | 10·403307 | 10·031497 | 7 6 | 9·968503 | 46 | 30 |
| 34 | 16 | 9·565356 | 8 42 | 10·434644 | 9·596878 | 8 49 | 10·403122 | 10·031521 | 8 7 | 9·968479 | 44 | 26 |
| 30 | 18 | 9·565516 | 9 48 | 10·434484 | 9·597062 | 9 55 | 10·402938 | 10·031546 | 9 8 | 9·968454 | 42 | 30 |
| 35 | 20 | 9·565676 | 10 53 | 10·434324 | 9·597247 | 10 61 | 10·402753 | 10·031571 | 10 8 | 9·968429 | 40 | 25 |
| 30 | 22 | 9·565835 | 11 58 | 10·434165 | 9·597432 | 11 68 | 10·402568 | 10·031596 | 11 9 | 9·968404 | 38 | 30 |
| 36 | 24 | 9·565995 | 12 64 | 10·434005 | 9·597616 | 12 74 | 10·402384 | 10·031621 | 12 10 | 9·968379 | 36 | 24 |
| 30 | 26 | 9·566154 | 13 69 | 10·433846 | 9·597801 | 13 80 | 10·402199 | 10·031646 | 13 11 | 9·968354 | 34 | 30 |
| 37 | 28 | 9·566314 | 14 74 | 10·433686 | 9·597985 | 14 86 | 10·402015 | 10·031671 | 14 12 | 9·968329 | 32 | 23 |
| 30 | 30 | 9·566473 | 15 80 | 10·433527 | 9·598170 | 15 92 | 10·401830 | 10·031697 | 15 12 | 9·968303 | 30 | 30 |
| 38 | 32 | 9·566632 | 16 85 | 10·433368 | 9·598354 | 16 98 | 10·401646 | 10·031722 | 16 13 | 9·968278 | 28 | 22 |
| 30 | 34 | 9·566792 | 17 90 | 10·433208 | 9·598538 | 17 105 | 10·401462 | 10·031747 | 17 14 | 9·968253 | 26 | 30 |
| 39 | 36 | 9·566951 | 18 96 | 10·433049 | 9·598722 | 18 111 | 10·401278 | 10·031772 | 18 15 | 9·968228 | 24 | 21 |
| 30 | 38 | 9·567110 | 19 101 | 10·432890 | 9·598907 | 19 117 | 10·401093 | 10·031797 | 19 16 | 9·968203 | 22 | 30 |
| 40 | 40 | 9·567269 | 20 106 | 10·432731 | 9·599091 | 20 123 | 10·400909 | 10·031822 | 20 17 | 9·968178 | 20 | 20 |
| 30 | 42 | 9·567428 | 21 112 | 10·432572 | 9·599275 | 21 129 | 10·400725 | 10·031847 | 21 17 | 9·968153 | 18 | 30 |
| 41 | 44 | 9·567587 | 22 117 | 10·432413 | 9·599459 | 22 135 | 10·400541 | 10·031872 | 22 18 | 9·968128 | 16 | 19 |
| 30 | 46 | 9·567746 | 23 122 | 10·432254 | 9·599643 | 23 141 | 10·400357 | 10·031897 | 23 19 | 9·968103 | 14 | 30 |
| 42 | 48 | 9·567904 | 24 127 | 10·432096 | 9·599827 | 24 148 | 10·400173 | 10·031922 | 24 20 | 9·968078 | 12 | 18 |
| 30 | 50 | 9·568063 | 25 133 | 10·431937 | 9·600011 | 25 154 | 10·399989 | 10·031947 | 25 21 | 9·968053 | 10 | 30 |
| 43 | 52 | 9·568222 | 26 138 | 10·431778 | 9·600194 | 26 160 | 10·399806 | 10·031973 | 26 22 | 9·968027 | 8 | 17 |
| 30 | 54 | 9·568380 | 27 143 | 10·431620 | 9·600378 | 27 166 | 10·399622 | 10·031998 | 27 22 | 9·968002 | 6 | 30 |
| 44 | 56 | 9·568539 | 28 149 | 10·431461 | 9·600562 | 28 172 | 10·399438 | 10·032023 | 28 23 | 9·9679[illegible] | 4 | 16 |
| 30 | 58 | 9·568697 | 29 154 | 10·431303 | 9·600745 | 29 178 | 10·399255 | 10·032048 | 29 24 | 9·967952 | 2 | 30 |
| 45 | 27 | 9·568856 | 30 159 | 10·431144 | 9·600929 | 30 184 | 10·399071 | 10·032073 | 30 25 | 9·967927 | 33 | 15 |
| 30 | 2 | 9·569014 | 1 5 | 10·430986 | 9·601112 | 1 6 | 10·398888 | 10·032099 | 1 1 | 9·967901 | 58 | 30 |
| 46 | 4 | 9·569172 | 2 10 | 10·430828 | 9·601296 | 2 12 | 10·398704 | 10·032124 | 2 2 | 9·967876 | 56 | 14 |
| 30 | 6 | 9·569330 | 3 16 | 10·430670 | 9·601479 | 3 18 | 10·398521 | 10·032149 | 3 3 | 9·967851 | 54 | 30 |
| 47 | 8 | 9·569488 | 4 21 | 10·430512 | 9·601663 | 4 24 | 10·398337 | 10·032174 | 4 3 | 9·967826 | 52 | 13 |
| 30 | 10 | 9·569646 | 5 26 | 10·430354 | 9·601846 | 5 30 | 10·398154 | 10·032199 | 5 4 | 9·967801 | 50 | 30 |
| 48 | 12 | 9·569804 | 6 31 | 10·430196 | 9·602029 | 6 37 | 10·397971 | 10·032225 | 6 5 | 9·967775 | 48 | 12 |
| 30 | 14 | 9·569962 | 7 37 | 10·430038 | 9·602212 | 7 43 | 10·397788 | 10·032250 | 7 6 | 9·967750 | 46 | 30 |
| 49 | 16 | 9·570120 | 8 42 | 10·429880 | 9·602395 | 8 49 | 10·397605 | 10·032275 | 8 7 | 9·967725 | 44 | 11 |
| 30 | 18 | 9·570278 | 9 47 | 10·429722 | 9·602578 | 9 55 | 10·397422 | 10·032301 | 9 8 | 9·967699 | 42 | 30 |
| 50 | 20 | 9·570435 | 10 52 | 10·429565 | 9·602761 | 10 61 | 10·397239 | 10·032326 | 10 8 | 9·967674 | 40 | 10 |
| 30 | 22 | 9·570593 | 11 58 | 10·429407 | 9·602944 | 11 67 | 10·397056 | 10·032351 | 11 9 | 9·967649 | 38 | 30 |
| 51 | 24 | 9·570751 | 12 63 | 10·429249 | 9·603127 | 12 73 | 10·396873 | 10·032376 | 12 10 | 9·967624 | 36 | 9 |
| 30 | 26 | 9·570908 | 13 68 | 10·429092 | 9·603310 | 13 79 | 10·396690 | 10·032402 | 13 11 | 9·967598 | 34 | 30 |
| 52 | 28 | 9·571066 | 14 73 | 10·428934 | 9·603493 | 14 85 | 10·396507 | 10·032427 | 14 12 | 9·967573 | 32 | 8 |
| 30 | 30 | 9·571223 | 15 79 | 10·428777 | 9·603675 | 15 91 | 10·396325 | 10·032453 | 15 13 | 9·967547 | 30 | 30 |
| 53 | 32 | 9·571380 | 16 84 | 10·428620 | 9·603858 | 16 97 | 10·396142 | 10·032478 | 16 14 | 9·967522 | 28 | 7 |
| 30 | 34 | 9·571537 | 17 89 | 10·428463 | 9·604041 | 17 104 | 10·395959 | 10·032503 | 17 14 | 9·967497 | 26 | 30 |
| 54 | 36 | 9·571695 | 18 95 | 10·428305 | 9·604223 | 18 110 | 10·395777 | 10·032529 | 18 15 | 9·967471 | 24 | 6 |
| 30 | 38 | 9·571852 | 19 100 | 10·428148 | 9·604406 | 19 116 | 10·395594 | 10·032554 | 19 16 | 9·967446 | 22 | 30 |
| 55 | 40 | 9·572009 | 20 105 | 10·427991 | 9·604588 | 20 122 | 10·395412 | 10·032579 | 20 17 | 9·967421 | 20 | 5 |
| 30 | 42 | 9·572166 | 21 110 | 10·427834 | 9·604771 | 21 128 | 10·395229 | 10·032605 | 21 18 | 9·967395 | 18 | 30 |
| 56 | 44 | 9·572323 | 22 116 | 10·427677 | 9·604953 | 22 134 | 10·395047 | 10·032630 | 22 19 | 9·967370 | 16 | 4 |
| 30 | 46 | 9·572479 | 23 121 | 10·427521 | 9·605135 | 23 140 | 10·394865 | 10·032656 | 23 20 | 9·967344 | 14 | 30 |
| 57 | 48 | 9·572636 | 24 126 | 10·427364 | 9·605317 | 24 146 | 10·394683 | 10·032681 | 24 20 | 9·967319 | 12 | 3 |
| 30 | 50 | 9·572793 | 25 131 | 10·427207 | 9·605500 | 25 152 | 10·394500 | 10·032707 | 25 21 | 9·967293 | 10 | 30 |
| 58 | 52 | 9·572950 | 26 137 | 10·427050 | 9·605682 | 26 158 | 10·394318 | 10·032732 | 26 22 | 9·967268 | 8 | 2 |
| 30 | 54 | 9·573106 | 27 142 | 10·426894 | 9·605864 | 27 164 | 10·394136 | 10·032758 | 27 23 | 9·967242 | 6 | 30 |
| 59 | 56 | 9·573263 | 28 147 | 10·426737 | 9·606046 | 28 171 | 10·393954 | 10·032783 | 28 24 | 9·967217 | 4 | 1 |
| 30 | 58 | 9·573419 | 29 152 | 10·426581 | 9·606228 | 29 177 | 10·393772 | 10·032809 | 29 25 | 9·967191 | 2 | 30 |
| 60 | 28 | 9·573575 | 30 157 | 10·426425 | 9·606410 | 30 183 | 10·393590 | 10·032834 | 30 25 | 9·967166 | 0 | 0 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

68° — 4h 32m

## LOG. SINES, COSINES, &c.

1h 28m — 22°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 9·573575 | | 10·426425 | 9·606410 | | 10·393590 | 10·032834 | | 9·967166 | 32 | 60 |
| 30 | 2 | 9·573732 | 1″ 5 | 10·426268 | 9·606591 | 1″ 6 | 10·393409 | 10·032860 | 1″ 1 | 9·967140 | 58 | 30 |
| 1 | 4 | 9·573888 | 2 10 | 10·426112 | 9·606773 | 2 12 | 10·393227 | 10·032885 | 2 2 | 9·967115 | 56 | 59 |
| 30 | 6 | 9·574044 | 3 16 | 10·425956 | 9·606955 | 3 18 | 10·393045 | 10·032911 | 3 3 | 9·967089 | 54 | 30 |
| 2 | 8 | 9·574200 | 4 21 | 10·425800 | 9·607137 | 4 24 | 10·392863 | 10·032936 | 4 3 | 9·967064 | 52 | 58 |
| 30 | 10 | 9·574356 | 5 26 | 10·425644 | 9·607318 | 5 30 | 10·392682 | 10·032962 | 5 4 | 9·967038 | 50 | 30 |
| 3 | 12 | 9·574512 | 6 31 | 10·425488 | 9·607500 | 6 36 | 10·392500 | 10·032987 | 6 5 | 9·967013 | 48 | 57 |
| 30 | 14 | 9·574668 | 7 36 | 10·425332 | 9·607681 | 7 42 | 10·392319 | 10·033013 | 7 6 | 9·966987 | 46 | 30 |
| 4 | 16 | 9·574824 | 8 41 | 10·425176 | 9·607863 | 8 48 | 10·392137 | 10·033039 | 8 7 | 9·966961 | 44 | 56 |
| 30 | 18 | 9·574980 | 9 47 | 10·425020 | 9·608044 | 9 54 | 10·391956 | 10·033064 | 9 8 | 9·966936 | 42 | 30 |
| 5 | 20 | 9·575136 | 10 52 | 10·424864 | 9·608225 | 10 60 | 10·391775 | 10·033090 | 10 9 | 9·966910 | 40 | 55 |
| 30 | 22 | 9·575291 | 11 57 | 10·424709 | 9·608407 | 11 66 | 10·391593 | 10·033116 | 11 9 | 9·966884 | 38 | 30 |
| 6 | 24 | 9·575447 | 12 62 | 10·424553 | 9·608588 | 12 72 | 10·391412 | 10·033141 | 12 10 | 9·966859 | 36 | 54 |
| 30 | 26 | 9·575602 | 13 67 | 10·424398 | 9·608769 | 13 78 | 10·391231 | 10·033167 | 13 11 | 9·966833 | 34 | 30 |
| 7 | 28 | 9·375758 | 14 73 | 10·424242 | 9·608950 | 14 84 | 10·391050 | 10·033192 | 14 12 | 9·966808 | 32 | 53 |
| 30 | 30 | 9·575913 | 15 78 | 10·424087 | 9·609131 | 15 90 | 10·390869 | 10·033218 | 15 13 | 9·966782 | 30 | 30 |
| 8 | 32 | 9·576069 | 16 83 | 10·423931 | 9·609312 | 16 96 | 10·390688 | 10·033244 | 16 14 | 9·966756 | 28 | 52 |
| 30 | 34 | 9·576224 | 17 88 | 10·423776 | 9·609493 | 17 103 | 10·390507 | 10·033270 | 17 14 | 9·966730 | 26 | 30 |
| 9 | 36 | 9·576379 | 18 93 | 10·423621 | 9·609674 | 18 109 | 10·390326 | 10·033295 | 18 15 | 9·966705 | 24 | 51 |
| 30 | 38 | 9·576534 | 19 99 | 10·423466 | 9·609855 | 19 115 | 10·390145 | 10·033321 | 19 16 | 9·966679 | 22 | 30 |
| 10 | 40 | 9·576689 | 20 104 | 10·423311 | 9·610036 | 20 121 | 10·389964 | 10·033347 | 20 17 | 9·966653 | 20 | 50 |
| 30 | 42 | 9·576844 | 21 109 | 10·423156 | 9·610217 | 21 127 | 10·389783 | 10·033372 | 21 18 | 9·966628 | 18 | 30 |
| 11 | 44 | 9·576999 | 22 114 | 10·423001 | 9·610397 | 22 133 | 10·389603 | 10·033398 | 22 19 | 9·966602 | 16 | 49 |
| 30 | 46 | 9·577154 | 23 119 | 10·422846 | 9·610578 | 23 139 | 10·389422 | 10·033424 | 23 20 | 9·966576 | 14 | 30 |
| 12 | 48 | 9·577309 | 24 124 | 10·422691 | 9·610759 | 24 145 | 10·389241 | 10·033450 | 24 21 | 9·966550 | 12 | 48 |
| 30 | 50 | 9·577464 | 25 130 | 10·422536 | 9·610939 | 25 151 | 10·389061 | 10·033475 | 25 21 | 9·966525 | 10 | 30 |
| 13 | 52 | 9·577618 | 26 135 | 10·422382 | 9·611120 | 26 157 | 10·388880 | 10·033501 | 26 22 | 9·966499 | 8 | 47 |
| 30 | 54 | 9·577773 | 27 140 | 10·422227 | 9·611300 | 27 163 | 10·388700 | 10·033527 | 27 23 | 9·966473 | 6 | 30 |
| 14 | 56 | 9·577927 | 28 145 | 10·422073 | 9·611480 | 28 169 | 10·388520 | 10·033553 | 28 24 | 9·966447 | 4 | 46 |
| 30 | 58 | 9·578082 | 29 150 | 10·421918 | 9·611661 | 29 175 | 10·388339 | 10·033579 | 29 25 | 9·966421 | 2 | 30 |
| 15 | 60 | 9·578236 | 30 155 | 10·421764 | 9·611841 | 30 181 | 10·388159 | 10·033605 | 30 26 | 9·966395 | 32 | 45 |
| 30 | 2 | 9·578391 | 1 5 | 10·421609 | 9·612021 | 1 6 | 10·387979 | 10·033630 | 1 1 | 9·966370 | 58 | 30 |
| 16 | 4 | 9·578545 | 2 10 | 10·421455 | 9·612201 | 2 12 | 10·387799 | 10·033656 | 2 2 | 9·966344 | 56 | 44 |
| 30 | 6 | 9·578699 | 3 15 | 10·421301 | 9·612381 | 3 18 | 10·387619 | 10·033682 | 3 3 | 9·966318 | 54 | 30 |
| 17 | 8 | 9·578853 | 4 20 | 10·421147 | 9·612561 | 4 24 | 10·387439 | 10·033708 | 4 3 | 9·966292 | 52 | 43 |
| 30 | 10 | 9·579008 | 5 26 | 10·420992 | 9·612741 | 5 30 | 10·387259 | 10·033734 | 5 4 | 9·966266 | 50 | 30 |
| 18 | 12 | 9·579162 | 6 31 | 10·420838 | 9·612921 | 6 36 | 10·387079 | 10·033760 | 6 5 | 9·966240 | 48 | 42 |
| 30 | 14 | 9·579316 | 7 36 | 10·420684 | 9·613101 | 7 42 | 10·386899 | 10·033786 | 7 6 | 9·966214 | 46 | 30 |
| 19 | 16 | 9·579470 | 8 41 | 10·420530 | 9·613281 | 8 48 | 10·386719 | 10·033812 | 8 7 | 9·966188 | 44 | 41 |
| 30 | 18 | 9·579623 | 9 46 | 10·420377 | 9·613461 | 9 54 | 10·386539 | 10·033838 | 9 8 | 9·966162 | 42 | 30 |
| 20 | 20 | 9·579777 | 10 51 | 10·420223 | 9·613641 | 10 60 | 10·386359 | 10·033864 | 10 9 | 9·966136 | 40 | 40 |
| 30 | 22 | 9·579931 | 11 56 | 10·420069 | 9·613820 | 11 66 | 10·386180 | 10·033890 | 11 10 | 9·966110 | 38 | 30 |
| 21 | 24 | 9·580085 | 12 61 | 10·419915 | 9·614000 | 12 72 | 10·386000 | 10·033915 | 12 10 | 9·966085 | 36 | 39 |
| 30 | 26 | 9·580238 | 13 66 | 10·419762 | 9·614180 | 13 78 | 10·385820 | 10·033941 | 13 11 | 9·966059 | 34 | 30 |
| 22 | 28 | 9·580392 | 14 71 | 10·419608 | 9·614359 | 14 84 | 10·385641 | 10·033967 | 14 12 | 9·966033 | 32 | 38 |
| 30 | 30 | 9·580545 | 15 77 | 10·419455 | 9·614539 | 15 90 | 10·385461 | 10·033993 | 15 13 | 9·966007 | 30 | 30 |
| 23 | 32 | 9·580699 | 16 82 | 10·419301 | 9·614718 | 16 96 | 10·385282 | 10·034019 | 16 14 | 9·965981 | 28 | 37 |
| 30 | 34 | 9·580852 | 17 87 | 10·419148 | 9·614897 | 17 102 | 10·385103 | 10·034045 | 17 15 | 9·965955 | 26 | 30 |
| 24 | 36 | 9·581005 | 18 92 | 10·418995 | 9·615077 | 18 108 | 10·384923 | 10·034071 | 18 16 | 9·965929 | 24 | 36 |
| 30 | 38 | 9·581158 | 19 97 | 10·418842 | 9·615256 | 19 114 | 10·384744 | 10·034098 | 19 17 | 9·965902 | 22 | 30 |
| 25 | 40 | 9·581312 | 20 102 | 10·418688 | 9·615435 | 20 120 | 10·384565 | 10·034124 | 20 17 | 9·965876 | 20 | 35 |
| 30 | 42 | 9·581465 | 21 107 | 10·418535 | 9·615614 | 21 126 | 10·384386 | 10·034150 | 21 18 | 9·965850 | 18 | 30 |
| 26 | 44 | 9·581618 | 22 112 | 10·418382 | 9·615793 | 22 132 | 10·384207 | 10·034176 | 22 19 | 9·965824 | 16 | 34 |
| 30 | 46 | 9·581771 | 23 118 | 10·418229 | 9·615972 | 23 138 | 10·384028 | 10·034202 | 23 20 | 9·965798 | 14 | 30 |
| 27 | 48 | 9·581924 | 24 123 | 10·418076 | 9·616151 | 24 144 | 10·383849 | 10·034228 | 24 21 | 9·965772 | 12 | 33 |
| 30 | 50 | 9·582076 | 25 128 | 10·417924 | 9·616330 | 25 149 | 10·383670 | 10·034254 | 25 22 | 9·965746 | 10 | 30 |
| 28 | 52 | 9·582229 | 26 133 | 10·417771 | 9·616509 | 26 155 | 10·383491 | 10·034280 | 26 23 | 9·965720 | 8 | 32 |
| 30 | 54 | 9·582382 | 27 138 | 10·417618 | 9·616688 | 27 161 | 10·383312 | 10·034306 | 27 23 | 9·965694 | 6 | 30 |
| 29 | 56 | 9·582535 | 28 143 | 10·417465 | 9·616867 | 28 167 | 10·383133 | 10·034332 | 28 24 | 9·965668 | 4 | 31 |
| 30 | 58 | 9·582687 | 29 148 | 10·417313 | 9·617046 | 29 173 | 10·382954 | 10·034358 | 29 25 | 9·965642 | 2 | 30 |
| 30 | 60 | 9·582840 | 30 153 | 10·417160 | 9·617224 | 30 179 | 10·382776 | 10·034385 | 30 26 | 9·965615 | 0 | 30 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

67° — 4h 30m

LOG. SINES, COSINES, &c.

1h 30m — 22°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 9·582840 | | 10·417160 | 9·617224 | | 10·382776 | 10·034385 | | 9·965615 | 30 | 30 |
| 30 | 2 | 9·582992 | 1″ 5 | 10·417008 | 9·617403 | 1″ 6 | 10·382597 | 10·034411 | 1″ 1 | 9·965589 | 58 | 30 |
| 31 | 4 | 9·583145 | 2 10 | 10·416855 | 9·617582 | 2 12 | 10·382418 | 10·034437 | 2 2 | 9·965563 | 56 | 29 |
| 30 | 6 | 9·583297 | 3 15 | 10·416703 | 9·617760 | 3 18 | 10·382240 | 10·034463 | 3 3 | 9·965537 | 54 | 30 |
| 32 | 8 | 9·583449 | 4 20 | 10·416551 | 9·617939 | 4 24 | 10·382061 | 10·034489 | 4 4 | 9·965511 | 52 | 28 |
| 30 | 10 | 9·583601 | 5 25 | 10·416399 | 9·618117 | 5 30 | 10·381883 | 10·034516 | 5 4 | 9·965484 | 50 | 30 |
| 33 | 12 | 9·583754 | 6 30 | 10·416246 | 9·618295 | 6 36 | 10·381705 | 10·034542 | 6 5 | 9·965458 | 48 | 27 |
| 30 | 14 | 9·583906 | 7 35 | 10·416094 | 9·618474 | 7 42 | 10·381526 | 10·034568 | 7 6 | 9·965432 | 46 | 30 |
| 34 | 16 | 9·584058 | 8 40 | 10·415942 | 9·618652 | 8 47 | 10·381348 | 10·034594 | 8 7 | 9·965406 | 44 | 26 |
| 30 | 18 | 9·584210 | 9 45 | 10·415790 | 9·618830 | 9 53 | 10·381170 | 10·034621 | 9 8 | 9·965379 | 42 | 30 |
| 35 | 20 | 9·584361 | 10 50 | 10·415639 | 9·619008 | 10 59 | 10·380992 | 10·034647 | 10 9 | 9·965353 | 40 | 25 |
| 30 | 22 | 9·584513 | 11 56 | 10·415487 | 9·619186 | 11 65 | 10·380814 | 10·034673 | 11 10 | 9·965327 | 38 | 30 |
| 36 | 24 | 9·584665 | 12 61 | 10·415335 | 9·619364 | 12 71 | 10·380636 | 10·034699 | 12 11 | 9·965301 | 36 | 24 |
| 30 | 26 | 9·584817 | 13 66 | 10·415183 | 9·619543 | 13 77 | 10·380457 | 10·034726 | 13 11 | 9·965274 | 34 | 30 |
| 37 | 28 | 9·584968 | 14 71 | 10·415032 | 9·619720 | 14 83 | 10·380280 | 10·034752 | 14 12 | 9·965248 | 32 | 23 |
| 30 | 30 | 9·585120 | 15 76 | 10·414880 | 9·619898 | 15 90 | 10·380102 | 10·034778 | 15 13 | 9·965222 | 30 | 30 |
| 38 | 32 | 9·585272 | 16 81 | 10·414728 | 9·620076 | 16 95 | 10·379924 | 10·034805 | 16 14 | 9·965195 | 28 | 22 |
| 30 | 34 | 9·585423 | 17 86 | 10·414577 | 9·620254 | 17 101 | 10·379746 | 10·034831 | 17 15 | 9·965169 | 26 | 30 |
| 39 | 36 | 9·585574 | 18 91 | 10·414426 | 9·620432 | 18 107 | 10·379568 | 10·034857 | 18 16 | 9·965143 | 24 | 21 |
| 30 | 38 | 9·585726 | 19 96 | 10·414274 | 9·620610 | 19 113 | 10·379390 | 10·034884 | 19 17 | 9·965116 | 22 | 30 |
| 40 | 40 | 9·585877 | 20 101 | 10·414123 | 9·620787 | 20 119 | 10·379213 | 10·034910 | 20 18 | 9·965090 | 20 | 20 |
| 30 | 42 | 9·586028 | 21 106 | 10·413972 | 9·620965 | 21 125 | 10·379035 | 10·034936 | 21 18 | 9·965064 | 18 | 30 |
| 41 | 44 | 9·586179 | 22 111 | 10·413821 | 9·621142 | 22 130 | 10·378858 | 10·034963 | 22 19 | 9·965037 | 16 | 19 |
| 30 | 46 | 9·586331 | 23 116 | 10·413669 | 9·621320 | 23 136 | 10·378680 | 10·034989 | 23 20 | 9·965011 | 14 | 30 |
| 42 | 48 | 9·586482 | 24 121 | 10·413518 | 9·621497 | 24 142 | 10·378503 | 10·035016 | 24 21 | 9·964984 | 12 | 18 |
| 30 | 50 | 9·586633 | 25 126 | 10·413367 | 9·621675 | 25 148 | 10·378325 | 10·035042 | 25 22 | 9·964958 | 10 | 30 |
| 43 | 52 | 9·586783 | 26 131 | 10·413217 | 9·621852 | 26 154 | 10·378148 | 10·035069 | 26 23 | 9·964931 | 8 | 17 |
| 30 | 54 | 9·586934 | 27 136 | 10·413066 | 9·622029 | 27 160 | 10·377971 | 10·035095 | 27 24 | 9·964905 | 6 | 30 |
| 44 | 56 | 9·587085 | 28 141 | 10·412915 | 9·622207 | 28 166 | 10·377793 | 10·035121 | 28 25 | 9·964879 | 4 | 16 |
| 30 | 58 | 9·587236 | 29 146 | 10·412764 | 9·622384 | 29 172 | 10·377616 | 10·035148 | 29 26 | 9·964852 | 2 | 30 |
| 45 | 31 | 9·587386 | 30 151 | 10·412614 | 9·622561 | 30 178 | 10·377439 | 10·035174 | 30 26 | 9·964826 | 29 | 15 |
| 30 | 2 | 9·587537 | 1 5 | 10·412463 | 9·622738 | 1 6 | 10·377262 | 10·035201 | 1 1 | 9·964799 | 58 | 30 |
| 46 | 4 | 9·587688 | 2 10 | 10·412312 | 9·622915 | 2 12 | 10·377085 | 10·035227 | 2 2 | 9·964773 | 56 | 14 |
| 30 | 6 | 9·587838 | 3 15 | 10·412162 | 9·623092 | 3 18 | 10·376908 | 10·035254 | 3 3 | 9·964746 | 54 | 30 |
| 47 | 8 | 9·587989 | 4 20 | 10·412011 | 9·623269 | 4 24 | 10·376731 | 10·035280 | 4 4 | 9·964720 | 52 | 13 |
| 30 | 10 | 9·588139 | 5 25 | 10·411861 | 9·623446 | 5 29 | 10·376554 | 10·035307 | 5 4 | 9·964693 | 50 | 30 |
| 48 | 12 | 9·588289 | 6 30 | 10·411711 | 9·623623 | 6 35 | 10·376377 | 10·035334 | 6 5 | 9·964666 | 48 | 12 |
| 30 | 14 | 9·588439 | 7 35 | 10·411561 | 9·623800 | 7 41 | 10·376200 | 10·035360 | 7 6 | 9·964640 | 46 | 30 |
| 49 | 16 | 9·588590 | 8 40 | 10·411410 | 9·623976 | 8 47 | 10·376024 | 10·035387 | 8 7 | 9·964613 | 44 | 11 |
| 30 | 18 | 9·588740 | 9 45 | 10·411260 | 9·624153 | 9 53 | 10·375847 | 10·035413 | 9 8 | 9·964[illegible]87 | 42 | 30 |
| 50 | 20 | 9·588890 | 10 50 | 10·411110 | 9·624330 | 10 59 | 10·375670 | 10·035440 | 10 9 | 9·96456[illegible] | 40 | 10 |
| 30 | 22 | 9·589040 | 11 55 | 10·410960 | 9·624506 | 11 65 | 10·375494 | 10·035466 | 11 10 | 9·964534 | 38 | 30 |
| 51 | 24 | 9·589190 | 12 60 | 10·410810 | 9·624683 | 12 71 | 10·375317 | 10·035493 | 12 11 | 9·9645[illegible] | 36 | 9 |
| 30 | 26 | 9·589340 | 13 65 | 10·410660 | 9·624859 | 13 76 | 10·375141 | 10·035520 | 13 12 | 9·964480 | 34 | 30 |
| 52 | 28 | 9·589489 | 14 70 | 10·410511 | 9·625036 | 14 82 | 10·374964 | 10·035546 | 14 12 | 9·964454 | 32 | 8 |
| 30 | 30 | 9·589639 | 15 75 | 10·410361 | 9·625212 | 15 88 | 10·374788 | 10·035573 | 15 13 | 9·964427 | 30 | 30 |
| 53 | 32 | 9·589789 | 16 80 | 10·410211 | 9·625388 | 16 94 | 10·374612 | 10·035600 | 16 14 | 9·964400 | 28 | 7 |
| 30 | 34 | 9·589938 | 17 85 | 10·410062 | 9·625565 | 17 100 | 10·374435 | 10·035626 | 17 15 | 9·964374 | 26 | 30 |
| 54 | 36 | 9·590088 | 18 90 | 10·409912 | 9·625741 | 18 106 | 10·374259 | 10·035653 | 18 16 | 9·964347 | 24 | 6 |
| 30 | 38 | 9·590237 | 19 95 | 10·409763 | 9·625917 | 19 112 | 10·374083 | 10·035680 | 19 17 | 9·964320 | 22 | 30 |
| 55 | 40 | 9·590387 | 20 100 | 10·409613 | 9·626093 | 20 118 | 10·373907 | 10·035706 | 20 18 | 9·964294 | 20 | 5 |
| 30 | 42 | 9·590536 | 21 105 | 10·409464 | 9·626269 | 21 123 | 10·373731 | 10·035733 | 21 19 | 9·964267 | 18 | 30 |
| 56 | 44 | 9·590686 | 22 110 | 10·409314 | 9·626445 | 22 129 | 10·373555 | 10·035760 | 22 20 | 9·964240 | 16 | 4 |
| 30 | 46 | 9·590835 | 23 115 | 10·409165 | 9·626621 | 23 135 | 10·373379 | 10·035786 | 23 20 | 9·964214 | 14 | 30 |
| 57 | 48 | 9·590984 | 24 120 | 10·409016 | 9·626797 | 24 141 | 10·373203 | 10·035813 | 24 21 | 9·964187 | 12 | 3 |
| 30 | 50 | 9·591133 | 25 125 | 10·408867 | 9·626973 | 25 147 | 10·373027 | 10·035840 | 25 22 | 9·964160 | 10 | 30 |
| 58 | 52 | 9·591282 | 26 130 | 10·408718 | 9·627149 | 26 153 | 10·372851 | 10·035867 | 26 23 | 9·964133 | 8 | 2 |
| 30 | 54 | 9·591431 | 27 135 | 10·408569 | 9·627325 | 27 159 | 10·372675 | 10·035894 | 27 24 | 9·964106 | 6 | 30 |
| 60 | 56 | 9·591580 | 28 140 | 10·408420 | 9·627501 | 28 165 | 10·372499 | 10·035920 | 28 25 | 9·964080 | 4 | 1 |
| 30 | 58 | 9·591729 | 29 145 | 10·408271 | 9·627676 | 29 171 | 10·372324 | 10·035947 | 29 26 | 9·964053 | 2 | 30 |
| 60 | 32 | 9·591878 | 30 150 | 10·408122 | 9·627852 | 30 176 | 10·372148 | 10·035974 | 30 27 | 9·964026 | 0 | 0 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

67° — 4h 28m

## LOG. SINES, COSINES, &c.

1h 32m — 23°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 9·591878 | | 10·408122 | 9·627852 | | 10·372148 | 10·035974 | | 9·964026 | 28 | 60 |
| 30 | 2 | 9·592027 | 1″ 5 | 10·407973 | 9·628028 | 1″ 6 | 10·371972 | 10·036001 | 1″ 1 | 9·963999 | 58 | 30 |
| 1 | 4 | 9·592176 | 2 10 | 10·407824 | 9·628203 | 2 12 | 10·371797 | 10·036028 | 2 2 | 9·963972 | 56 | 59 |
| 30 | 6 | 9·592324 | 3 15 | 10·407676 | 9·628379 | 3 17 | 10·371621 | 10·036054 | 3 3 | 9·963946 | 54 | 30 |
| 2 | 8 | 9·592473 | 4 20 | 10·407527 | 9·628554 | 4 23 | 10·371446 | 10·036081 | 4 4 | 9·963919 | 52 | 58 |
| 30 | 10 | 9·592621 | 5 25 | 10·407379 | 9·628729 | 5 29 | 10·371271 | 10·036108 | 5 4 | 9·963892 | 50 | 30 |
| 3 | 12 | 9·592770 | 6 30 | 10·407230 | 9·628905 | 6 35 | 10·371095 | 10·036135 | 6 5 | 9·963865 | 48 | 57 |
| 30 | 14 | 9·592918 | 7 35 | 10·407082 | 9·629080 | 7 41 | 10·370920 | 10·036162 | 7 6 | 9·963838 | 46 | 30 |
| 4 | 16 | 9·593067 | 8 39 | 10·406933 | 9·629255 | 8 47 | 10·370745 | 10·036189 | 8 7 | 9·963811 | 44 | 56 |
| 30 | 18 | 9·593215 | 9 44 | 10·406785 | 9·629431 | 9 52 | 10·370569 | 10·036216 | 9 8 | 9·963784 | 42 | 30 |
| 5 | 20 | 9·593363 | 10 49 | 10·406637 | 9·629606 | 10 58 | 10·370394 | 10·036243 | 10 9 | 9·963757 | 40 | 55 |
| 30 | 22 | 9·593511 | 11 54 | 10·406489 | 9·629781 | 11 64 | 10·370219 | 10·036270 | 11 10 | 9·963730 | 38 | 30 |
| 6 | 24 | 9·593659 | 12 59 | 10·406341 | 9·629956 | 12 70 | 10·370044 | 10·036296 | 12 11 | 9·963704 | 36 | 54 |
| 30 | 26 | 9·593807 | 13 64 | 10·406193 | 9·630131 | 13 76 | 10·369869 | 10·036323 | 13 12 | 9·963677 | 34 | 30 |
| 7 | 28 | 9·593955 | 14 69 | 10·406045 | 9·630306 | 14 82 | 10·369694 | 10·036350 | 14 13 | 9·963650 | 32 | 53 |
| 30 | 30 | 9·594103 | 15 74 | 10·405897 | 9·630481 | 15 87 | 10·369519 | 10·036377 | 15 13 | 9·963623 | 30 | 30 |
| 8 | 32 | 9·594251 | 16 79 | 10·405749 | 9·630656 | 16 93 | 10·369344 | 10·036404 | 16 14 | 9·963596 | 28 | 52 |
| 30 | 34 | 9·594399 | 17 84 | 10·405601 | 9·630830 | 17 99 | 10·369170 | 10·036431 | 17 15 | 9·963569 | 26 | 30 |
| 9 | 36 | 9·594547 | 18 89 | 10·405453 | 9·631005 | 18 105 | 10·368995 | 10·036458 | 18 16 | 9·963542 | 24 | 51 |
| 30 | 38 | 9·594695 | 19 94 | 10·405305 | 9·631180 | 19 111 | 10·368820 | 10·036485 | 19 17 | 9·963515 | 22 | 30 |
| 10 | 40 | 9·594842 | 20 99 | 10·405158 | 9·631355 | 20 117 | 10·368645 | 10·036512 | 20 18 | 9·963488 | 20 | 50 |
| 30 | 42 | 9·594990 | 21 104 | 10·405010 | 9·631529 | 21 122 | 10·368471 | 10·036539 | 21 19 | 9·963461 | 18 | 30 |
| 11 | 44 | 9·595137 | 22 109 | 10·404863 | 9·631704 | 22 128 | 10·368296 | 10·036566 | 22 20 | 9·963434 | 16 | 49 |
| 30 | 46 | 9·595285 | 23 114 | 10·404715 | 9·631878 | 23 134 | 10·368122 | 10·036593 | 23 21 | 9·963407 | 14 | 30 |
| 12 | 48 | 9·595432 | 24 118 | 10·404568 | 9·632053 | 24 140 | 10·367947 | 10·036621 | 24 22 | 9·963379 | 12 | 48 |
| 30 | 50 | 9·595580 | 25 123 | 10·404420 | 9·632227 | 25 146 | 10·367773 | 10·036648 | 25 22 | 9·963352 | 10 | 30 |
| 13 | 52 | 9·595727 | 26 128 | 10·404273 | 9·632402 | 26 152 | 10·367598 | 10·036675 | 26 23 | 9·963325 | 8 | 47 |
| 30 | 54 | 9·595874 | 27 133 | 10·404126 | 9·632576 | 27 157 | 10·367424 | 10·036702 | 27 24 | 9·963298 | 6 | 30 |
| 14 | 56 | 9·596021 | 28 138 | 10·403979 | 9·632750 | 28 163 | 10·367250 | 10·036729 | 28 25 | 9·963271 | 4 | 46 |
| 30 | 58 | 9·596168 | 29 143 | 10·403832 | 9·632924 | 29 169 | 10·367076 | 10·036756 | 29 26 | 9·963244 | 2 | 30 |
| 15 | 33 | 9·596315 | 30 148 | 10·403685 | 9·633099 | 30 175 | 10·366901 | 10·036783 | 30 27 | 9·963217 | 27 | 45 |
| 30 | 2 | 9·596462 | 1 5 | 10·403538 | 9·633273 | 1 6 | 10·366727 | 10·036810 | 1 1 | 9·963190 | 58 | 30 |
| 16 | 4 | 9·596609 | 2 10 | 10·403391 | 9·633447 | 2 12 | 10·366553 | 10·036837 | 2 2 | 9·963163 | 56 | 44 |
| 30 | 6 | 9·596756 | 3 15 | 10·403244 | 9·633621 | 3 17 | 10·366379 | 10·036865 | 3 3 | 9·963135 | 54 | 30 |
| 17 | 8 | 9·596903 | 4 20 | 10·403097 | 9·633795 | 4 23 | 10·366205 | 10·036892 | 4 4 | 9·963108 | 52 | 43 |
| 30 | 10 | 9·597050 | 5 24 | 10·402950 | 9·633969 | 5 29 | 10·366031 | 10·036919 | 5 5 | 9·963081 | 50 | 30 |
| 18 | 12 | 9·597196 | 6 29 | 10·402804 | 9·634143 | 6 35 | 10·365857 | 10·036946 | 6 5 | 9·963054 | 48 | 42 |
| 30 | 14 | 9·597343 | 7 34 | 10·402657 | 9·634316 | 7 40 | 10·365684 | 10·036973 | 7 6 | 9·963027 | 46 | 30 |
| 19 | 16 | 9·597490 | 8 39 | 10·402510 | 9·634490 | 8 46 | 10·365510 | 10·037001 | 8 7 | 9·962999 | 44 | 41 |
| 30 | 18 | 9·597636 | 9 44 | 10·402364 | 9·634664 | 9 52 | 10·365336 | 10·037028 | 9 8 | 9·962972 | 42 | 30 |
| 20 | 20 | 9·597783 | 10 49 | 10·402217 | 9·634838 | 10 58 | 10·365162 | 10·037055 | 10 9 | 9·962945 | 40 | 40 |
| 30 | 22 | 9·597929 | 11 54 | 10·402071 | 9·635011 | 11 64 | 10·364989 | 10·037082 | 11 10 | 9·962918 | 38 | 30 |
| 21 | 24 | 9·598075 | 12 58 | 10·401925 | 9·635185 | 12 69 | 10·364815 | 10·037110 | 12 11 | 9·962890 | 36 | 39 |
| 30 | 26 | 9·598222 | 13 63 | 10·401778 | 9·635359 | 13 75 | 10·364641 | 10·037137 | 13 12 | 9·962863 | 34 | 30 |
| 22 | 28 | 9·598368 | 14 68 | 10·401632 | 9·635532 | 14 81 | 10·364468 | 10·037164 | 14 13 | 9·962836 | 32 | 38 |
| 30 | 30 | 9·598514 | 15 73 | 10·401486 | 9·635706 | 15 87 | 10·364294 | 10·037191 | 15 14 | 9·962809 | 30 | 30 |
| 23 | 32 | 9·598660 | 16 78 | 10·401340 | 9·635879 | 16 92 | 10·364121 | 10·037219 | 16 15 | 9·962781 | 28 | 37 |
| 30 | 34 | 9·598806 | 17 83 | 10·401194 | 9·636052 | 17 98 | 10·363948 | 10·037246 | 17 15 | 9·962754 | 26 | 30 |
| 24 | 36 | 9·598952 | 18 88 | 10·401048 | 9·636226 | 18 104 | 10·363774 | 10·037273 | 18 16 | 9·962727 | 24 | 36 |
| 30 | 38 | 9·599098 | 19 93 | 10·400902 | 9·636399 | 19 110 | 10·363601 | 10·037301 | 19 17 | 9·962699 | 22 | 30 |
| 25 | 40 | 9·599244 | 20 98 | 10·400756 | 9·636572 | 20 116 | 10·363428 | 10·037328 | 20 18 | 9·962672 | 20 | 35 |
| 30 | 42 | 9·599390 | 21 102 | 10·400610 | 9·636745 | 21 121 | 10·363255 | 10·037355 | 21 19 | 9·962645 | 18 | 30 |
| 26 | 44 | 9·599536 | 22 107 | 10·400464 | 9·636919 | 22 127 | 10·363081 | 10·037383 | 22 20 | 9·962617 | 16 | 34 |
| 30 | 46 | 9·599681 | 23 112 | 10·400319 | 9·637092 | 23 133 | 10·362908 | 10·037410 | 23 21 | 9·962590 | 14 | 30 |
| 27 | 48 | 9·599827 | 24 117 | 10·400173 | 9·637265 | 24 139 | 10·362735 | 10·037438 | 24 22 | 9·962562 | 12 | 33 |
| 30 | 50 | 9·599973 | 25 122 | 10·400027 | 9·637438 | 25 144 | 10·362562 | 10·037465 | 25 23 | 9·962535 | 10 | 30 |
| 28 | 52 | 9·600118 | 26 127 | 10·399882 | 9·637611 | 26 150 | 10·362389 | 10·037492 | 26 24 | 9·962508 | 8 | 32 |
| 30 | 54 | 9·600264 | 27 131 | 10·399736 | 9·637783 | 27 156 | 10·362217 | 10·037520 | 27 25 | 9·962480 | 6 | 30 |
| 29 | 56 | 9·600409 | 28 136 | 10·399591 | 9·637956 | 28 162 | 10·362044 | 10·037547 | 28 25 | 9·962453 | 4 | 31 |
| 30 | 58 | 9·600554 | 29 141 | 10·399446 | 9·638129 | 29 168 | 10·361871 | 10·037575 | 29 26 | 9·962425 | 2 | 30 |
| 30 | 34 | 9·600700 | 30 146 | 10·399300 | 9·638302 | 30 173 | 10·361698 | 10·037602 | 30 27 | 9·962398 | 0 | 30 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

66° — 4h 26m

## LOG. SINES, COSINES, &c.

1h 34m — 23°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 9·600700 | | 10·399300 | 9·638302 | | 10·361698 | 10·037602 | | 9·962398 | 26 | 30 |
| 30 | 2 | 9·600845 | 1″ 5 | 10·399155 | 9·638475 | 1″ 6 | 10·361525 | 10·037630 | 1″ 1 | 9·962370 | 58 | 30 |
| 31 | 4 | 9·600990 | 2 10 | 10·399010 | 9·638647 | 2 11 | 10·361353 | 10·037657 | 2 2 | 9·962343 | 56 | 29 |
| 30 | 6 | 9·601135 | 3 14 | 10·398865 | 9·638820 | 3 17 | 10·361180 | 10·037685 | 3 3 | 9·962315 | 54 | 30 |
| 32 | 8 | 9·601280 | 4 19 | 10·398720 | 9·638992 | 4 23 | 10·361008 | 10·037712 | 4 4 | 9·962288 | 52 | 28 |
| 30 | 10 | 9·601425 | 5 24 | 10·398575 | 9·639165 | 5 29 | 10·360835 | 10·037740 | 5 5 | 9·962260 | 50 | 30 |
| 33 | 12 | 9·601570 | 6 29 | 10·398430 | 9·639337 | 6 34 | 10·360663 | 10·037767 | 6 6 | 9·962233 | 48 | 27 |
| 30 | 14 | 9·601715 | 7 34 | 10·398285 | 9·639510 | 7 40 | 10·360490 | 10·037795 | 7 6 | 9·962205 | 46 | 30 |
| 34 | 16 | 9·601860 | 8 38 | 10·398140 | 9·639682 | 8 46 | 10·360318 | 10·037822 | 8 7 | 9·962178 | 44 | 26 |
| 30 | 18 | 9·602005 | 9 43 | 10·397995 | 9·639855 | 9 52 | 10·360145 | 10·037850 | 9 8 | 9·962150 | 42 | 30 |
| 35 | 20 | 9·602150 | 10 48 | 10·397850 | 9·640027 | 10 57 | 10·359973 | 10·037877 | 10 9 | 9·962123 | 40 | 25 |
| 30 | 22 | 9·602294 | 11 53 | 10·397706 | 9·640199 | 11 63 | 10·359801 | 10·037905 | 11 10 | 9·962095 | 38 | 30 |
| 36 | 24 | 9·602439 | 12 58 | 10·397561 | 9·640371 | 12 69 | 10·359629 | 10·037933 | 12 11 | 9·962067 | 36 | 24 |
| 30 | 26 | 9·602583 | 13 62 | 10·397417 | 9·640544 | 13 74 | 10·359456 | 10·037960 | 13 12 | 9·962040 | 34 | 30 |
| 37 | 28 | 9·602728 | 14 67 | 10·397272 | 9·640716 | 14 80 | 10·359284 | 10·037988 | 14 13 | 9·962012 | 32 | 23 |
| 30 | 30 | 9·602872 | 15 72 | 10·397128 | 9·640888 | 15 86 | 10·359112 | 10·038015 | 15 14 | 9·961985 | 30 | 30 |
| 38 | 32 | 9·603017 | 16 77 | 10·396983 | 9·641060 | 16 92 | 10·358940 | 10·038043 | 16 15 | 9·961957 | 28 | 22 |
| 30 | 34 | 9·603161 | 17 82 | 10·396839 | 9·641232 | 17 97 | 10·358768 | 10·038071 | 17 16 | 9·961929 | 26 | 30 |
| 39 | 36 | 9·603305 | 18 87 | 10·396695 | 9·641404 | 18 103 | 10·358596 | 10·038098 | 18 17 | 9·961902 | 24 | 21 |
| 30 | 38 | 9·603449 | 19 92 | 10·396551 | 9·641575 | 19 109 | 10·358425 | 10·038126 | 19 17 | 9·961874 | 22 | 30 |
| 40 | 40 | 9·603594 | 20 96 | 10·396406 | 9·641747 | 20 115 | 10·358253 | 10·038154 | 20 18 | 9·961846 | 20 | 20 |
| 30 | 42 | 9·603738 | 21 101 | 10·396262 | 9·641919 | 21 120 | 10·358081 | 10·038181 | 21 19 | 9·961819 | 18 | 30 |
| 41 | 44 | 9·603882 | 22 106 | 10·396118 | 9·642091 | 22 126 | 10·357909 | 10·038209 | 22 20 | 9·961791 | 16 | 19 |
| 30 | 46 | 9·604026 | 23 111 | 10·395974 | 9·642263 | 23 132 | 10·357737 | 10·038237 | 23 21 | 9·961763 | 14 | 30 |
| 42 | 48 | 9·604170 | 24 115 | 10·395830 | 9·642434 | 24 138 | 10·357566 | 10·038265 | 24 22 | 9·961735 | 12 | 18 |
| 30 | 50 | 9·604313 | 25 120 | 10·395687 | 9·642606 | 25 143 | 10·357394 | 10·038292 | 25 23 | 9·961708 | 10 | 30 |
| 43 | 52 | 9·604457 | 26 125 | 10·395543 | 9·642777 | 26 149 | 10·357223 | 10·038320 | 26 24 | 9·961680 | 8 | 17 |
| 30 | 54 | 9·604601 | 27 130 | 10·395399 | 9·642949 | 27 155 | 10·357051 | 10·038348 | 27 25 | 9·961652 | 6 | 30 |
| 44 | 56 | 9·604745 | 28 134 | 10·395255 | 9·643120 | 28 160 | 10·356880 | 10·038376 | 28 26 | 9·961624 | 4 | 16 |
| 30 | 58 | 9·604888 | 29 139 | 10·395112 | 9·643292 | 29 166 | 10·356708 | 10·038403 | 29 27 | 9·961597 | 2 | 30 |
| 45 | 35 | 9·605032 | 30 144 | 10·394968 | 9·643463 | 30 172 | 10·356537 | 10·038431 | 30 28 | 9·961569 | 25 | 15 |
| 30 | 2 | 9·605176 | 1 5 | 10·394824 | 9·643634 | 1 6 | 10·356366 | 10·038459 | 1 1 | 9·961541 | 58 | 30 |
| 46 | 4 | 9·605319 | 2 10 | 10·394681 | 9·643806 | 2 11 | 10·356194 | 10·038487 | 2 2 | 9·961513 | 56 | 14 |
| 30 | 6 | 9·605462 | 3 14 | 10·394538 | 9·643977 | 3 17 | 10·356023 | 10·038515 | 3 3 | 9·961485 | 54 | 30 |
| 47 | 8 | 9·605606 | 4 19 | 10·394394 | 9·644148 | 4 23 | 10·355852 | 10·038542 | 4 4 | 9·961458 | 52 | 13 |
| 30 | 10 | 9·605749 | 5 24 | 10·394251 | 9·644319 | 5 28 | 10·355681 | 10·038570 | 5 5 | 9·961430 | 50 | 30 |
| 48 | 12 | 9·605892 | 6 29 | 10·394108 | 9·644490 | 6 34 | 10·355510 | 10·038598 | 6 6 | 9·961402 | 48 | 12 |
| 30 | 14 | 9·606035 | 7 33 | 10·393965 | 9·644661 | 7 40 | 10·355339 | 10·038626 | 7 7 | 9·961374 | 46 | 30 |
| 49 | 16 | 9·606179 | 8 38 | 10·393821 | 9·644832 | 8 46 | 10·355168 | 10·038654 | 8 7 | 9·961346 | 44 | 11 |
| 30 | 18 | 9·606322 | 9 43 | 10·393678 | 9·645003 | 9 51 | 10·354997 | 10·038682 | 9 8 | 9·961318 | 42 | 30 |
| 50 | 20 | 9·606465 | 10 48 | 10·393535 | 9·645174 | 10 57 | 10·354826 | 10·038710 | 10 9 | 9·961290 | 40 | 10 |
| 30 | 22 | 9·606608 | 11 52 | 10·393392 | 9·645345 | 11 63 | 10·354655 | 10·038737 | 11 10 | 9·961263 | 38 | 30 |
| 51 | 24 | 9·606751 | 12 57 | 10·393249 | 9·645516 | 12 68 | 10·354484 | 10·038765 | 12 11 | 9·961235 | 36 | 9 |
| 30 | 26 | 9·606893 | 13 62 | 10·393107 | 9·645687 | 13 74 | 10·354313 | 10·038793 | 13 12 | 9·961207 | 34 | 30 |
| 52 | 28 | 9·607036 | 14 67 | 10·392964 | 9·645857 | 14 80 | 10·354143 | 10·038821 | 14 13 | 9·961179 | 32 | 8 |
| 30 | 30 | 9·607179 | 15 71 | 10·392821 | 9·646028 | 15 85 | 10·353972 | 10·038849 | 15 14 | 9·961151 | 30 | 30 |
| 53 | 32 | 9·607322 | 16 76 | 10·392678 | 9·646199 | 16 91 | 10·353801 | 10·038877 | 16 15 | 9·961123 | 28 | 7 |
| 30 | 34 | 9·607464 | 17 81 | 10·392536 | 9·646369 | 17 97 | 10·353631 | 10·038905 | 17 16 | 9·961095 | 26 | 30 |
| 54 | 36 | 9·607607 | 18 86 | 10·392393 | 9·646540 | 18 102 | 10·353460 | 10·038933 | 18 17 | 9·961067 | 24 | 6 |
| 30 | 38 | 9·607749 | 19 90 | 10·392251 | 9·646710 | 19 108 | 10·353290 | 10·038961 | 19 18 | 9·961039 | 22 | 30 |
| 55 | 40 | 9·607892 | 20 95 | 10·392108 | 9·646881 | 20 114 | 10·353119 | 10·038989 | 20 19 | 9·961011 | 20 | 5 |
| 30 | 42 | 9·608034 | 21 100 | 10·391966 | 9·647051 | 21 119 | 10·352949 | 10·039017 | 21 20 | 9·960983 | 18 | 30 |
| 56 | 44 | 9·608177 | 22 105 | 10·391823 | 9·647222 | 22 125 | 10·352778 | 10·039045 | 22 20 | 9·960955 | 16 | 4 |
| 30 | 46 | 9·608319 | 23 110 | 10·391681 | 9·647392 | 23 131 | 10·352608 | 10·039073 | 23 21 | 9·960927 | 14 | 30 |
| 57 | 48 | 9·608461 | 24 114 | 10·391539 | 9·647562 | 24 137 | 10·352438 | 10·039101 | 24 22 | 9·960899 | 12 | 3 |
| 30 | 50 | 9·608603 | 25 119 | 10·391397 | 9·647733 | 25 142 | 10·352267 | 10·039129 | 25 23 | 9·960871 | 10 | 30 |
| 58 | 52 | 9·608745 | 26 124 | 10·391255 | 9·647903 | 26 148 | 10·352097 | 10·039157 | 26 24 | 9·960843 | 8 | 2 |
| 30 | 54 | 9·608887 | 27 128 | 10·391113 | 9·648073 | 27 154 | 10·351927 | 10·039186 | 27 25 | 9·960814 | 6 | 30 |
| 59 | 56 | 9·609029 | 28 133 | 10·390971 | 9·648243 | 28 159 | 10·351757 | 10·039214 | 28 26 | 9·960786 | 4 | 1 |
| 30 | 58 | 9·609171 | 29 138 | 10·390829 | 9·648413 | 29 165 | 10·351587 | 10·039242 | 29 27 | 9·960758 | 2 | 30 |
| 60 | 36 | 9·609313 | 30 143 | 10·390687 | 9·648583 | 30 171 | 10·351417 | 10·039270 | 30 28 | 9·960730 | 0 | 0 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

66° — 4h 24m

## LOG. SINES, COSINES, &c.

1ʰ 36ᵐ — 24°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |
| 0 | 0 | 9·609313 | | 10·390687 | 9·648583 | | 10·351417 | 10·039270 | | 9·960730 | 24 | 60 |
| 30 | 2 | 9·609455 | 1″ 5 | 10·390545 | 9·648753 | 1″ 6 | 10·351247 | 10·039298 | 1″ 1 | 9·960702 | 58 | 30 |
| 1 | 4 | 9·609597 | 2 9 | 10·390403 | 9·648923 | 2 11 | 10·351077 | 10·039326 | 2 2 | 9·960674 | 56 | 59 |
| 30 | 6 | 9·609739 | 3 14 | 10·390261 | 9·649093 | 3 17 | 10·350907 | 10·039354 | 3 3 | 9·960646 | 54 | 30 |
| 2 | 8 | 9·609880 | 4 19 | 10·390120 | 9·649263 | 4 23 | 10·350737 | 10·039382 | 4 4 | 9·960618 | 52 | 58 |
| 30 | 10 | 9·610022 | 5 23 | 10·389978 | 9·649433 | 5 28 | 10·350567 | 10·039411 | 5 5 | 9·960589 | 50 | 30 |
| 3 | 12 | 9·610164 | 6 28 | 10·389836 | 9·649602 | 6 34 | 10·350398 | 10·039439 | 6 6 | 9·960561 | 48 | 57 |
| 30 | 14 | 9·610305 | 7 33 | 10·389695 | 9·649772 | 7 39 | 10·350228 | 10·039467 | 7 7 | 9·960533 | 46 | 30 |
| 4 | 16 | 9·610447 | 8 38 | 10·389553 | 9·649942 | 8 45 | 10·350058 | 10·039495 | 8 8 | 9·960505 | 44 | 56 |
| 30 | 18 | 9·610588 | 9 42 | 10·389412 | 9·650111 | 9 51 | 10·349889 | 10·039523 | 9 8 | 9·960477 | 42 | 30 |
| 5 | 20 | 9·610729 | 10 47 | 10·389271 | 9·650281 | 10 56 | 10·349719 | 10·039552 | 10 9 | 9·960448 | 40 | 55 |
| 30 | 22 | 9·610871 | 11 52 | 10·389129 | 9·650450 | 11 62 | 10·349550 | 10·039580 | 11 10 | 9·960420 | 38 | 30 |
| 6 | 24 | 9·611012 | 12 56 | 10·388988 | 9·650620 | 12 68 | 10·349380 | 10·039608 | 12 11 | 9·960392 | 36 | 54 |
| 30 | 26 | 9·611153 | 13 61 | 10·388847 | 9·650789 | 13 73 | 10·349211 | 10·039636 | 13 12 | 9·960364 | 34 | 30 |
| 7 | 28 | 9·611294 | 14 66 | 10·388706 | 9·650959 | 14 79 | 10·349041 | 10·039665 | 14 13 | 9·960335 | 32 | 53 |
| 30 | 30 | 9·611435 | 15 71 | 10·388565 | 9·651128 | 15 85 | 10·348872 | 10·039693 | 15 14 | 9·960307 | 30 | 30 |
| 8 | 32 | 9·611576 | 16 75 | 10·388424 | 9·651297 | 16 90 | 10·348703 | 10·039721 | 16 15 | 9·960279 | 28 | 52 |
| 30 | 34 | 9·611717 | 17 80 | 10·388283 | 9·651467 | 17 96 | 10·348533 | 10·039750 | 17 16 | 9·960250 | 26 | 30 |
| 9 | 36 | 9·611858 | 18 85 | 10·388142 | 9·651636 | 18 102 | 10·348364 | 10·039778 | 18 17 | 9·960222 | 24 | 51 |
| 30 | 38 | 9·611999 | 19 89 | 10·388001 | 9·651805 | 19 107 | 10·348195 | 10·039806 | 19 18 | 9·960194 | 22 | 30 |
| 10 | 40 | 9·612140 | 20 94 | 10·387860 | 9·651974 | 20 113 | 10·348026 | 10·039835 | 20 19 | 9·960165 | 20 | 50 |
| 30 | 42 | 9·612280 | 21 99 | 10·387720 | 9·652143 | 21 118 | 10·347857 | 10·039863 | 21 20 | 9·960137 | 18 | 30 |
| 11 | 44 | 9·612421 | 22 103 | 10·387579 | 9·652312 | 22 124 | 10·347688 | 10·039891 | 22 21 | 9·960109 | 16 | 49 |
| 30 | 46 | 9·612562 | 23 108 | 10·387438 | 9·652481 | 23 130 | 10·347519 | 10·039920 | 23 22 | 9·960080 | 14 | 30 |
| 12 | 48 | 9·612702 | 24 113 | 10·387298 | 9·652650 | 24 135 | 10·347350 | 10·039948 | 24 23 | 9·960052 | 12 | 48 |
| 30 | 50 | 9·612843 | 25 117 | 10·387157 | 9·652819 | 25 141 | 10·347181 | 10·039976 | 25 23 | 9·960024 | 10 | 30 |
| 13 | 52 | 9·612983 | 26 122 | 10·387017 | 9·652988 | 26 147 | 10·347012 | 10·040005 | 26 24 | 9·959995 | 8 | 47 |
| 30 | 54 | 9·613124 | 27 127 | 10·386876 | 9·653157 | 27 152 | 10·346843 | 10·040033 | 27 25 | 9·959967 | 6 | 30 |
| 14 | 56 | 9·613264 | 28 132 | 10·386736 | 9·653326 | 28 158 | 10·346674 | 10·040062 | 28 26 | 9·959938 | 4 | 46 |
| 30 | 58 | 9·613404 | 29 136 | 10·386596 | 9·653494 | 29 164 | 10·346506 | 10·040090 | 29 27 | 9·959910 | 2 | 30 |
| 15 | 37 | 9·613545 | 30 141 | 10·386455 | 9·653663 | 30 169 | 10·346337 | 10·040118 | 30 28 | 9·959882 | 23 | 45 |
| 30 | 2 | 9·613685 | 1 5 | 10·386315 | 9·653832 | 1 6 | 10·346168 | 10·040147 | 1 1 | 9·959853 | 58 | 30 |
| 16 | 4 | 9·613825 | 2 9 | 10·386175 | 9·654000 | 2 11 | 10·346000 | 10·040175 | 2 2 | 9·959825 | 56 | 44 |
| 30 | 6 | 9·613965 | 3 14 | 10·386035 | 9·654169 | 3 17 | 10·345831 | 10·040204 | 3 3 | 9·959796 | 54 | 30 |
| 17 | 8 | 9·614105 | 4 19 | 10·385895 | 9·654337 | 4 22 | 10·345663 | 10·040232 | 4 4 | 9·959768 | 52 | 43 |
| 30 | 10 | 9·614245 | 5 23 | 10·385755 | 9·654506 | 5 28 | 10·345494 | 10·040261 | 5 5 | 9·959739 | 50 | 30 |
| 18 | 12 | 9·614385 | 6 28 | 10·385615 | 9·654674 | 6 34 | 10·345326 | 10·040289 | 6 6 | 9·959711 | 48 | 42 |
| 30 | 14 | 9·614525 | 7 32 | 10·385475 | 9·654843 | 7 39 | 10·345157 | 10·040318 | 7 7 | 9·959682 | 46 | 30 |
| 19 | 16 | 9·614665 | 8 37 | 10·385335 | 9·655011 | 8 45 | 10·344989 | 10·040346 | 8 8 | 9·959654 | 44 | 41 |
| 30 | 18 | 9·614804 | 9 42 | 10·385196 | 9·655179 | 9 50 | 10·344821 | 10·040375 | 9 9 | 9·959625 | 42 | 30 |
| 20 | 20 | 9·614944 | 10 46 | 10·385056 | 9·655348 | 10 56 | 10·344652 | 10·040404 | 10 10 | 9·959596 | 40 | 40 |
| 30 | 22 | 9·615084 | 11 51 | 10·384916 | 9·655516 | 11 62 | 10·344484 | 10·040432 | 11 10 | 9·959568 | 38 | 30 |
| 21 | 24 | 9·615223 | 12 56 | 10·384777 | 9·655684 | 12 67 | 10·344316 | 10·040461 | 12 11 | 9·959539 | 36 | 39 |
| 30 | 26 | 9·615363 | 13 61 | 10·384637 | 9·655852 | 13 73 | 10·344148 | 10·040489 | 13 12 | 9·959511 | 34 | 30 |
| 22 | 28 | 9·615502 | 14 65 | 10·384498 | 9·656020 | 14 78 | 10·343980 | 10·040518 | 14 13 | 9·959482 | 32 | 38 |
| 30 | 30 | 9·615642 | 15 70 | 10·384358 | 9·656188 | 15 84 | 10·343812 | 10·040547 | 15 14 | 9·959453 | 30 | 30 |
| 23 | 32 | 9·615781 | 16 75 | 10·384219 | 9·656356 | 16 90 | 10·343644 | 10·040575 | 16 15 | 9·959425 | 28 | 37 |
| 30 | 34 | 9·615921 | 17 79 | 10·384079 | 9·656524 | 17 95 | 10·343476 | 10·040604 | 17 16 | 9·959396 | 26 | 30 |
| 24 | 36 | 9·616060 | 18 84 | 10·383940 | 9·656692 | 18 101 | 10·343308 | 10·040632 | 18 17 | 9·959368 | 24 | 36 |
| 30 | 38 | 9·616199 | 19 89 | 10·383801 | 9·656860 | 19 106 | 10·343140 | 10·040661 | 19 18 | 9·959339 | 22 | 30 |
| 25 | 40 | 9·616338 | 20 93 | 10·383662 | 9·657028 | 20 112 | 10·342972 | 10·040690 | 20 19 | 9·959310 | 20 | 35 |
| 30 | 42 | 9·616477 | 21 98 | 10·383523 | 9·657196 | 21 118 | 10·342804 | 10·040718 | 21 20 | 9·959282 | 18 | 30 |
| 26 | 44 | 9·616616 | 22 103 | 10·383384 | 9·657364 | 22 123 | 10·342636 | 10·040747 | 22 21 | 9·959253 | 16 | 34 |
| 30 | 46 | 9·616755 | 23 107 | 10·383245 | 9·657531 | 23 129 | 10·342469 | 10·040776 | 23 22 | 9·959224 | 14 | 30 |
| 27 | 48 | 9·616894 | 24 112 | 10·383106 | 9·657699 | 24 134 | 10·342301 | 10·040805 | 24 23 | 9·959195 | 12 | 33 |
| 30 | 50 | 9·617033 | 25 117 | 10·382967 | 9·657867 | 25 140 | 10·342133 | 10·040833 | 25 24 | 9·959167 | 10 | 30 |
| 28 | 52 | 9·617172 | 26 122 | 10·382828 | 9·658034 | 26 146 | 10·341966 | 10·040862 | 26 25 | 9·959138 | 8 | 32 |
| 30 | 54 | 9·617311 | 27 126 | 10·382689 | 9·658202 | 27 151 | 10·341798 | 10·040891 | 27 26 | 9·959109 | 6 | 30 |
| 29 | 56 | 9·617450 | 28 131 | 10·382550 | 9·658369 | 28 157 | 10·341631 | 10·040920 | 28 27 | 9·959080 | 4 | 31 |
| 30 | 58 | 9·617588 | 29 135 | 10·382412 | 9·658537 | 29 162 | 10·341463 | 10·040948 | 29 28 | 9·959052 | 2 | 30 |
| 30 | 38 | 9·617727 | 30 140 | 10·382273 | 9·658704 | 30 168 | 10·341296 | 10·040977 | 30 29 | 9·959023 | 0 | 30 |

65° — 4ʰ 22ᵐ

## LOG. SINES, COSINES, &c.

1ʰ 38ᵐ — 24°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 9·617727 | | 10·382273 | 9·658704 | | 10·341296 | 10·040977 | | 9·959023 | 22 | 30 |
| 30 | 2 | 9·617866 | 1″ 5 | 10·382134 | 9·658871 | 1″ 6 | 10·341129 | 10·041006 | 1″ 1 | 9·958994 | 58 | 30 |
| 31 | 4 | 9·618004 | 2 9 | 10·381996 | 9·659039 | 2 11 | 10·340961 | 10·041035 | 2 2 | 9·958965 | 56 | 29 |
| 30 | 6 | 9·618143 | 3 14 | 10·381857 | 9·659206 | 3 17 | 10·340794 | 10·041063 | 3 3 | 9·958937 | 54 | 30 |
| 32 | 8 | 9·618281 | 4 18 | 10·381719 | 9·659373 | 4 22 | 10·340627 | 10·041092 | 4 4 | 9·958908 | 52 | 28 |
| 30 | 10 | 9·618419 | 5 23 | 10·381581 | 9·659540 | 5 28 | 10·340460 | 10·041121 | 5 5 | 9·958879 | 50 | 30 |
| 33 | 12 | 9·618558 | 6 28 | 10·381442 | 9·659708 | 6 33 | 10·340292 | 10·041150 | 6 6 | 9·958850 | 48 | 27 |
| 30 | 14 | 9·618696 | 7 32 | 10·381304 | 9·659875 | 7 39 | 10·340125 | 10·041179 | 7 7 | 9·958821 | 46 | 30 |
| 34 | 16 | 9·618834 | 8 37 | 10·381166 | 9·660042 | 8 44 | 10·339958 | 10·041208 | 8 8 | 9·958792 | 44 | 26 |
| 30 | 18 | 9·618972 | 9 41 | 10·381028 | 9·660209 | 9 50 | 10·339791 | 10·041237 | 9 9 | 9·958763 | 42 | 30 |
| 35 | 20 | 9·619110 | 10 46 | 10·380890 | 9·660376 | 10 56 | 10·339624 | 10·041266 | 10 10 | 9·958734 | 40 | 25 |
| 30 | 22 | 9·619248 | 11 50 | 10·380752 | 9·660543 | 11 61 | 10·339457 | 10·041294 | 11 11 | 9·958706 | 38 | 30 |
| 36 | 24 | 9·619386 | 12 55 | 10·380614 | 9·660710 | 12 67 | 10·339290 | 10·041323 | 12 12 | 9·958677 | 36 | 24 |
| 30 | 26 | 9·619524 | 13 59 | 10·380476 | 9·660877 | 13 72 | 10·339123 | 10·041352 | 13 12 | 9·958648 | 34 | 30 |
| 37 | 28 | 9·619662 | 14 64 | 10·380338 | 9·661043 | 14 78 | 10·338957 | 10·041381 | 14 13 | 9·958619 | 32 | 23 |
| 30 | 30 | 9·619800 | 15 69 | 10·380200 | 9·661210 | 15 83 | 10·338790 | 10·041410 | 15 14 | 9·958590 | 30 | 30 |
| 38 | 32 | 9·619938 | 16 73 | 10·380062 | 9·661377 | 16 89 | 10·338623 | 10·041439 | 16 15 | 9·958561 | 28 | 22 |
| 30 | 34 | 9·620076 | 17 78 | 10·379924 | 9·661544 | 17 95 | 10·338456 | 10·041468 | 17 16 | 9·958532 | 26 | 30 |
| 39 | 36 | 9·620213 | 18 83 | 10·379787 | 9·661710 | 18 100 | 10·338290 | 10·041497 | 18 17 | 9·958503 | 24 | 21 |
| 30 | 38 | 9·620351 | 19 87 | 10·379649 | 9·661877 | 19 106 | 10·338123 | 10·041526 | 19 18 | 9·958474 | 22 | 30 |
| 40 | 40 | 9·620488 | 20 92 | 10·379512 | 9·662043 | 20 111 | 10·337957 | 10·041555 | 20 19 | 9·958445 | 20 | 20 |
| 30 | 42 | 9·620626 | 21 96 | 10·379374 | 9·662210 | 21 117 | 10·337790 | 10·041584 | 21 20 | 9·958416 | 18 | 30 |
| 41 | 44 | 9·620763 | 22 101 | 10·379237 | 9·662376 | 22 122 | 10·337624 | 10·041613 | 22 21 | 9·958387 | 16 | 19 |
| 30 | 46 | 9·620901 | 23 105 | 10·379099 | 9·662543 | 23 128 | 10·337457 | 10·041642 | 23 22 | 9·958358 | 14 | 30 |
| 42 | 48 | 9·621038 | 24 110 | 10·378962 | 9·662709 | 24 133 | 10·337291 | 10·041671 | 24 23 | 9·958329 | 12 | 18 |
| 30 | 50 | 9·621175 | 25 114 | 10·378825 | 9·662876 | 25 139 | 10·337124 | 10·041700 | 25 24 | 9·958300 | 10 | 30 |
| 43 | 52 | 9·621313 | 26 119 | 10·378687 | 9·663042 | 26 145 | 10·336958 | 10·041729 | 26 25 | 9·958271 | 8 | 17 |
| 30 | 54 | 9·621450 | 27 124 | 10·378550 | 9·663208 | 27 150 | 10·336792 | 10·041758 | 27 26 | 9·958242 | 6 | 30 |
| 44 | 56 | 9·621587 | 28 129 | 10·378413 | 9·663375 | 28 156 | 10·336625 | 10·041787 | 28 27 | 9·958213 | 4 | 16 |
| 30 | 58 | 9·621724 | 29 133 | 10·378276 | 9·663541 | 29 161 | 10·336459 | 10·041817 | 29 28 | 9·958183 | 2 | 30 |
| 45 | 39 | 9·621861 | 30 138 | 10·378139 | 9·663707 | 30 167 | 10·336293 | 10·041846 | 30 29 | 9·958154 | 21 | 15 |
| 30 | 2 | 9·621998 | 1 5 | 10·378002 | 9·663873 | 1 6 | 10·336127 | 10·041875 | 1 1 | 9·958125 | 58 | 30 |
| 46 | 4 | 9·622135 | 2 9 | 10·377865 | 9·664039 | 2 11 | 10·335961 | 10·041904 | 2 2 | 9·958096 | 56 | 14 |
| 30 | 6 | 9·622272 | 3 14 | 10·377728 | 9·664205 | 3 17 | 10·335795 | 10·041933 | 3 3 | 9·958067 | 54 | 30 |
| 47 | 8 | 9·622409 | 4 18 | 10·377591 | 9·664371 | 4 22 | 10·335629 | 10·041962 | 4 4 | 9·958038 | 52 | 13 |
| 30 | 10 | 9·622546 | 5 23 | 10·377454 | 9·664537 | 5 28 | 10·335463 | 10·041991 | 5 5 | 9·958009 | 50 | 30 |
| 48 | 12 | 9·622682 | 6 27 | 10·377318 | 9·664703 | 6 33 | 10·335297 | 10·042021 | 6 6 | 9·957979 | 48 | 12 |
| 30 | 14 | 9·622819 | 7 32 | 10·377181 | 9·664869 | 7 39 | 10·335131 | 10·042050 | 7 7 | 9·957950 | 46 | 30 |
| 49 | 16 | 9·622956 | 8 36 | 10·377044 | 9·665035 | 8 44 | 10·334965 | 10·042079 | 8 8 | 9·957921 | 44 | 11 |
| 30 | 18 | 9·623092 | 9 41 | 10·376908 | 9·665200 | 9 50 | 10·334800 | 10·042108 | 9 9 | 9·957892 | 42 | 30 |
| 50 | 20 | 9·623229 | 10 45 | 10·376771 | 9·665366 | 10 55 | 10·334634 | 10·042137 | 10 10 | 9·957863 | 40 | 10 |
| 30 | 22 | 9·623365 | 11 50 | 10·376635 | 9·665532 | 11 61 | 10·334468 | 10·042167 | 11 11 | 9·957833 | 38 | 30 |
| 51 | 24 | 9·623502 | 12 54 | 10·376498 | 9·665698 | 12 66 | 10·334302 | 10·042196 | 12 12 | 9·957804 | 36 | 9 |
| 30 | 26 | 9·623638 | 13 59 | 10·376362 | 9·665863 | 13 72 | 10·334137 | 10·042225 | 13 13 | 9·957775 | 34 | 30 |
| 52 | 28 | 9·623774 | 14 63 | 10·376226 | 9·666029 | 14 77 | 10·333971 | 10·042254 | 14 14 | 9·957746 | 32 | 8 |
| 30 | 30 | 9·623911 | 15 68 | 10·376089 | 9·666194 | 15 83 | 10·333806 | 10·042284 | 15 15 | 9·957716 | 30 | 30 |
| 53 | 32 | 9·624047 | 16 72 | 10·375953 | 9·666360 | 16 88 | 10·333640 | 10·042313 | 16 16 | 9·957687 | 28 | 7 |
| 30 | 34 | 9·624183 | 17 77 | 10·375817 | 9·666525 | 17 94 | 10·333475 | 10·042342 | 17 17 | 9·957658 | 26 | 30 |
| 54 | 36 | 9·624319 | 18 82 | 10·375681 | 9·666691 | 18 99 | 10·333309 | 10·042372 | 18 18 | 9·957628 | 24 | 6 |
| 30 | 38 | 9·624455 | 19 86 | 10·375545 | 9·666856 | 19 105 | 10·333144 | 10·042401 | 19 19 | 9·957599 | 22 | 30 |
| 55 | 40 | 9·624591 | 20 91 | 10·375409 | 9·667021 | 20 110 | 10·332979 | 10·042430 | 20 20 | 9·957570 | 20 | 5 |
| 30 | 42 | 9·624727 | 21 95 | 10·375273 | 9·667187 | 21 116 | 10·332813 | 10·042460 | 21 20 | 9·957540 | 18 | 30 |
| 56 | 44 | 9·624863 | 22 100 | 10·375137 | 9·667352 | 22 121 | 10·332648 | 10·042489 | 22 21 | 9·957511 | 16 | 4 |
| 30 | 46 | 9·624999 | 23 104 | 10·375001 | 9·667517 | 23 127 | 10·332483 | 10·042518 | 23 22 | 9·957482 | 14 | 30 |
| 57 | 48 | 9·625135 | 24 109 | 10·374865 | 9·667682 | 24 132 | 10·332318 | 10·042548 | 24 23 | 9·957452 | 12 | 3 |
| 30 | 50 | 9·625270 | 25 113 | 10·374730 | 9·667847 | 25 138 | 10·332153 | 10·042577 | 25 24 | 9·957423 | 10 | 30 |
| 58 | 52 | 9·625406 | 26 118 | 10·374594 | 9·668013 | 26 144 | 10·331987 | 10·042607 | 26 25 | 9·957393 | 8 | 2 |
| 30 | 54 | 9·625542 | 27 123 | 10·374458 | 9·668178 | 27 149 | 10·331822 | 10·042636 | 27 26 | 9·957364 | 6 | 30 |
| 59 | 56 | 9·625677 | 28 127 | 10·374323 | 9·668343 | 28 155 | 10·331657 | 10·042665 | 28 27 | 9·957335 | 4 | 1 |
| 30 | 58 | 9·625813 | 29 132 | 10·374187 | 9·668508 | 29 160 | 10·331492 | 10·042695 | 29 28 | 9·957305 | 2 | 30 |
| 60 | 40 | 9·625948 | 30 136 | 10·374052 | 9·668672 | 30 166 | 10·331327 | 10·042724 | 30 29 | 9·957276 | 0 | 0 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

65° — 4ʰ 20ᵐ

## LOG. SINES, COSINES, &c.

1ʰ 40ᵐ — 25°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 9·625948 | | 10·374052 | 9·668673 | | 10·331327 | 10·042724 | | 9·957276 | 20 | 60 |
| 30 | 2 | 9·626084 | 1″ 4 | 10·373916 | 9·668837 | 1″ 5 | 10·331163 | 10·042754 | 1″ 1 | 9·957246 | 58 | 30 |
| 1 | 4 | 9·626219 | 2 9 | 10·373781 | 9·669002 | 2 11 | 10·330998 | 10·042783 | 2 2 | 9·957217 | 56 | 59 |
| 30 | 6 | 9·626354 | 3 13 | 10·373646 | 9·669167 | 3 16 | 10·330833 | 10·042813 | 3 3 | 9·957187 | 54 | 30 |
| 2 | 8 | 9·626490 | 4 18 | 10·373510 | 9·669332 | 4 22 | 10·330668 | 10·042842 | 4 4 | 9·957158 | 52 | 58 |
| 30 | 10 | 9·626625 | 5 22 | 10·373375 | 9·669497 | 5 27 | 10·330503 | 10·042872 | 5 5 | 9·957128 | 50 | 30 |
| 3 | 12 | 9·626760 | 6 27 | 10·373240 | 9·669661 | 6 33 | 10·330339 | 10·042901 | 6 6 | 9·957099 | 48 | 57 |
| 30 | 14 | 9·626895 | 7 31 | 10·373105 | 9·669826 | 7 38 | 10·330174 | 10·042931 | 7 7 | 9·957069 | 46 | 30 |
| 4 | 16 | 9·627030 | 8 36 | 10·372970 | 9·669991 | 8 44 | 10·330009 | 10·042960 | 8 8 | 9·957040 | 44 | 56 |
| 30 | 18 | 9·627165 | 9 40 | 10·372835 | 9·670155 | 9 49 | 10·329845 | 10·042990 | 9 9 | 9·957010 | 42 | 30 |
| 5 | 20 | 9·627300 | 10 45 | 10·372700 | 9·670320 | 10 55 | 10·329680 | 10·043019 | 10 10 | 9·956981 | 40 | 55 |
| 30 | 22 | 9·627435 | 11 49 | 10·372565 | 9·670484 | 11 60 | 10·329516 | 10·043049 | 11 11 | 9·956951 | 38 | 30 |
| 6 | 24 | 9·627570 | 12 54 | 10·372430 | 9·670649 | 12 66 | 10·329351 | 10·043079 | 12 12 | 9·956921 | 36 | 54 |
| 30 | 26 | 9·627705 | 13 58 | 10·372295 | 9·670813 | 13 71 | 10·329187 | 10·043108 | 13 13 | 9·956892 | 34 | 30 |
| 7 | 28 | 9·627840 | 14 63 | 10·372160 | 9·670977 | 14 77 | 10·329023 | 10·043138 | 14 14 | 9·956862 | 32 | 53 |
| 30 | 30 | 9·627974 | 15 67 | 10·372026 | 9·671142 | 15 82 | 10·328858 | 10·043167 | 15 15 | 9·956833 | 30 | 30 |
| 8 | 32 | 9·628109 | 16 72 | 10·371891 | 9·671306 | 16 88 | 10·328694 | 10·043197 | 16 16 | 9·956803 | 28 | 52 |
| 30 | 34 | 9·628244 | 17 76 | 10·371756 | 9·671470 | 17 93 | 10·328530 | 10·043227 | 17 17 | 9·956773 | 26 | 30 |
| 9 | 36 | 9·628378 | 18 81 | 10·371622 | 9·671635 | 18 99 | 10·328365 | 10·043256 | 18 18 | 9·956744 | 24 | 51 |
| 30 | 38 | 9·628513 | 19 85 | 10·371487 | 9·671799 | 19 104 | 10·328201 | 10·043286 | 19 19 | 9·956714 | 22 | 30 |
| 10 | 40 | 9·628647 | 20 90 | 10·371353 | 9·671963 | 20 110 | 10·328037 | 10·043316 | 20 20 | 9·956684 | 20 | 50 |
| 30 | 42 | 9·628782 | 21 94 | 10·371218 | 9·672127 | 21 115 | 10·327873 | 10·043345 | 21 21 | 9·956655 | 18 | 30 |
| 11 | 44 | 9·628916 | 22 99 | 10·371084 | 9·672291 | 22 121 | 10·327709 | 10·043375 | 22 22 | 9·956625 | 16 | 49 |
| 30 | 46 | 9·629050 | 23 103 | 10·370950 | 9·672455 | 23 126 | 10·327545 | 10·043405 | 23 23 | 9·956595 | 14 | 30 |
| 12 | 48 | 9·629185 | 24 108 | 10·370815 | 9·672619 | 24 132 | 10·327381 | 10·043434 | 24 24 | 9·956566 | 12 | 48 |
| 30 | 50 | 9·629319 | 25 112 | 10·370681 | 9·672783 | 25 137 | 10·327217 | 10·043464 | 25 25 | 9·956536 | 10 | 30 |
| 13 | 52 | 9·629453 | 26 117 | 10·370547 | 9·672947 | 26 142 | 10·327053 | 10·043494 | 26 26 | 9·956506 | 8 | 47 |
| 30 | 54 | 9·629587 | 27 121 | 10·370413 | 9·673111 | 27 148 | 10·326889 | 10·043524 | 27 27 | 9·956476 | 6 | 30 |
| 14 | 56 | 9·629721 | 28 126 | 10·370279 | 9·673274 | 28 153 | 10·326726 | 10·043553 | 28 28 | 9·956447 | 4 | 46 |
| 30 | 58 | 9·629855 | 29 130 | 10·370145 | 9·673438 | 29 159 | 10·326562 | 10·043583 | 29 29 | 9·956417 | 2 | 30 |
| 15 | 41 | 9·629989 | 30 135 | 10·370011 | 9·673602 | 30 164 | 10·326398 | 10·043613 | 30 30 | 9·956387 | 19 | 45 |
| 30 | 2 | 9·630123 | 1 4 | 10·369877 | 9·673766 | 1 5 | 10·326234 | 10·043643 | 1 1 | 9·956357 | 58 | 30 |
| 16 | 4 | 9·630257 | 2 9 | 10·369743 | 9·673929 | 2 11 | 10·326071 | 10·043673 | 2 2 | 9·956327 | 56 | 44 |
| 30 | 6 | 9·630391 | 3 13 | 10·369609 | 9·674093 | 3 16 | 10·325907 | 10·043702 | 3 3 | 9·956298 | 54 | 30 |
| 17 | 8 | 9·630524 | 4 18 | 10·369476 | 9·674257 | 4 22 | 10·325743 | 10·043732 | 4 4 | 9·956268 | 52 | 43 |
| 30 | 10 | 9·630658 | 5 22 | 10·369342 | 9·674420 | 5 27 | 10·325580 | 10·043762 | 5 5 | 9·956238 | 50 | 30 |
| 18 | 12 | 9·630792 | 6 27 | 10·369208 | 9·674584 | 6 33 | 10·325416 | 10·043792 | 6 6 | 9·956208 | 48 | 42 |
| 30 | 14 | 9·630925 | 7 31 | 10·369075 | 9·674747 | 7 38 | 10·325253 | 10·043822 | 7 7 | 9·956178 | 46 | 30 |
| 19 | 16 | 9·631059 | 8 36 | 10·368941 | 9·674911 | 8 44 | 10·325089 | 10·043852 | 8 8 | 9·956148 | 44 | 41 |
| 30 | 18 | 9·631192 | 9 40 | 10·368808 | 9·675074 | 9 49 | 10·324926 | 10·043882 | 9 9 | 9·956118 | 42 | 30 |
| 20 | 20 | 9·631326 | 10 44 | 10·368674 | 9·675237 | 10 54 | 10·324763 | 10·043911 | 10 10 | 9·956089 | 40 | 40 |
| 30 | 22 | 9·631459 | 11 49 | 10·368541 | 9·675401 | 11 60 | 10·324599 | 10·043941 | 11 11 | 9·956059 | 38 | 30 |
| 21 | 24 | 9·631593 | 12 53 | 10·368407 | 9·675564 | 12 65 | 10·324436 | 10·043971 | 12 12 | 9·956029 | 36 | 39 |
| 30 | 26 | 9·631726 | 13 58 | 10·368274 | 9·675727 | 13 71 | 10·324273 | 10·044001 | 13 13 | 9·955999 | 34 | 30 |
| 22 | 28 | 9·631859 | 14 62 | 10·368141 | 9·675890 | 14 76 | 10·324110 | 10·044031 | 14 14 | 9·955969 | 32 | 38 |
| 30 | 30 | 9·631992 | 15 67 | 10·368008 | 9·676053 | 15 82 | 10·323947 | 10·044061 | 15 15 | 9·955939 | 30 | 30 |
| 23 | 32 | 9·632125 | 16 71 | 10·367875 | 9·676217 | 16 87 | 10·323783 | 10·044091 | 16 16 | 9·955909 | 28 | 37 |
| 30 | 34 | 9·632259 | 17 75 | 10·367741 | 9·676380 | 17 92 | 10·323620 | 10·044121 | 17 17 | 9·955879 | 26 | 30 |
| 24 | 36 | 9·632392 | 18 80 | 10·367608 | 9·676543 | 18 98 | 10·323457 | 10·044151 | 18 18 | 9·955849 | 24 | 36 |
| 30 | 38 | 9·632525 | 19 84 | 10·367475 | 9·676706 | 19 103 | 10·323294 | 10·044181 | 19 19 | 9·955819 | 22 | 30 |
| 25 | 40 | 9·632658 | 20 89 | 10·367342 | 9·676869 | 20 109 | 10·323131 | 10·044211 | 20 20 | 9·955789 | 20 | 35 |
| 30 | 42 | 9·632790 | 21 93 | 10·367208 | 9·677032 | 21 114 | 10·322968 | 10·044241 | 21 21 | 9·955759 | 18 | 30 |
| 26 | 44 | 9·632923 | 22 98 | 10·367077 | 9·677194 | 22 120 | 10·322806 | 10·044271 | 22 22 | 9·955729 | 16 | 34 |
| 30 | 46 | 9·633056 | 23 102 | 10·366944 | 9·677357 | 23 125 | 10·322643 | 10·044301 | 23 23 | 9·955699 | 14 | 30 |
| 27 | 48 | 9·633189 | 24 107 | 10·366811 | 9·677520 | 24 131 | 10·322480 | 10·044331 | 24 24 | 9·955669 | 12 | 33 |
| 30 | 50 | 9·633322 | 25 111 | 10·366678 | 9·677683 | 25 136 | 10·322317 | 10·044361 | 25 25 | 9·955639 | 10 | 30 |
| 28 | 52 | 9·633454 | 26 116 | 10·366546 | 9·677846 | 26 141 | 10·322154 | 10·044391 | 26 26 | 9·955609 | 8 | 32 |
| 30 | 54 | 9·633587 | 27 120 | 10·366413 | 9·678008 | 27 147 | 10·321992 | 10·044421 | 27 27 | 9·955579 | 6 | 30 |
| 29 | 56 | 9·633719 | 28 125 | 10·366281 | 9·678171 | 28 152 | 10·321829 | 10·044452 | 28 28 | 9·955548 | 4 | 31 |
| 30 | 58 | 9·633852 | 29 129 | 10·366148 | 9·678334 | 29 158 | 10·321666 | 10·044482 | 29 29 | 9·955518 | 2 | 30 |
| 30 | 42 | 9·633984 | 30 133 | 10·366016 | 9·678496 | 30 163 | 10·321504 | 10·044512 | 30 30 | 9·955488 | 0 | 30 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

64° — 4ʰ 18ᵘ

## LOG. SINES, COSINES, &c.

1h 42m — 25°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 9·633984 | | 10·366016 | 9·678496 | | 10·321504 | 10·044512 | | 9·955488 | 18 | 30 |
| 30 | 2 | 9·634117 | 1″ 4 | 10·365883 | 9·678659 | 1″ 5 | 10·321341 | 10·044542 | 1″ 1 | 9·955458 | 58 | 30 |
| 31 | 4 | 9·634249 | 2 9 | 10·365751 | 9·678821 | 2 11 | 10·321179 | 10·044572 | 2 2 | 9·955428 | 56 | 29 |
| 30 | 6 | 9·634381 | 3 13 | 10·365619 | 9·678984 | 3 16 | 10·321016 | 10·044602 | 3 3 | 9·955398 | 54 | 30 |
| 32 | 8 | 9·634514 | 4 18 | 10·365486 | 9·679146 | 4 22 | 10·320854 | 10·044632 | 4 4 | 9·955368 | 52 | 28 |
| 30 | 10 | 9·634646 | 5 22 | 10·365354 | 9·679308 | 5 27 | 10·320692 | 10·044663 | 5 5 | 9·955337 | 50 | 30 |
| 33 | 12 | 9·634778 | 6 26 | 10·365222 | 9·679471 | 6 32 | 10·320529 | 10·044693 | 6 6 | 9·955307 | 48 | 27 |
| 30 | 14 | 9·634910 | 7 31 | 10·365090 | 9·679633 | 7 38 | 10·320367 | 10·044723 | 7 7 | 9·955277 | 46 | 30 |
| 34 | 16 | 9·635042 | 8 35 | 10·364958 | 9·679795 | 8 43 | 10·320205 | 10·044753 | 8 8 | 9·955247 | 44 | 26 |
| 30 | 18 | 9·635174 | 9 40 | 10·364826 | 9·679958 | 9 49 | 10·320042 | 10·044783 | 9 9 | 9·955217 | 42 | 30 |
| 35 | 20 | 9·635306 | 10 44 | 10·364694 | 9·680120 | 10 54 | 10·319880 | 10·044814 | 10 10 | 9·955186 | 40 | 25 |
| 30 | 22 | 9·635438 | 11 48 | 10·364562 | 9·680282 | 11 59 | 10·319718 | 10·044844 | 11 11 | 9·955156 | 38 | 30 |
| 36 | 24 | 9·635570 | 12 53 | 10·364430 | 9·680444 | 12 65 | 10·319556 | 10·044874 | 12 12 | 9·955126 | 36 | 24 |
| 30 | 26 | 9·635702 | 13 57 | 10·364298 | 9·680606 | 13 70 | 10·319394 | 10·044904 | 13 13 | 9·955096 | 34 | 30 |
| 37 | 28 | 9·635834 | 14 61 | 10·364166 | 9·680768 | 14 76 | 10·319232 | 10·044935 | 14 14 | 9·955065 | 32 | 23 |
| 30 | 30 | 9·635965 | 15 66 | 10·364035 | 9·680930 | 15 81 | 10·319070 | 10·044965 | 15 15 | 9·955035 | 30 | 30 |
| 38 | 32 | 9·636097 | 16 70 | 10·363903 | 9·681092 | 16 86 | 10·318908 | 10·044995 | 16 16 | 9·955005 | 28 | 22 |
| 30 | 34 | 9·636229 | 17 75 | 10·363771 | 9·681254 | 17 92 | 10·318746 | 10·045026 | 17 17 | 9·954974 | 26 | 30 |
| 39 | 36 | 9·636360 | 18 79 | 10·363640 | 9·681416 | 18 97 | 10·318584 | 10·045056 | 18 18 | 9·954944 | 24 | 21 |
| 30 | 38 | 9·636492 | 19 83 | 10·363508 | 9·681578 | 19 103 | 10·318422 | 10·045086 | 19 19 | 9·954914 | 22 | 30 |
| 40 | 40 | 9·636623 | 20 88 | 10·363377 | 9·681740 | 20 108 | 10·318260 | 10·045117 | 20 20 | 9·954883 | 20 | 20 |
| 30 | 42 | 9·636754 | 21 92 | 10·363246 | 9·681901 | 21 113 | 10·318099 | 10·045147 | 21 21 | 9·954853 | 18 | 30 |
| 41 | 44 | 9·636886 | 22 96 | 10·363114 | 9·682063 | 22 119 | 10·317937 | 10·045177 | 22 22 | 9·954823 | 16 | 19 |
| 30 | 46 | 9·637017 | 23 101 | 10·362983 | 9·682225 | 23 124 | 10·317775 | 10·045208 | 23 23 | 9·954792 | 14 | 30 |
| 42 | 48 | 9·637148 | 24 105 | 10·362852 | 9·682387 | 24 130 | 10·317613 | 10·045238 | 24 24 | 9·954762 | 12 | 18 |
| 30 | 50 | 9·637280 | 25 110 | 10·362720 | 9·682548 | 25 135 | 10·317452 | 10·045268 | 25 25 | 9·954732 | 10 | 30 |
| 43 | 52 | 9·637411 | 26 114 | 10·362589 | 9·682710 | 26 140 | 10·317290 | 10·045299 | 26 26 | 9·954701 | 8 | 17 |
| 30 | 54 | 9·637542 | 27 119 | 10·362458 | 9·682871 | 27 146 | 10·317129 | 10·045329 | 27 27 | 9·954671 | 6 | 30 |
| 44 | 56 | 9·637673 | 28 123 | 10·362327 | 9·683033 | 28 151 | 10·316967 | 10·045360 | 28 28 | 9·954640 | 4 | 16 |
| 30 | 58 | 9·637804 | 29 127 | 10·362196 | 9·683194 | 29 157 | 10·316806 | 10·045390 | 29 29 | 9·954610 | 2 | 30 |
| 45 | 43 | 9·637935 | 30 132 | 10·362065 | 9·683356 | 30 162 | 10·316644 | 10·045421 | 30 30 | 9·954579 | 17 | 15 |
| 30 | 2 | 9·638066 | 1 4 | 10·361934 | 9·683517 | 1 5 | 10·316483 | 10·045451 | 1 1 | 9·954549 | 58 | 30 |
| 46 | 4 | 9·638197 | 2 9 | 10·361803 | 9·683679 | 2 11 | 10·316321 | 10·045482 | 2 2 | 9·954518 | 56 | 14 |
| 30 | 6 | 9·638328 | 3 13 | 10·361672 | 9·683840 | 3 16 | 10·316160 | 10·045512 | 3 3 | 9·954488 | 54 | 30 |
| 47 | 8 | 9·638458 | 4 17 | 10·361542 | 9·684001 | 4 21 | 10·315999 | 10·045543 | 4 4 | 9·954457 | 52 | 13 |
| 36 | 10 | 9·638589 | 5 22 | 10·361411 | 9·684162 | 5 27 | 10·315838 | 10·045573 | 5 5 | 9·954427 | 50 | 30 |
| 48 | 12 | 9·638720 | 6 26 | 10·361280 | 9·684324 | 6 32 | 10·315676 | 10·045604 | 6 6 | 9·954396 | 48 | 12 |
| 30 | 14 | 9·638851 | 7 30 | 10·361149 | 9·684485 | 7 38 | 10·315515 | 10·045634 | 7 7 | 9·954366 | 46 | 30 |
| 49 | 16 | 9·638981 | 8 35 | 10·361019 | 9·684646 | 8 43 | 10·315354 | 10·045665 | 8 8 | 9·954335 | 44 | 11 |
| 30 | 18 | 9·639112 | 9 39 | 10·360888 | 9·684807 | 9 48 | 10·315193 | 10·045695 | 9 9 | 9·954305 | 42 | 30 |
| 50 | 20 | 9·639242 | 10 43 | 10·360758 | 9·684968 | 10 54 | 10·315032 | 10·045726 | 10 10 | 9·954274 | 40 | 10 |
| 30 | 22 | 9·639373 | 11 48 | 10·360627 | 9·685129 | 11 59 | 10·314871 | 10·045757 | 11 11 | 9·954243 | 38 | 30 |
| 51 | 24 | 9·639503 | 12 52 | 10·360497 | 9·685290 | 12 64 | 10·314710 | 10·045787 | 12 12 | 9·954213 | 36 | 9 |
| 30 | 26 | 9·639633 | 13 56 | 10·360367 | 9·685451 | 13 70 | 10·314549 | 10·045818 | 13 13 | 9·954182 | 34 | 30 |
| 52 | 28 | 9·639764 | 14 61 | 10·360236 | 9·685612 | 14 75 | 10·314388 | 10·045848 | 14 14 | 9·954152 | 32 | 8 |
| 30 | 30 | 9·639894 | 15 65 | 10·360106 | 9·685773 | 15 80 | 10·314227 | 10·045879 | 15 15 | 9·954121 | 30 | 30 |
| 53 | 32 | 9·640024 | 16 69 | 10·359976 | 9·685934 | 16 86 | 10·314066 | 10·045910 | 16 16 | 9·954090 | 28 | 7 |
| 30 | 34 | 9·640154 | 17 74 | 10·359846 | 9·686095 | 17 91 | 10·313905 | 10·045940 | 17 17 | 9·954060 | 26 | 30 |
| 54 | 36 | 9·640284 | 18 78 | 10·359716 | 9·686255 | 18 96 | 10·313745 | 10·045971 | 18 18 | 9·954029 | 24 | 6 |
| 30 | 38 | 9·640414 | 19 82 | 10·359586 | 9·686416 | 19 102 | 10·313584 | 10·046002 | 19 19 | 9·953998 | 22 | 30 |
| 55 | 40 | 9·640544 | 20 87 | 10·359456 | 9·686577 | 20 107 | 10·313423 | 10·046032 | 20 20 | 9·953968 | 20 | 5 |
| 30 | 42 | 9·640674 | 21 91 | 10·359326 | 9·686737 | 21 113 | 10·313263 | 10·046063 | 21 21 | 9·953937 | 18 | 30 |
| 56 | 44 | 9·640804 | 22 95 | 10·359196 | 9·686898 | 22 118 | 10·313102 | 10·046094 | 22 22 | 9·953906 | 16 | 4 |
| 30 | 46 | 9·640934 | 23 100 | 10·359066 | 9·687059 | 23 123 | 10·312941 | 10·046124 | 23 23 | 9·953876 | 14 | 30 |
| 57 | 48 | 9·641064 | 24 104 | 10·358936 | 9·687219 | 24 129 | 10·312781 | 10·046155 | 24 24 | 9·953845 | 12 | 3 |
| 30 | 50 | 9·641194 | 25 109 | 10·358806 | 9·687380 | 25 134 | 10·312620 | 10·046186 | 25 25 | 9·953814 | 10 | 30 |
| 58 | 52 | 9·641324 | 26 113 | 10·358676 | 9·687540 | 26 139 | 10·312460 | 10·046217 | 26 27 | 9·953783 | 8 | 2 |
| 30 | 54 | 9·641453 | 27 117 | 10·358547 | 9·687701 | 27 145 | 10·312299 | 10·046247 | 27 28 | 9·953753 | 6 | 30 |
| 59 | 56 | 9·641583 | 28 122 | 10·358417 | 9·687861 | 28 150 | 10·312139 | 10·046278 | 28 29 | 9·953722 | 4 | 1 |
| 30 | 58 | 9·641712 | 29 126 | 10·358288 | 9·688021 | 29 155 | 10·311979 | 10·046309 | 29 30 | 9·953691 | 2 | 30 |
| 60 | 44 | 9·641842 | 30 130 | 10·358158 | 9·688182 | 30 161 | 10·311818 | 10·046340 | 30 31 | 9·953660 | 0 | 0 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

64° — 4h 16m

## LOG. SINES, COSINES, &c.

1h 44m — 26°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 9·641842 | | 10·358158 | 9·688182 | | 10·311818 | 10·046340 | | 9·953660 | 16 | 60 |
| 30 | 2 | 9·641971 | 1″ 4 | 10·358029 | 9·688342 | 1″ 5 | 10·311658 | 10·046371 | 1″ 1 | 9·953629 | 58 | 30 |
| 1 | 4 | 9·642101 | 2 9 | 10·357899 | 9·688502 | 2 11 | 10·311498 | 10·046401 | 2 2 | 9·953599 | 56 | 59 |
| 30 | 6 | 9·642230 | 3 13 | 10·357770 | 9·688663 | 3 16 | 10·311337 | 10·046432 | 3 3 | 9·953568 | 54 | 30 |
| 2 | 8 | 9·642360 | 4 17 | 10·357640 | 9·688823 | 4 21 | 10·311177 | 10·046463 | 4 4 | 9·953537 | 52 | 58 |
| 30 | 10 | 9·642489 | 5 21 | 10·357511 | 9·688983 | 5 27 | 10·311017 | 10·046494 | 5 5 | 9·953506 | 50 | 30 |
| 3 | 12 | 9·642618 | 6 26 | 10·357382 | 9·689143 | 6 32 | 10·310857 | 10·046525 | 6 6 | 9·953475 | 48 | 57 |
| 30 | 14 | 9·642747 | 7 30 | 10·357253 | 9·689303 | 7 37 | 10·310697 | 10·046556 | 7 7 | 9·953444 | 46 | 30 |
| 4 | 16 | 9·642877 | 8 34 | 10·357123 | 9·689463 | 8 43 | 10·310537 | 10·046587 | 8 8 | 9·953413 | 44 | 56 |
| 30 | 18 | 9·643006 | 9 39 | 10·356994 | 9·689623 | 9 48 | 10·310377 | 10·046618 | 9 9 | 9·953382 | 42 | 30 |
| 5 | 20 | 9·643135 | 10 43 | 10·356865 | 9·689783 | 10 53 | 10·310217 | 10·046648 | 10 10 | 9·953352 | 40 | 55 |
| 30 | 22 | 9·643264 | 11 47 | 10·356736 | 9·689943 | 11 59 | 10·310057 | 10·046679 | 11 11 | 9·953321 | 38 | 30 |
| 6 | 24 | 9·643393 | 12 51 | 10·356607 | 9·690103 | 12 64 | 10·309897 | 10·046710 | 12 12 | 9·953290 | 36 | 54 |
| 30 | 26 | 9·643522 | 13 56 | 10·356478 | 9·690263 | 13 69 | 10·309737 | 10·046741 | 13 13 | 9·953259 | 34 | 30 |
| 7 | 28 | 9·643650 | 14 60 | 10·356350 | 9·690423 | 14 75 | 10·309577 | 10·046772 | 14 14 | 9·953228 | 32 | 53 |
| 30 | 30 | 9·643779 | 15 64 | 10·356221 | 9·690582 | 15 80 | 10·309418 | 10·046803 | 15 15 | 9·953197 | 30 | 30 |
| 8 | 32 | 9·643908 | 16 68 | 10·356092 | 9·690742 | 16 85 | 10·309258 | 10·046834 | 16 16 | 9·953166 | 28 | 52 |
| 30 | 34 | 9·644037 | 17 73 | 10·355963 | 9·690902 | 17 91 | 10·309098 | 10·046865 | 17 18 | 9·953135 | 26 | 30 |
| 9 | 36 | 9·644165 | 18 77 | 10·355835 | 9·691062 | 18 96 | 10·308938 | 10·046896 | 18 19 | 9·953104 | 24 | 51 |
| 30 | 38 | 9·644294 | 19 82 | 10·355706 | 9·691221 | 19 101 | 10·308779 | 10·046927 | 19 20 | 9·953073 | 22 | 30 |
| 10 | 40 | 9·644423 | 20 86 | 10·355577 | 9·691381 | 20 107 | 10·308619 | 10·046958 | 20 21 | 9·953042 | 20 | 50 |
| 30 | 42 | 9·644551 | 21 90 | 10·355449 | 9·691540 | 21 112 | 10·308460 | 10·046989 | 21 22 | 9·953011 | 18 | 30 |
| 11 | 44 | 9·644680 | 22 94 | 10·355320 | 9·691700 | 22 117 | 10·308300 | 10·047020 | 22 23 | 9·952980 | 16 | 49 |
| 30 | 46 | 9·644808 | 23 99 | 10·355192 | 9·691859 | 23 123 | 10·308141 | 10·047051 | 23 24 | 9·952949 | 14 | 30 |
| 12 | 48 | 9·644936 | 24 103 | 10·355064 | 9·692019 | 24 128 | 10·307981 | 10·047082 | 24 25 | 9·952918 | 12 | 48 |
| 30 | 50 | 9·645065 | 25 107 | 10·354935 | 9·692178 | 25 133 | 10·307822 | 10·047114 | 25 26 | 9·952886 | 10 | 30 |
| 13 | 52 | 9·645193 | 26 112 | 10·354807 | 9·692338 | 26 139 | 10·307662 | 10·047145 | 26 27 | 9·952855 | 8 | 47 |
| 30 | 54 | 9·645321 | 27 116 | 10·354679 | 9·692497 | 27 144 | 10·307503 | 10·047176 | 27 28 | 9·952824 | 6 | 30 |
| 14 | 56 | 9·645450 | 28 120 | 10·354550 | 9·692656 | 28 149 | 10·307344 | 10·047207 | 28 29 | 9·952793 | 4 | 46 |
| 30 | 58 | 9·645578 | 29 124 | 10·354422 | 9·692816 | 29 155 | 10·307184 | 10·047238 | 29 30 | 9·952762 | 2 | 30 |
| 15 | 45 | 9·645706 | 30 129 | 10·354294 | 9·692975 | 30 160 | 10·307025 | 10·047269 | 30 31 | 9·952731 | 15 | 45 |
| 30 | 2 | 9·645834 | 1 4 | 10·354166 | 9·693134 | 1 5 | 10·306866 | 10·047300 | 1 1 | 9·952700 | 58 | 30 |
| 16 | 4 | 9·645962 | 2 9 | 10·354038 | 9·693293 | 2 11 | 10·306707 | 10·047331 | 2 2 | 9·952669 | 56 | 44 |
| 30 | 6 | 9·646090 | 3 13 | 10·353910 | 9·693453 | 3 16 | 10·306547 | 10·047363 | 3 3 | 9·952637 | 54 | 30 |
| 17 | 8 | 9·646218 | 4 17 | 10·353782 | 9·693612 | 4 21 | 10·306388 | 10·047394 | 4 4 | 9·952606 | 52 | 43 |
| 30 | 10 | 9·646346 | 5 21 | 10·353654 | 9·693771 | 5 26 | 10·306229 | 10·047425 | 5 5 | 9·952575 | 50 | 30 |
| 18 | 12 | 9·646474 | 6 25 | 10·353526 | 9·693930 | 6 32 | 10·306070 | 10·047456 | 6 6 | 9·952544 | 48 | 42 |
| 30 | 14 | 9·646601 | 7 30 | 10·353399 | 9·694089 | 7 37 | 10·305911 | 10·047488 | 7 7 | 9·952512 | 46 | 30 |
| 19 | 16 | 9·646729 | 8 34 | 10·353271 | 9·694248 | 8 42 | 10·305752 | 10·047519 | 8 8 | 9·952481 | 44 | 41 |
| 30 | 18 | 9·646857 | 9 38 | 10·353143 | 9·694407 | 9 48 | 10·305593 | 10·047550 | 9 9 | 9·952450 | 42 | 30 |
| 20 | 20 | 9·646984 | 10 42 | 10·353016 | 9·694566 | 10 53 | 10·305434 | 10·047581 | 10 10 | 9·952419 | 40 | 40 |
| 30 | 22 | 9·647112 | 11 47 | 10·352888 | 9·694724 | 11 58 | 10·305276 | 10·047613 | 11 11 | 9·952387 | 38 | 30 |
| 21 | 24 | 9·647240 | 12 51 | 10·352760 | 9·694883 | 12 63 | 10·305117 | 10·047644 | 12 13 | 9·952356 | 36 | 39 |
| 30 | 26 | 9·647367 | 13 55 | 10·352633 | 9·695042 | 13 69 | 10·304958 | 10·047675 | 13 14 | 9·952325 | 34 | 30 |
| 22 | 28 | 9·647494 | 14 59 | 10·352506 | 9·695201 | 14 74 | 10·304799 | 10·047706 | 14 15 | 9·952294 | 32 | 38 |
| 30 | 30 | 9·647622 | 15 64 | 10·352378 | 9·695360 | 15 79 | 10·304640 | 10·047738 | 15 16 | 9·952262 | 30 | 30 |
| 23 | 32 | 9·647749 | 16 68 | 10·352251 | 9·695518 | 16 85 | 10·304482 | 10·047769 | 16 17 | 9·952231 | 28 | 37 |
| 30 | 34 | 9·647877 | 17 72 | 10·352123 | 9·695677 | 17 90 | 10·304323 | 10·047800 | 17 18 | 9·952200 | 26 | 30 |
| 24 | 36 | 9·648004 | 18 76 | 10·351996 | 9·695836 | 18 95 | 10·304164 | 10·047832 | 18 19 | 9·952168 | 24 | 36 |
| 30 | 38 | 9·648131 | 19 81 | 10·351869 | 9·695994 | 19 101 | 10·304006 | 10·047863 | 19 20 | 9·952137 | 22 | 30 |
| 25 | 40 | 9·648258 | 20 85 | 10·351742 | 9·696153 | 20 106 | 10·303847 | 10·047894 | 20 21 | 9·952106 | 20 | 35 |
| 30 | 42 | 9·648385 | 21 89 | 10·351615 | 9·696311 | 21 111 | 10·303689 | 10·047926 | 21 22 | 9·952074 | 18 | 30 |
| 26 | 44 | 9·648512 | 22 93 | 10·351488 | 9·696470 | 22 116 | 10·303530 | 10·047957 | 22 23 | 9·952043 | 16 | 34 |
| 30 | 46 | 9·648639 | 23 98 | 10·351361 | 9·696628 | 23 122 | 10·303372 | 10·047989 | 23 24 | 9·952011 | 14 | 30 |
| 27 | 48 | 9·648766 | 24 102 | 10·351234 | 9·696787 | 24 127 | 10·303213 | 10·048020 | 24 25 | 9·951980 | 12 | 33 |
| 30 | 50 | 9·648893 | 25 106 | 10·351107 | 9·696945 | 25 132 | 10·303055 | 10·048051 | 25 26 | 9·951949 | 10 | 30 |
| 28 | 52 | 9·649020 | 26 110 | 10·350980 | 9·697103 | 26 138 | 10·302897 | 10·048083 | 26 27 | 9·951917 | 8 | 32 |
| 30 | 54 | 9·649147 | 27 115 | 10·350853 | 9·697262 | 27 143 | 10·302739 | 10·048114 | 27 28 | 9·951886 | 6 | 30 |
| 29 | 56 | 9·649274 | 28 119 | 10·350726 | 9·697420 | 28 148 | 10·302580 | 10·048146 | 28 29 | 9·951854 | 4 | 31 |
| 30 | 58 | 9·649401 | 29 123 | 10·350599 | 9·697578 | 29 153 | 10·302422 | 10·048177 | 29 30 | 9·951823 | 2 | 30 |
| 30 | 46 | 9·649527 | 30 127 | 10·350473 | 9·697736 | 30 159 | 10·302264 | 10·048209 | 30 31 | 9·951791 | 0 | 30 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

63° — 4h 14m

## LOG. SINES, COSINES, &c.

1ʰ 46ᵐ — 26°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 9·649527 | | 10·350473 | 9·697736 | | 10·302264 | 10·048209 | | 9·951791 | 14 | 30 |
| 30 | 2 | 9·649654 | 1″ 4 | 10·350346 | 9·697894 | 1″ 5 | 10·302106 | 10·048240 | 1″ 1 | 9·951760 | 58 | 30 |
| 31 | 4 | 9·649781 | 2 8 | 10·350219 | 9·698053 | 2 11 | 10·301947 | 10·048272 | 2 2 | 9·951728 | 56 | 29 |
| 30 | 6 | 9·649907 | 3 13 | 10·350093 | 9·698211 | 3 16 | 10·301789 | 10·048303 | 3 3 | 9·951697 | 54 | 30 |
| 32 | 8 | 9·650034 | 4 17 | 10·349966 | 9·698369 | 4 21 | 10·301631 | 10·048335 | 4 4 | 9·951665 | 52 | 28 |
| 30 | 10 | 9·650160 | 5 21 | 10·349840 | 9·698527 | 5 26 | 10·301473 | 10·048366 | 5 5 | 9·951634 | 50 | 30 |
| 33 | 12 | 9·650287 | 6 25 | 10·349713 | 9·698685 | 6 32 | 10·301315 | 10·048398 | 6 6 | 9·951602 | 48 | 27 |
| 30 | 14 | 9·650413 | 7 29 | 10·349587 | 9·698843 | 7 37 | 10·301157 | 10·048430 | 7 7 | 9·951570 | 46 | 30 |
| 34 | 16 | 9·650539 | 8 34 | 10·349461 | 9·699001 | 8 42 | 10·300999 | 10·048461 | 8 8 | 9·951539 | 44 | 26 |
| 30 | 18 | 9·650666 | 9 38 | 10·349334 | 9·699159 | 9 47 | 10·300841 | 10·048493 | 9 9 | 9·951507 | 42 | 30 |
| 35 | 20 | 9·650792 | 10 42 | 10·349208 | 9·699316 | 10 53 | 10·300684 | 10·048524 | 10 11 | 9·951476 | 40 | 25 |
| 30 | 22 | 9·650918 | 11 46 | 10·349082 | 9·699474 | 11 58 | 10·300526 | 10·048556 | 11 12 | 9·951444 | 38 | 30 |
| 36 | 24 | 9·651044 | 12 51 | 10·348956 | 9·699632 | 12 63 | 10·300368 | 10·048588 | 12 13 | 9·951412 | 36 | 24 |
| 30 | 26 | 9·651171 | 13 55 | 10·348829 | 9·699790 | 13 68 | 10·300210 | 10·048619 | 13 14 | 9·951381 | 34 | 30 |
| 37 | 28 | 9·651297 | 14 59 | 10·348703 | 9·699947 | 14 74 | 10·300053 | 10·048651 | 14 15 | 9·951349 | 32 | 23 |
| 30 | 30 | 9·651423 | 15 63 | 10·348577 | 9·700105 | 15 79 | 10·299895 | 10·048683 | 15 16 | 9·951317 | 30 | 30 |
| 38 | 32 | 9·651549 | 16 67 | 10·348451 | 9·700263 | 16 84 | 10·299737 | 10·048714 | 16 17 | 9·951286 | 28 | 22 |
| 30 | 34 | 9·651675 | 17 71 | 10·348325 | 9·700420 | 17 89 | 10·299580 | 10·048746 | 17 18 | 9·951254 | 26 | 30 |
| 39 | 36 | 9·651800 | 18 76 | 10·348200 | 9·700578 | 18 95 | 10·299422 | 10·048778 | 18 19 | 9·951222 | 24 | 21 |
| 30 | 38 | 9·651926 | 19 80 | 10·348074 | 9·700736 | 19 100 | 10·299264 | 10·048809 | 19 20 | 9·951191 | 22 | 30 |
| 40 | 40 | 9·652052 | 20 84 | 10·347948 | 9·700893 | 20 105 | 10·299107 | 10·048841 | 20 21 | 9·951159 | 20 | 20 |
| 30 | 42 | 9·652178 | 21 88 | 10·347822 | 9·701051 | 21 110 | 10·298949 | 10·048873 | 21 22 | 9·951127 | 18 | 30 |
| 41 | 44 | 9·652304 | 22 92 | 10·347696 | 9·701208 | 22 116 | 10·298792 | 10·048904 | 22 23 | 9·951096 | 16 | 19 |
| 30 | 46 | 9·652429 | 23 97 | 10·347571 | 9·701365 | 23 121 | 10·298635 | 10·048936 | 23 24 | 9·951064 | 14 | 30 |
| 42 | 48 | 9·652555 | 24 101 | 10·347445 | 9·701523 | 24 126 | 10·298477 | 10·048968 | 24 25 | 9·951032 | 12 | 18 |
| 30 | 50 | 9·652680 | 25 105 | 10·347320 | 9·701680 | 25 131 | 10·298320 | 10·049000 | 25 26 | 9·951000 | 10 | 30 |
| 43 | 52 | 9·652806 | 26 109 | 10·347194 | 9·701837 | 26 137 | 10·298163 | 10·049032 | 26 27 | 9·950968 | 8 | 17 |
| 30 | 54 | 9·652931 | 27 113 | 10·347069 | 9·701995 | 27 142 | 10·298005 | 10·049063 | 27 28 | 9·950937 | 6 | 30 |
| 44 | 56 | 9·653057 | 28 118 | 10·346943 | 9·702152 | 28 147 | 10·297848 | 10·049095 | 28 29 | 9·950905 | 4 | 16 |
| 30 | 58 | 9·653182 | 29 122 | 10·346818 | 9·702309 | 29 153 | 10·297691 | 10·049127 | 29 31 | 9·950873 | 2 | 30 |
| 45 | 47 | 9·653308 | 30 126 | 10·346692 | 9·702466 | 30 158 | 10·297534 | 10·049159 | 30 32 | 9·950841 | 13 | 15 |
| 30 | 2 | 9·653433 | 1 4 | 10·346567 | 9·702623 | 1 5 | 10·297377 | 10·049191 | 1 1 | 9·950809 | 58 | 30 |
| 46 | 4 | 9·653558 | 2 8 | 10·346442 | 9·702781 | 2 10 | 10·297219 | 10·049222 | 2 2 | 9·950778 | 56 | 14 |
| 30 | 6 | 9·653683 | 3 12 | 10·346317 | 9·702938 | 3 16 | 10·297062 | 10·049254 | 3 3 | 9·950746 | 54 | 30 |
| 47 | 8 | 9·653808 | 4 17 | 10·346192 | 9·703095 | 4 21 | 10·296905 | 10·049286 | 4 4 | 9·950714 | 52 | 13 |
| 30 | 10 | 9·653934 | 5 21 | 10·346066 | 9·703252 | 5 26 | 10·296748 | 10·049318 | 5 5 | 9·950682 | 50 | 30 |
| 48 | 12 | 9·654059 | 6 25 | 10·345941 | 9·703409 | 6 31 | 10·296591 | 10·049350 | 6 6 | 9·950650 | 48 | 12 |
| 30 | 14 | 9·654184 | 7 29 | 10·345816 | 9·703566 | 7 37 | 10·296434 | 10·049382 | 7 7 | 9·950618 | 46 | 30 |
| 49 | 16 | 9·654309 | 8 33 | 10·345691 | 9·703722 | 8 42 | 10·296278 | 10·049414 | 8 9 | 9·950586 | 44 | 11 |
| 30 | 18 | 9·654434 | 9 37 | 10·345566 | 9·703879 | 9 47 | 10·296121 | 10·049446 | 9 10 | 9·950554 | 42 | 30 |
| 50 | 20 | 9·654558 | 10 42 | 10·345442 | 9·704036 | 10 52 | 10·295964 | 10·049478 | 10 11 | 9·950522 | 40 | 10 |
| 30 | 22 | 9·654683 | 11 46 | 10·345317 | 9·704193 | 11 57 | 10·295807 | 10·049510 | 11 12 | 9·950490 | 38 | 30 |
| 51 | 24 | 9·654808 | 12 50 | 10·345192 | 9·704350 | 12 63 | 10·295650 | 10·049542 | 12 13 | 9·950458 | 36 | 9 |
| 30 | 26 | 9·654933 | 13 54 | 10·345067 | 9·704506 | 13 68 | 10·295494 | 10·049574 | 13 14 | 9·950426 | 34 | 30 |
| 52 | 28 | 9·655058 | 14 58 | 10·344942 | 9·704663 | 14 73 | 10·295337 | 10·049606 | 14 15 | 9·950394 | 32 | 8 |
| 30 | 30 | 9·655182 | 15 62 | 10·344818 | 9·704820 | 15 78 | 10·295180 | 10·049638 | 15 16 | 9·950362 | 30 | 30 |
| 53 | 32 | 9·655307 | 16 67 | 10·344693 | 9·704976 | 16 84 | 10·295024 | 10·049670 | 16 17 | 9·950330 | 28 | 7 |
| 30 | 34 | 9·655431 | 17 71 | 10·344569 | 9·705133 | 17 89 | 10·294867 | 10·049702 | 17 18 | 9·950298 | 26 | 30 |
| 54 | 36 | 9·655556 | 18 75 | 10·344444 | 9·705290 | 18 94 | 10·294710 | 10·049734 | 18 19 | 9·950266 | 24 | 6 |
| 30 | 38 | 9·655680 | 19 79 | 10·344320 | 9·705446 | 19 99 | 10·294554 | 10·049766 | 19 20 | 9·950234 | 22 | 30 |
| 55 | 40 | 9·655805 | 20 83 | 10·344195 | 9·705603 | 20 104 | 10·294397 | 10·049798 | 20 21 | 9·950202 | 20 | 5 |
| 30 | 42 | 9·655929 | 21 87 | 10·344071 | 9·705759 | 21 110 | 10·294241 | 10·049830 | 21 22 | 9·950170 | 18 | 30 |
| 56 | 44 | 9·656054 | 22 91 | 10·343946 | 9·705916 | 22 115 | 10·294084 | 10·049862 | 22 23 | 9·950138 | 16 | 4 |
| 30 | 46 | 9·656178 | 23 95 | 10·343822 | 9·706072 | 23 120 | 10·293928 | 10·049894 | 23 25 | 9·950106 | 14 | 30 |
| 57 | 48 | 9·656302 | 24 100 | 10·343698 | 9·706228 | 24 125 | 10·293772 | 10·049926 | 24 26 | 9·950074 | 12 | 3 |
| 30 | 50 | 9·656426 | 25 104 | 10·343574 | 9·706385 | 25 130 | 10·293615 | 10·049958 | 25 27 | 9·950042 | 10 | 30 |
| 58 | 52 | 9·656551 | 26 108 | 10·343449 | 9·706541 | 26 136 | 10·293459 | 10·049990 | 26 28 | 9·950010 | 8 | 2 |
| 30 | 54 | 9·656675 | 27 112 | 10·343325 | 9·706697 | 27 141 | 10·293303 | 10·050023 | 27 29 | 9·949977 | 6 | 30 |
| 59 | 56 | 9·656799 | 28 116 | 10·343201 | 9·706854 | 28 146 | 10·293146 | 10·050055 | 28 30 | 9·949945 | 4 | 1 |
| 30 | 58 | 9·656923 | 29 120 | 10·343077 | 9·707010 | 29 151 | 10·292990 | 10·050087 | 29 31 | 9·949913 | 2 | 30 |
| 60 | 48 | 9·657047 | 30 125 | 10·342953 | 9·707166 | 30 157 | 10·292834 | 10·050119 | 30 32 | 9·949881 | 0 | 0 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

63° — 4ʰ 12ᵐ

## LOG. SINES, COSINES, &c.

1h 48m — 27°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 9·657047 | | 10·342953 | 9·707166 | | 10·292834 | 10·050119 | | 9·949881 | 12 | 60 |
| 30 | 2 | 9·657171 | 1″ 4 | 10·342829 | 9·707322 | 1″ 5 | 10·292678 | 10·050151 | 1″ 1 | 9·949849 | 58 | 30 |
| 1 | 4 | 9·657295 | 2 8 | 10·342705 | 9·707478 | 2 10 | 10·292522 | 10·050184 | 2 2 | 9·949816 | 56 | 59 |
| 30 | 6 | 9·657418 | 3 12 | 10·342582 | 9·707634 | 3 16 | 10·292366 | 10·050216 | 3 3 | 9·949784 | 54 | 30 |
| 2 | 8 | 9·657542 | 4 16 | 10·342458 | 9·707790 | 4 21 | 10·292210 | 10·050248 | 4 4 | 9·949752 | 52 | 58 |
| 30 | 10 | 9·657666 | 5 21 | 10·342334 | 9·707946 | 5 26 | 10·292054 | 10·050280 | 5 5 | 9·949720 | 50 | 30 |
| 3 | 12 | 9·657790 | 6 25 | 10·342210 | 9·708102 | 6 31 | 10·291898 | 10·050312 | 6 6 | 9·949688 | 48 | 57 |
| 30 | 14 | 9·657913 | 7 29 | 10·342087 | 9·708258 | 7 36 | 10·291742 | 10·050345 | 7 8 | 9·949655 | 46 | 30 |
| 4 | 16 | 9·658037 | 8 33 | 10·341963 | 9·708414 | 8 42 | 10·291586 | 10·050377 | 8 9 | 9·949623 | 44 | 56 |
| 30 | 18 | 9·658161 | 9 37 | 10·341839 | 9·708570 | 9 47 | 10·291430 | 10·050409 | 9 10 | 9·949591 | 42 | 30 |
| 5 | 20 | 9·658284 | 10 41 | 10·341716 | 9·708726 | 10 52 | 10·291274 | 10·050442 | 10 11 | 9·949558 | 40 | 55 |
| 30 | 22 | 9·658408 | 11 45 | 10·341592 | 9·708882 | 11 57 | 10·291118 | 10·050474 | 11 12 | 9·949526 | 38 | 30 |
| 6 | 24 | 9·658531 | 12 49 | 10·341469 | 9·709037 | 12 62 | 10·290963 | 10·050506 | 12 13 | 9·949494 | 36 | 54 |
| 30 | 26 | 9·658655 | 13 53 | 10·341345 | 9·709193 | 13 67 | 10·290807 | 10·050538 | 13 14 | 9·949462 | 34 | 30 |
| 7 | 28 | 9·658778 | 14 57 | 10·341222 | 9·709349 | 14 73 | 10·290651 | 10·050571 | 14 15 | 9·949429 | 32 | 53 |
| 30 | 30 | 9·658901 | 15 62 | 10·341099 | 9·709504 | 15 78 | 10·290496 | 10·050603 | 15 16 | 9·949397 | 30 | 30 |
| 8 | 32 | 9·659025 | 16 66 | 10·340975 | 9·709660 | 16 83 | 10·290340 | 10·050636 | 16 17 | 9·949364 | 28 | 52 |
| 30 | 34 | 9·659148 | 17 70 | 10·340852 | 9·709816 | 17 88 | 10·290184 | 10·050668 | 17 18 | 9·949332 | 26 | 30 |
| 9 | 36 | 9·659271 | 18 74 | 10·340729 | 9·709971 | 18 93 | 10·290029 | 10·050700 | 18 19 | 9·949300 | 24 | 51 |
| 30 | 38 | 9·659394 | 19 78 | 10·340606 | 9·710127 | 19 99 | 10·289873 | 10·050733 | 19 21 | 9·949267 | 22 | 30 |
| 10 | 40 | 9·659517 | 20 82 | 10·340483 | 9·710282 | 20 104 | 10·289718 | 10·050765 | 20 22 | 9·949235 | 20 | 50 |
| 30 | 42 | 9·659640 | 21 86 | 10·340360 | 9·710438 | 21 109 | 10·289562 | 10·050798 | 21 23 | 9·949202 | 18 | 30 |
| 11 | 44 | 9·659763 | 22 90 | 10·340237 | 9·710593 | 22 114 | 10·289407 | 10·050830 | 22 24 | 9·949170 | 16 | 49 |
| 30 | 46 | 9·659886 | 23 95 | 10·340114 | 9·710749 | 23 119 | 10·289251 | 10·050862 | 23 25 | 9·949138 | 14 | 30 |
| 12 | 48 | 9·660009 | 24 99 | 10·339991 | 9·710904 | 24 125 | 10·289096 | 10·050895 | 24 26 | 9·949105 | 12 | 48 |
| 30 | 50 | 9·660132 | 25 103 | 10·339868 | 9·711059 | 25 130 | 10·288941 | 10·050927 | 25 27 | 9·949073 | 10 | 30 |
| 13 | 52 | 9·660255 | 26 107 | 10·339745 | 9·711215 | 26 135 | 10·288785 | 10·050960 | 26 28 | 9·949040 | 8 | 47 |
| 30 | 54 | 9·660378 | 27 111 | 10·339622 | 9·711370 | 27 140 | 10·288630 | 10·050992 | 27 29 | 9·949008 | 6 | 30 |
| 14 | 56 | 9·660501 | 28 115 | 10·339499 | 9·711525 | 28 145 | 10·288475 | 10·051025 | 28 30 | 9·948975 | 4 | 46 |
| 30 | 58 | 9·660623 | 29 119 | 10·339377 | 9·711681 | 29 151 | 10·288319 | 10·051057 | 29 31 | 9·948943 | 2 | 30 |
| 15 | 49 | 9·660746 | 30 123 | 10·339254 | 9·711836 | 30 156 | 10·288164 | 10·051090 | 30 32 | 9·948910 | 11 | 45 |
| 30 | 2 | 9·660869 | 1 4 | 10·339131 | 9·711991 | 1 5 | 10·288009 | 10·051122 | 1 1 | 9·948878 | 58 | 30 |
| 16 | 4 | 9·660991 | 2 8 | 10·339009 | 9·712146 | 2 10 | 10·287854 | 10·051155 | 2 2 | 9·948845 | 56 | 44 |
| 30 | 6 | 9·661114 | 3 12 | 10·338886 | 9·712301 | 3 15 | 10·287699 | 10·051188 | 3 3 | 9·948812 | 54 | 30 |
| 17 | 8 | 9·661236 | 4 16 | 10·338764 | 9·712456 | 4 21 | 10·287544 | 10·051220 | 4 4 | 9·948780 | 52 | 43 |
| 30 | 10 | 9·661359 | 5 20 | 10·338641 | 9·712611 | 5 26 | 10·287389 | 10·051253 | 5 5 | 9·948747 | 50 | 30 |
| 18 | 12 | 9·661481 | 6 24 | 10·338519 | 9·712766 | 6 31 | 10·287234 | 10·051285 | 6 7 | 9·948715 | 48 | 42 |
| 30 | 14 | 9·661603 | 7 28 | 10·338397 | 9·712921 | 7 36 | 10·287079 | 10·051318 | 7 8 | 9·948682 | 46 | 30 |
| 19 | 16 | 9·661726 | 8 33 | 10·338274 | 9·713076 | 8 41 | 10·286924 | 10·051350 | 8 9 | 9·948650 | 44 | 41 |
| 30 | 18 | 9·661848 | 9 37 | 10·338152 | 9·713231 | 9 46 | 10·286769 | 10·051383 | 9 10 | 9·948617 | 42 | 30 |
| 20 | 20 | 9·661970 | 10 41 | 10·338030 | 9·713386 | 10 52 | 10·286614 | 10·051416 | 10 11 | 9·948584 | 40 | 40 |
| 30 | 22 | 9·662092 | 11 45 | 10·337908 | 9·713541 | 11 57 | 10·286459 | 10·051448 | 11 12 | 9·948552 | 38 | 30 |
| 21 | 24 | 9·662214 | 12 49 | 10·337786 | 9·713696 | 12 62 | 10·286304 | 10·051481 | 12 13 | 9·948519 | 36 | 39 |
| 30 | 26 | 9·662337 | 13 53 | 10·337663 | 9·713850 | 13 67 | 10·286150 | 10·051514 | 13 14 | 9·948486 | 34 | 30 |
| 22 | 28 | 9·662459 | 14 57 | 10·337541 | 9·714005 | 14 72 | 10·285995 | 10·051546 | 14 15 | 9·948454 | 32 | 38 |
| 30 | 30 | 9·662581 | 15 61 | 10·337419 | 9·714160 | 15 77 | 10·285840 | 10·051579 | 15 16 | 9·948421 | 30 | 30 |
| 23 | 32 | 9·662703 | 16 65 | 10·337297 | 9·714314 | 16 83 | 10·285686 | 10·051612 | 16 17 | 9·948388 | 28 | 37 |
| 30 | 34 | 9·662825 | 17 69 | 10·337175 | 9·714469 | 17 88 | 10·285531 | 10·051645 | 17 18 | 9·948355 | 26 | 30 |
| 24 | 36 | 9·662946 | 18 73 | 10·337054 | 9·714624 | 18 93 | 10·285376 | 10·051677 | 18 19 | 9·948323 | 24 | 36 |
| 30 | 38 | 9·663068 | 19 77 | 10·336932 | 9·714778 | 19 98 | 10·285222 | 10·051710 | 19 21 | 9·948290 | 22 | 30 |
| 25 | 40 | 9·663190 | 20 81 | 10·336810 | 9·714933 | 20 103 | 10·285067 | 10·051743 | 20 22 | 9·948257 | 20 | 35 |
| 30 | 42 | 9·663312 | 21 85 | 10·336688 | 9·715087 | 21 108 | 10·284913 | 10·051776 | 21 23 | 9·948224 | 18 | 30 |
| 26 | 44 | 9·663433 | 22 89 | 10·336567 | 9·715242 | 22 114 | 10·284758 | 10·051808 | 22 24 | 9·948192 | 16 | 34 |
| 30 | 46 | 9·663555 | 23 94 | 10·336445 | 9·715396 | 23 119 | 10·284604 | 10·051841 | 23 25 | 9·948159 | 14 | 30 |
| 27 | 48 | 9·663677 | 24 98 | 10·336323 | 9·715551 | 24 124 | 10·284449 | 10·051874 | 24 26 | 9·948126 | 12 | 33 |
| 30 | 50 | 9·663798 | 25 102 | 10·336202 | 9·715705 | 25 129 | 10·284295 | 10·051907 | 25 27 | 9·948093 | 10 | 30 |
| 28 | 52 | 9·663920 | 26 106 | 10·336080 | 9·715860 | 26 134 | 10·284140 | 10·051940 | 26 28 | 9·948060 | 8 | 32 |
| 30 | 54 | 9·664041 | 27 110 | 10·335959 | 9·716014 | 27 139 | 10·283986 | 10·051972 | 27 29 | 9·948028 | 6 | 30 |
| 29 | 56 | 9·664163 | 28 114 | 10·335837 | 9·716168 | 28 144 | 10·283832 | 10·052005 | 28 31 | 9·947995 | 4 | 31 |
| 30 | 58 | 9·664284 | 29 118 | 10·335716 | 9·716322 | 29 150 | 10·283678 | 10·052038 | 29 32 | 9·947962 | 2 | 30 |
| 30 | 50 | 9·664406 | 30 122 | 10·335594 | 9·716477 | 30 155 | 10·283523 | 10·052071 | 30 33 | 9·947929 | 0 | 30 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

62° — 4h 10m

## LOG. SINES, COSINES, &c.

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| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 9·664406 | | 10·335594 | 9·716477 | | 10·283523 | 10·052071 | | 9·947929 | 10 | 30 |
| 30 | 2 | 9·664527 | 1″ 4 | 10·335473 | 9·716631 | 1″ 5 | 10·283369 | 10·052104 | 1″ 1 | 9·947896 | 58 | 30 |
| 31 | 4 | 9·664648 | 2 8 | 10·335352 | 9·716785 | 2 10 | 10·283215 | 10·052137 | 2 2 | 9·947863 | 56 | 29 |
| 30 | 6 | 9·664769 | 3 12 | 10·335231 | 9·716939 | 3 15 | 10·283061 | 10·052170 | 3 3 | 9·947830 | 54 | 30 |
| 32 | 8 | 9·664891 | 4 16 | 10·335109 | 9·717093 | 4 20 | 10·282907 | 10·052203 | 4 4 | 9·947797 | 52 | 28 |
| 30 | 10 | 9·665012 | 5 20 | 10·334988 | 9·717247 | 5 26 | 10·282753 | 10·052236 | 5 5 | 9·947764 | 50 | 30 |
| 33 | 12 | 9·665133 | 6 24 | 10·334867 | 9·717401 | 6 31 | 10·282599 | 10·052269 | 6 7 | 9·947731 | 48 | 27 |
| 30 | 14 | 9·665254 | 7 28 | 10·334746 | 9·717555 | 7 36 | 10·282445 | 10·052302 | 7 8 | 9·947698 | 46 | 30 |
| 34 | 16 | 9·665375 | 8 32 | 10·334625 | 9·717709 | 8 41 | 10·282291 | 10·052335 | 8 9 | 9·947665 | 44 | 26 |
| 30 | 18 | 9·665496 | 9 36 | 10·334504 | 9·717863 | 9 46 | 10·282137 | 10·052367 | 9 10 | 9·947633 | 42 | 30 |
| 35 | 20 | 9·665617 | 10 40 | 10·334383 | 9·718017 | 10 51 | 10·281983 | 10·052400 | 10 11 | 9·947600 | 40 | 25 |
| 30 | 22 | 9·665738 | 11 44 | 10·334262 | 9·718171 | 11 56 | 10·281829 | 10·052433 | 11 12 | 9·947567 | 38 | 30 |
| 36 | 24 | 9·665859 | 12 48 | 10·334141 | 9·718325 | 12 61 | 10·281675 | 10·052467 | 12 13 | 9·947533 | 36 | 24 |
| 30 | 26 | 9·665979 | 13 52 | 10·334021 | 9·718479 | 13 67 | 10·281521 | 10·052500 | 13 14 | 9·947500 | 34 | 30 |
| 37 | 28 | 9·666100 | 14 56 | 10·333900 | 9·718633 | 14 72 | 10·281367 | 10·052533 | 14 15 | 9·947467 | 32 | 23 |
| 30 | 30 | 9·666221 | 15 60 | 10·333779 | 9·718786 | 15 77 | 10·281214 | 10·052566 | 15 16 | 9·947434 | 30 | 30 |
| 38 | 32 | 9·666342 | 16 64 | 10·333658 | 9·718940 | 16 82 | 10·281060 | 10·052599 | 16 18 | 9·947401 | 28 | 22 |
| 30 | 34 | 9·666462 | 17 68 | 10·333538 | 9·719094 | 17 87 | 10·280906 | 10·052632 | 17 19 | 9·947368 | 26 | 30 |
| 39 | 36 | 9·666583 | 18 72 | 10·333417 | 9·719248 | 18 92 | 10·280752 | 10·052665 | 18 20 | 9·947335 | 24 | 21 |
| 30 | 38 | 9·666703 | 19 76 | 10·333297 | 9·719401 | 19 97 | 10·280599 | 10·052698 | 19 21 | 9·947302 | 22 | 30 |
| 40 | 40 | 9·666824 | 20 80 | 10·333176 | 9·719555 | 20 102 | 10·280445 | 10·052731 | 20 22 | 9·947269 | 20 | 20 |
| 30 | 42 | 9·666944 | 21 84 | 10·333056 | 9·719708 | 21 108 | 10·280292 | 10·052764 | 21 23 | 9·947236 | 18 | 30 |
| 41 | 44 | 9·667065 | 22 88 | 10·332935 | 9·719862 | 22 113 | 10·280138 | 10·052797 | 22 24 | 9·947203 | 16 | 19 |
| 30 | 46 | 9·667185 | 23 92 | 10·332815 | 9·720016 | 23 118 | 10·279984 | 10·052830 | 23 25 | 9·947170 | 14 | 30 |
| 42 | 48 | 9·667305 | 24 96 | 10·332695 | 9·720169 | 24 123 | 10·279831 | 10·052864 | 24 26 | 9·947136 | 12 | 18 |
| 30 | 50 | 9·667426 | 25 101 | 10·332574 | 9·720322 | 25 128 | 10·279678 | 10·052897 | 25 28 | 9·947103 | 10 | 30 |
| 43 | 52 | 9·667546 | 26 105 | 10·332454 | 9·720476 | 26 133 | 10·279524 | 10·052930 | 26 29 | 9·947070 | 8 | 17 |
| 30 | 54 | 9·667666 | 27 109 | 10·332334 | 9·720629 | 27 138 | 10·279371 | 10·052963 | 27 30 | 9·947037 | 6 | 30 |
| 44 | 56 | 9·667786 | 28 113 | 10·332214 | 9·720783 | 28 143 | 10·279217 | 10·052996 | 28 31 | 9·947004 | 4 | 16 |
| 30 | 58 | 9·667906 | 29 117 | 10·332094 | 9·720936 | 29 148 | 10·279064 | 10·053030 | 29 32 | 9·946970 | 2 | 30 |
| 45 | 51 | 9·668027 | 30 121 | 10·331973 | 9·721089 | 30 154 | 10·278911 | 10·053063 | 30 33 | 9·946937 | 9 | 15 |
| 30 | 2 | 9·668147 | 1 4 | 10·331853 | 9·721243 | 1 5 | 10·278757 | 10·053096 | 1 1 | 9·946904 | 58 | 30 |
| 46 | 4 | 9·668267 | 2 8 | 10·331733 | 9·721396 | 2 10 | 10·278604 | 10·053129 | 2 2 | 9·946871 | 56 | 14 |
| 30 | 6 | 9·668386 | 3 12 | 10·331614 | 9·721549 | 3 15 | 10·278451 | 10·053163 | 3 3 | 9·946837 | 54 | 30 |
| 47 | 8 | 9·668506 | 4 16 | 10·331494 | 9·721702 | 4 20 | 10·278298 | 10·053196 | 4 4 | 9·946804 | 52 | 13 |
| 30 | 10 | 9·668626 | 5 20 | 10·331374 | 9·721855 | 5 25 | 10·278145 | 10·053229 | 5 6 | 9·946771 | 50 | 30 |
| 48 | 12 | 9·668746 | 6 24 | 10·331254 | 9·722009 | 6 30 | 10·277991 | 10·053262 | 6 7 | 9·946738 | 48 | 12 |
| 30 | 14 | 9·668866 | 7 28 | 10·331134 | 9·722162 | 7 36 | 10·277838 | 10·053296 | 7 8 | 9·946704 | 46 | 30 |
| 49 | 16 | 9·668986 | 8 32 | 10·331014 | 9·722315 | 8 41 | 10·277685 | 10·053329 | 8 9 | 9·946671 | 44 | 11 |
| 30 | 18 | 9·669105 | 9 36 | 10·330895 | 9·722468 | 9 46 | 10·277532 | 10·053362 | 9 10 | 9·946638 | 42 | 30 |
| 50 | 20 | 9·669225 | 10 40 | 10·330775 | 9·722621 | 10 51 | 10·277379 | 10·053396 | 10 11 | 9·946604 | 40 | 10 |
| 30 | 22 | 9·669345 | 11 44 | 10·330655 | 9·722774 | 11 56 | 10·277226 | 10·053429 | 11 12 | 9·946571 | 38 | 30 |
| 51 | 24 | 9·669464 | 12 48 | 10·330536 | 9·722927 | 12 61 | 10·277073 | 10·053462 | 12 13 | 9·946538 | 36 | 9 |
| 30 | 26 | 9·669584 | 13 52 | 10·330416 | 9·723080 | 13 66 | 10·276920 | 10·053496 | 13 14 | 9·946504 | 34 | 30 |
| 52 | 28 | 9·669703 | 14 56 | 10·330297 | 9·723232 | 14 71 | 10·276768 | 10·053529 | 14 16 | 9·946471 | 32 | 8 |
| 30 | 30 | 9·669823 | 15 60 | 10·330177 | 9·723385 | 15 76 | 10·276615 | 10·053563 | 15 17 | 9·946437 | 30 | 30 |
| 53 | 32 | 9·669942 | 16 64 | 10·330058 | 9·723538 | 16 81 | 10·276462 | 10·053596 | 16 18 | 9·946404 | 28 | 7 |
| 30 | 34 | 9·670061 | 17 68 | 10·329939 | 9·723691 | 17 87 | 10·276309 | 10·053629 | 17 19 | 9·946371 | 26 | 30 |
| 54 | 36 | 9·670181 | 18 72 | 10·329819 | 9·723844 | 18 92 | 10·276156 | 10·053663 | 18 20 | 9·946337 | 24 | 6 |
| 30 | 38 | 9·670300 | 19 76 | 10·329700 | 9·723996 | 19 97 | 10·276004 | 10·053696 | 19 21 | 9·946304 | 22 | 30 |
| 55 | 40 | 9·670419 | 20 80 | 10·329581 | 9·724149 | 20 102 | 10·275851 | 10·053730 | 20 22 | 9·946270 | 20 | 5 |
| 30 | 42 | 9·670538 | 21 84 | 10·329462 | 9·724302 | 21 107 | 10·275698 | 10·053763 | 21 23 | 9·946237 | 18 | 30 |
| 56 | 44 | 9·670658 | 22 88 | 10·329342 | 9·724454 | 22 112 | 10·275546 | 10·053797 | 22 24 | 9·946203 | 16 | 4 |
| 30 | 46 | 9·670777 | 23 92 | 10·329223 | 9·724607 | 23 117 | 10·275393 | 10·053830 | 23 26 | 9·946170 | 14 | 30 |
| 57 | 48 | 9·670896 | 24 96 | 10·329104 | 9·724760 | 24 122 | 10·275240 | 10·053864 | 24 27 | 9·946136 | 12 | 3 |
| 30 | 50 | 9·671015 | 25 100 | 10·328985 | 9·724912 | 25 127 | 10·275088 | 10·053897 | 25 28 | 9·946103 | 10 | 30 |
| 58 | 52 | 9·671134 | 26 104 | 10·328866 | 9·725065 | 26 132 | 10·274935 | 10·053931 | 26 29 | 9·946069 | 8 | 2 |
| 30 | 54 | 9·671253 | 27 107 | 10·328747 | 9·725217 | 27 137 | 10·274783 | 10·053964 | 27 30 | 9·946036 | 6 | 30 |
| 59 | 56 | 9·671372 | 28 111 | 10·328628 | 9·725370 | 28 143 | 10·274630 | 10·053998 | 28 31 | 9·946002 | 4 | 1 |
| 30 | 58 | 9·671490 | 29 115 | 10·328510 | 9·725522 | 29 148 | 10·274478 | 10·054031 | 29 32 | 9·945969 | 2 | 30 |
| 60 | 52 | 9·671609 | 30 119 | 10·328391 | 9·725674 | 30 153 | 10·274326 | 10·054065 | 30 33 | 9·945935 | 8 | 0 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

62° — 4ʰ 8ᵐ

## LOG. SINES, COSINES, &c.

1h 52m — 28° 

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 9·671609 | | 10·328391 | 9·725674 | | 10·274326 | 10·054065 | | 9·945935 | 0 | 60 |
| 30 | 2 | 9·671728 | 1″ 4 | 10·328272 | 9·725827 | 1″ 5 | 10·274173 | 10·054099 | 1″ 1 | 9·945901 | 58 | 30 |
| 1 | 4 | 9·671847 | 2 8 | 10·328153 | 9·725979 | 2 10 | 10·274021 | 10·054132 | 2 2 | 9·945868 | 56 | 59 |
| 30 | 6 | 9·671965 | 3 12 | 10·328035 | 9·726131 | 3 15 | 10·273869 | 10·054166 | 3 3 | 9·945834 | 54 | 30 |
| 2 | 8 | 9·672084 | 4 16 | 10·327916 | 9·726284 | 4 20 | 10·273716 | 10·054200 | 4 4 | 9·945800 | 52 | 58 |
| 30 | 10 | 9·672203 | 5 20 | 10·327797 | 9·726436 | 5 25 | 10·273564 | 10·054233 | 5 6 | 9·945767 | 50 | 30 |
| 3 | 12 | 9·672321 | 6 24 | 10·327679 | 9·726588 | 6 30 | 10·273412 | 10·054267 | 6 7 | 9·945733 | 48 | 57 |
| 30 | 14 | 9·672440 | 7 28 | 10·327560 | 9·726740 | 7 35 | 10·273260 | 10·054300 | 7 8 | 9·945700 | 46 | 30 |
| 4 | 16 | 9·672558 | 8 32 | 10·327442 | 9·726892 | 8 40 | 10·273108 | 10·054334 | 8 9 | 9·945666 | 44 | 56 |
| 30 | 18 | 9·672677 | 9 35 | 10·327323 | 9·727045 | 9 46 | 10·272955 | 10·054368 | 9 10 | 9·945632 | 42 | 30 |
| 5 | 20 | 9·672795 | 10 39 | 10·327205 | 9·727197 | 10 51 | 10·272803 | 10·054402 | 10 11 | 9·945598 | 40 | 55 |
| 30 | 22 | 9·672914 | 11 43 | 10·327086 | 9·727349 | 11 56 | 10·272651 | 10·054435 | 11 12 | 9·945565 | 38 | 30 |
| 6 | 24 | 9·673032 | 12 47 | 10·326968 | 9·727501 | 12 61 | 10·272499 | 10·054469 | 12 13 | 9·945531 | 36 | 54 |
| 30 | 26 | 9·673150 | 13 51 | 10·326850 | 9·727653 | 13 66 | 10·272347 | 10·054503 | 13 15 | 9·945497 | 34 | 30 |
| 7 | 28 | 9·673268 | 14 55 | 10·326732 | 9·727805 | 14 71 | 10·272195 | 10·054536 | 14 16 | 9·945464 | 32 | 53 |
| 30 | 30 | 9·673387 | 15 59 | 10·326613 | 9·727957 | 15 76 | 10·272043 | 10·054570 | 15 17 | 9·945430 | 30 | 30 |
| 8 | 32 | 9·673505 | 16 63 | 10·326495 | 9·728109 | 16 81 | 10·271891 | 10·054604 | 16 18 | 9·945396 | 28 | 52 |
| 30 | 34 | 9·673623 | 17 67 | 10·326377 | 9·728261 | 17 86 | 10·271739 | 10·054638 | 17 19 | 9·945362 | 26 | 30 |
| 9 | 36 | 9·673741 | 18 71 | 10·326259 | 9·728412 | 18 91 | 10·271588 | 10·054672 | 18 20 | 9·945328 | 24 | 51 |
| 30 | 38 | 9·673859 | 19 75 | 10·326141 | 9·728564 | 19 96 | 10·271436 | 10·054705 | 19 21 | 9·945295 | 22 | 30 |
| 10 | 40 | 9·673977 | 20 79 | 10·326023 | 9·728716 | 20 101 | 10·271284 | 10·054739 | 20 23 | 9·945261 | 20 | 50 |
| 30 | 42 | 9·674095 | 21 83 | 10·325905 | 9·728868 | 21 106 | 10·271132 | 10·054773 | 21 24 | 9·945227 | 18 | 30 |
| 11 | 44 | 9·674213 | 22 87 | 10·325787 | 9·729020 | 22 111 | 10·270980 | 10·054807 | 22 25 | 9·945193 | 16 | 49 |
| 30 | 46 | 9·674331 | 23 91 | 10·325669 | 9·729171 | 23 116 | 10·270829 | 10·054841 | 23 26 | 9·945159 | 14 | 30 |
| 12 | 48 | 9·674448 | 24 95 | 10·325552 | 9·729323 | 24 121 | 10·270677 | 10·054875 | 24 27 | 9·945125 | 12 | 48 |
| 30 | 50 | 9·674566 | 25 99 | 10·325434 | 9·729475 | 25 126 | 10·270525 | 10·054908 | 25 28 | 9·945092 | 10 | 30 |
| 13 | 52 | 9·674684 | 26 103 | 10·325316 | 9·729626 | 26 132 | 10·270374 | 10·054942 | 26 29 | 9·945058 | 8 | 47 |
| 30 | 54 | 9·674802 | 27 106 | 10·325198 | 9·729778 | 27 137 | 10·270222 | 10·054976 | 27 30 | 9·945024 | 6 | 30 |
| 14 | 56 | 9·674919 | 28 110 | 10·325081 | 9·729929 | 28 142 | 10·270071 | 10·055010 | 28 31 | 9·944990 | 4 | 46 |
| 30 | 58 | 9·675037 | 29 114 | 10·324963 | 9·730081 | 29 147 | 10·269919 | 10·055044 | 29 32 | 9·944956 | 2 | 30 |
| 15 | 52 | 9·675155 | 30 118 | 10·324845 | 9·730233 | 30 152 | 10·269767 | 10·055078 | 30 34 | 9·944922 | 7 | 45 |
| 30 | 2 | 9·675272 | 1 4 | 10·324728 | 9·730384 | 1 5 | 10·269616 | 10·055112 | 1 1 | 9·944888 | 58 | 30 |
| 16 | 4 | 9·675390 | 2 8 | 10·324610 | 9·730535 | 2 10 | 10·269465 | 10·055146 | 2 2 | 9·944854 | 56 | 44 |
| 30 | 6 | 9·675507 | 3 12 | 10·324493 | 9·730687 | 3 15 | 10·269313 | 10·055180 | 3 3 | 9·944820 | 54 | 30 |
| 17 | 8 | 9·675624 | 4 16 | 10·324376 | 9·730838 | 4 20 | 10·269162 | 10·055214 | 4 5 | 9·944786 | 52 | 43 |
| 30 | 10 | 9·675742 | 5 19 | 10·324258 | 9·730990 | 5 25 | 10·269010 | 10·055248 | 5 6 | 9·944752 | 50 | 30 |
| 18 | 12 | 9·675859 | 6 23 | 10·324141 | 9·731141 | 6 30 | 10·268859 | 10·055282 | 6 7 | 9·944718 | 48 | 42 |
| 30 | 14 | 9·675976 | 7 27 | 10·324024 | 9·731292 | 7 35 | 10·268708 | 10·055316 | 7 8 | 9·944684 | 46 | 30 |
| 19 | 16 | 9·676094 | 8 31 | 10·323906 | 9·731444 | 8 40 | 10·268556 | 10·055350 | 8 9 | 9·944650 | 44 | 41 |
| 30 | 18 | 9·676211 | 9 35 | 10·323789 | 9·731595 | 9 45 | 10·268405 | 10·055384 | 9 10 | 9·944616 | 42 | 30 |
| 20 | 20 | 9·676328 | 10 39 | 10·323672 | 9·731746 | 10 50 | 10·268254 | 10·055418 | 10 11 | 9·944582 | 40 | 40 |
| 30 | 22 | 9·676445 | 11 43 | 10·323555 | 9·731897 | 11 55 | 10·268103 | 10·055452 | 11 12 | 9·944548 | 38 | 30 |
| 21 | 24 | 9·676562 | 12 47 | 10·323438 | 9·732048 | 12 60 | 10·267952 | 10·055486 | 12 14 | 9·944514 | 36 | 39 |
| 30 | 26 | 9·676679 | 13 51 | 10·323321 | 9·732200 | 13 65 | 10·267800 | 10·055520 | 13 15 | 9·944480 | 34 | 30 |
| 22 | 28 | 9·676796 | 14 55 | 10·323204 | 9·732351 | 14 70 | 10·267649 | 10·055554 | 14 16 | 9·944446 | 32 | 38 |
| 30 | 30 | 9·676913 | 15 58 | 10·323087 | 9·732502 | 15 75 | 10·267498 | 10·055588 | 15 17 | 9·944412 | 30 | 30 |
| 23 | 32 | 9·677030 | 16 62 | 10·322970 | 9·732653 | 16 80 | 10·267347 | 10·055623 | 16 18 | 9·944377 | 28 | 37 |
| 30 | 34 | 9·677147 | 17 66 | 10·322853 | 9·732804 | 17 86 | 10·267196 | 10·055657 | 17 19 | 9·944343 | 26 | 30 |
| 24 | 36 | 9·677264 | 18 70 | 10·322736 | 9·732955 | 18 91 | 10·267045 | 10·055691 | 18 20 | 9·944309 | 24 | 36 |
| 30 | 38 | 9·677381 | 19 74 | 10·322619 | 9·733106 | 19 96 | 10·266894 | 10·055725 | 19 22 | 9·944275 | 22 | 30 |
| 25 | 40 | 9·677498 | 20 78 | 10·322502 | 9·733257 | 20 101 | 10·266743 | 10·055759 | 20 23 | 9·944241 | 20 | 35 |
| 30 | 42 | 9·677614 | 21 82 | 10·322386 | 9·733408 | 21 106 | 10·266592 | 10·055793 | 21 24 | 9·944207 | 18 | 30 |
| 26 | 44 | 9·677731 | 22 86 | 10·322269 | 9·733558 | 22 111 | 10·266442 | 10·055828 | 22 25 | 9·944172 | 16 | 34 |
| 30 | 46 | 9·677848 | 23 89 | 10·322152 | 9·733709 | 23 116 | 10·266291 | 10·055862 | 23 26 | 9·944138 | 14 | 30 |
| 27 | 48 | 9·677964 | 24 93 | 10·322036 | 9·733860 | 24 121 | 10·266140 | 10·055896 | 24 27 | 9·944104 | 12 | 33 |
| 30 | 50 | 9·678081 | 25 97 | 10·321919 | 9·734011 | 25 126 | 10·265989 | 10·055930 | 25 28 | 9·944070 | 10 | 30 |
| 28 | 52 | 9·678197 | 26 101 | 10·321803 | 9·734162 | 26 131 | 10·265838 | 10·055964 | 26 29 | 9·944036 | 8 | 32 |
| 30 | 54 | 9·678314 | 27 105 | 10·321686 | 9·734312 | 27 136 | 10·265688 | 10·055999 | 27 31 | 9·944001 | 6 | 30 |
| 29 | 56 | 9·678430 | 28 109 | 10·321570 | 9·734463 | 28 141 | 10·265537 | 10·056033 | 28 32 | 9·943967 | 4 | 31 |
| 30 | 58 | 9·678547 | 29 113 | 10·321453 | 9·734614 | 29 146 | 10·265386 | 10·056067 | 29 33 | 9·943933 | 2 | 30 |
| 30 | 54 | 9·678663 | 30 117 | 10·321337 | 9·734764 | 30 151 | 10·265236 | 10·056101 | 30 34 | 9·943899 | 0 | 30 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

61° — 4h 6m

## LOG. SINES, COSINES, &c.

1h 54m — 28°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 9·678663 | | 10·321337 | 9·734764 | | 10·265236 | 10·056101 | | 9·943899 | 6 | 30 |
| 30 | 2 | 9·678779 | 1″ 4 | 10·321221 | 9·734915 | 1″ 5 | 10·265085 | 10·056136 | 1″ 1 | 9·943864 | 58 | 30 |
| 31 | 4 | 9·678895 | 2 8 | 10·321105 | 9·735066 | 2 10 | 10·264934 | 10·056170 | 2 2 | 9·943830 | 56 | 29 |
| 30 | 6 | 9·679012 | 3 12 | 10·320988 | 9·735216 | 3 15 | 10·264784 | 10·056204 | 3 3 | 9·943796 | 54 | 30 |
| 32 | 8 | 9·679128 | 4 15 | 10·320872 | 9·735367 | 4 20 | 10·264633 | 10·056239 | 4 5 | 9·943761 | 52 | 28 |
| 30 | 10 | 9·679244 | 5 19 | 10·320756 | 9·735517 | 5 25 | 10·264483 | 10·056273 | 5 6 | 9·943727 | 50 | 30 |
| 33 | 12 | 9·679360 | 6 23 | 10·320640 | 9·735668 | 6 30 | 10·264332 | 10·056307 | 6 7 | 9·943693 | 48 | 27 |
| 30 | 14 | 9·679476 | 7 27 | 10·320524 | 9·735818 | 7 35 | 10·264182 | 10·056342 | 7 8 | 9·943658 | 46 | 30 |
| 34 | 16 | 9·679592 | 8 31 | 10·320408 | 9·735969 | 8 40 | 10·264031 | 10·056376 | 8 9 | 9·943624 | 44 | 26 |
| 30 | 18 | 9·679708 | 9 35 | 10·320292 | 9·736119 | 9 45 | 10·263881 | 10·056411 | 9 10 | 9·943589 | 42 | 30 |
| 35 | 20 | 9·679824 | 10 39 | 10·320176 | 9·736269 | 10 50 | 10·263731 | 10·056445 | 10 11 | 9·943555 | 40 | 25 |
| 30 | 22 | 9·679940 | 11 42 | 10·320060 | 9·736420 | 11 55 | 10·263580 | 10·056479 | 11 13 | 9·943521 | 38 | 30 |
| 36 | 24 | 9·680056 | 12 46 | 10·319944 | 9·736570 | 12 60 | 10·263430 | 10·056514 | 12 14 | 9·943486 | 36 | 24 |
| 30 | 26 | 9·680172 | 13 50 | 10·319828 | 9·736720 | 13 65 | 10·263280 | 10·056548 | 13 15 | 9·943452 | 34 | 30 |
| 37 | 28 | 9·680288 | 14 54 | 10·319712 | 9·736870 | 14 70 | 10·263130 | 10·056583 | 14 16 | 9·943417 | 32 | 23 |
| 30 | 30 | 9·680403 | 15 58 | 10·319597 | 9·737021 | 15 75 | 10·262979 | 10·056617 | 15 17 | 9·943383 | 30 | 30 |
| 38 | 32 | 9·680519 | 16 62 | 10·319481 | 9·737171 | 16 80 | 10·262829 | 10·056652 | 16 18 | 9·943348 | 28 | 22 |
| 30 | 34 | 9·680635 | 17 66 | 10·319365 | 9·737321 | 17 85 | 10·262679 | 10·056686 | 17 20 | 9·943314 | 26 | 30 |
| 39 | 36 | 9·680750 | 18 69 | 10·319250 | 9·737471 | 18 90 | 10·262529 | 10·056721 | 18 21 | 9·943279 | 24 | 21 |
| 30 | 38 | 9·680866 | 19 73 | 10·319134 | 9·737621 | 19 95 | 10·262379 | 10·056755 | 19 22 | 9·943245 | 22 | 30 |
| 40 | 40 | 9·680982 | 20 77 | 10·319018 | 9·737771 | 20 100 | 10·262229 | 10·056790 | 20 23 | 9·943210 | 20 | 20 |
| 30 | 42 | 9·681097 | 21 81 | 10·318903 | 9·737921 | 21 105 | 10·262079 | 10·056824 | 21 24 | 9·943176 | 18 | 30 |
| 41 | 44 | 9·681213 | 22 85 | 10·318787 | 9·738071 | 22 110 | 10·261929 | 10·056859 | 22 25 | 9·943141 | 16 | 19 |
| 30 | 46 | 9·681328 | 23 89 | 10·318672 | 9·738221 | 23 115 | 10·261779 | 10·056893 | 23 26 | 9·943107 | 14 | 30 |
| 42 | 48 | 9·681443 | 24 93 | 10·318557 | 9·738371 | 24 120 | 10·261629 | 10·056928 | 24 28 | 9·943072 | 12 | 18 |
| 30 | 50 | 9·681559 | 25 97 | 10·318441 | 9·738521 | 25 125 | 10·261479 | 10·056963 | 25 29 | 9·943037 | 10 | 30 |
| 43 | 52 | 9·681674 | 26 100 | 10·318326 | 9·738671 | 26 130 | 10·261329 | 10·056997 | 26 30 | 9·943003 | 8 | 17 |
| 30 | 54 | 9·681789 | 27 104 | 10·318211 | 9·738821 | 27 135 | 10·261179 | 10·057032 | 27 31 | 9·942968 | 6 | 30 |
| 44 | 56 | 9·681905 | 28 108 | 10·318095 | 9·738971 | 28 140 | 10·261029 | 10·057066 | 28 32 | 9·942934 | 4 | 16 |
| 30 | 58 | 9·682020 | 29 112 | 10·317980 | 9·739121 | 29 145 | 10·260879 | 10·057101 | 29 33 | 9·942899 | 2 | 30 |
| 45 | 55 | 9·682135 | 30 116 | 10·317865 | 9·739271 | 30 150 | 10·260729 | 10·057136 | 30 34 | 9·942864 | 5 | 15 |
| 30 | 2 | 9·682250 | 1 4 | 10·317750 | 9·739420 | 1 5 | 10·260580 | 10·057170 | 1 1 | 9·942830 | 58 | 30 |
| 46 | 4 | 9·682365 | 2 8 | 10·317635 | 9·739570 | 2 10 | 10·260430 | 10·057205 | 2 2 | 9·942795 | 56 | 14 |
| 30 | 6 | 9·682480 | 3 11 | 10·317520 | 9·739720 | 3 15 | 10·260280 | 10·057240 | 3 3 | 9·942760 | 54 | 30 |
| 47 | 8 | 9·682595 | 4 15 | 10·317405 | 9·739870 | 4 20 | 10·260130 | 10·057274 | 4 5 | 9·942726 | 52 | 13 |
| 30 | 10 | 9·682[illegible]10 | 5 19 | 10·317290 | 9·740019 | 5 25 | 10·259981 | 10·057309 | 5 6 | 9·942691 | 50 | 30 |
| 48 | 12 | 9·682825 | 6 23 | 10·317175 | 9·740169 | 6 30 | 10·259831 | 10·057344 | 6 7 | 9·942656 | 48 | 12 |
| 30 | 14 | 9·682940 | 7 27 | 10·317060 | 9·740319 | 7 35 | 10·259681 | 10·057379 | 7 8 | 9·942621 | 46 | 30 |
| 49 | 16 | 9·683055 | 8 31 | 10·316945 | 9·740468 | 8 40 | 10·259532 | 10·057413 | 8 9 | 9·942587 | 44 | 11 |
| 30 | 18 | 9·683170 | 9 34 | 10·316830 | 9·740618 | 9 45 | 10·259382 | 10·057448 | 9 10 | 9·942552 | 42 | 30 |
| 50 | 20 | 9·683284 | 10 38 | 10·316716 | 9·740767 | 10 50 | 10·259233 | 10·057483 | 10 11 | 9·942517 | 40 | 10 |
| 30 | 22 | 9·683399 | 11 42 | 10·316601 | 9·740917 | 11 55 | 10·259083 | 10·057518 | 11 13 | 9·942482 | 38 | 30 |
| 51 | 24 | 9·683514 | 12 46 | 10·316486 | 9·741066 | 12 60 | 10·258934 | 10·057552 | 12 14 | 9·942448 | 36 | 9 |
| 30 | 26 | 9·683628 | 13 50 | 10·316372 | 9·741216 | 13 65 | 10·258784 | 10·057587 | 13 15 | 9·942413 | 34 | 30 |
| 52 | 28 | 9·683743 | 14 54 | 10·316257 | 9·741365 | 14 70 | 10·258635 | 10·057622 | 14 16 | 9·942378 | 32 | 8 |
| 30 | 30 | 9·683858 | 15 57 | 10·316142 | 9·741514 | 15 75 | 10·258486 | 10·057657 | 15 17 | 9·942343 | 30 | 30 |
| 53 | 32 | 9·683972 | 16 61 | 10·316028 | 9·741664 | 16 80 | 10·258336 | 10·057692 | 16 19 | 9·942308 | 28 | 7 |
| 30 | 34 | 9·684087 | 17 65 | 10·315913 | 9·741813 | 17 85 | 10·258187 | 10·057727 | 17 20 | 9·942273 | 26 | 30 |
| 54 | 36 | 9·684201 | 18 69 | 10·315799 | 9·741962 | 18 90 | 10·258038 | 10·057761 | 18 21 | 9·942239 | 24 | 6 |
| 30 | 38 | 9·684315 | 19 73 | 10·315685 | 9·742112 | 19 95 | 10·257888 | 10·057796 | 19 22 | 9·942204 | 22 | 30 |
| 55 | 40 | 9·684430 | 20 76 | 10·315570 | 9·742261 | 20 100 | 10·257739 | 10·057831 | 20 23 | 9·942169 | 20 | 5 |
| 30 | 42 | 9·684544 | 21 80 | 10·315456 | 9·742410 | 21 105 | 10·257590 | 10·057866 | 21 24 | 9·942134 | 18 | 30 |
| 56 | 44 | 9·684658 | 22 84 | 10·315342 | 9·742559 | 22 110 | 10·257441 | 10·057901 | 22 26 | 9·942099 | 16 | 4 |
| 30 | 46 | 9·684773 | 23 88 | 10·315227 | 9·742709 | 23 115 | 10·257291 | 10·057936 | 23 27 | 9·942064 | 14 | 30 |
| 57 | 48 | 9·684887 | 24 92 | 10·315113 | 9·742858 | 24 120 | 10·257142 | 10·057971 | 24 28 | 9·942029 | 12 | 3 |
| 30 | 50 | 9·685001 | 25 96 | 10·314999 | 9·743007 | 25 124 | 10·256993 | 10·058006 | 25 29 | 9·941994 | 10 | 30 |
| 58 | 52 | 9·685115 | 26 100 | 10·314885 | 9·743156 | 26 129 | 10·256844 | 10·058041 | 26 30 | 9·941959 | 8 | 2 |
| 30 | 54 | 9·685229 | 27 103 | 10·3147[illegible]1 | 9·743305 | 27 134 | 10·256695 | 10·058076 | 27 31 | 9·941924 | 6 | 30 |
| 59 | 56 | 9·685343 | 28 107 | 10·314657 | 9·743454 | 28 139 | 10·256546 | 10·058111 | 28 32 | 9·941889 | 4 | 1 |
| 30 | 58 | 9·685457 | 29 111 | 10·314543 | 9·743603 | 29 144 | 10·256397 | 10·058146 | 29 34 | 9·941854 | 2 | 30 |
| 60 | 56 | 9·685571 | 30 115 | 10·314429 | 9·743752 | 30 149 | 10·256248 | 10·058181 | 30 35 | 9·941819 | 0 | 0 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

61° — 4h 4m

## LOG. SINES, COSINES, &c.

1h 56m — 30°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 9·685571 | | 10·314429 | 9·743752 | | 10·256248 | 10·058181 | | 9·941819 | 4 | 60 |
| 30 | 2 | 9·685685 | 1″ 4 | 10·314315 | 9·743901 | 1″ 5 | 10·256099 | 10·058216 | 1″ 1 | 9·941784 | 58 | 30 |
| 1 | 4 | 9·685799 | 2 8 | 10·314201 | 9·744050 | 2 10 | 10·255950 | 10·058251 | 2 2 | 9·941749 | 56 | 59 |
| 30 | 6 | 9·685913 | 3 11 | 10·314087 | 9·744199 | 3 15 | 10·255801 | 10·058286 | 3 4 | 9·941714 | 54 | 30 |
| 2 | 8 | 9·686027 | 4 15 | 10·313973 | 9·744348 | 4 20 | 10·255652 | 10·058321 | 4 5 | 9·941679 | 52 | 58 |
| 30 | 10 | 9·686141 | 5 19 | 10·313859 | 9·744496 | 5 25 | 10·255504 | 10·058356 | 5 6 | 9·941644 | 50 | 30 |
| 3 | 12 | 9·686254 | 6 23 | 10·313746 | 9·744645 | 6 30 | 10·255355 | 10·058391 | 6 7 | 9·941609 | 48 | 57 |
| 30 | 14 | 9·686368 | 7 26 | 10·313632 | 9·744794 | 7 35 | 10·255206 | 10·058426 | 7 8 | 9·941574 | 46 | 30 |
| 4 | 16 | 9·686482 | 8 30 | 10·313518 | 9·744943 | 8 40 | 10·255057 | 10·058461 | 8 9 | 9·941539 | 44 | 56 |
| 30 | 18 | 9·686595 | 9 34 | 10·313405 | 9·745092 | 9 45 | 10·254908 | 10·058496 | 9 11 | 9·941504 | 42 | 30 |
| 5 | 20 | 9·686709 | 10 38 | 10·313291 | 9·745240 | 10 49 | 10·254760 | 10·058531 | 10 12 | 9·941469 | 40 | 55 |
| 30 | 22 | 9·686822 | 11 42 | 10·313178 | 9·745389 | 11 54 | 10·254611 | 10·058567 | 11 13 | 9·941433 | 38 | 30 |
| 6 | 24 | 9·686936 | 12 46 | 10·313064 | 9·745538 | 12 59 | 10·254462 | 10·058602 | 12 14 | 9·941398 | 36 | 54 |
| 30 | 26 | 9·687049 | 13 49 | 10·312951 | 9·745686 | 13 64 | 10·254314 | 10·058637 | 13 15 | 9·941363 | 34 | 30 |
| 7 | 28 | 9·687163 | 14 53 | 10·312837 | 9·745835 | 14 69 | 10·254165 | 10·058672 | 14 16 | 9·941328 | 32 | 53 |
| 30 | 30 | 9·687276 | 15 57 | 10·312724 | 9·745983 | 15 74 | 10·254017 | 10·058707 | 15 18 | 9·941293 | 30 | 30 |
| 8 | 32 | 9·687389 | 16 61 | 10·312611 | 9·746132 | 16 79 | 10·253868 | 10·058742 | 16 19 | 9·941258 | 28 | 52 |
| 30 | 34 | 9·687503 | 17 64 | 10·312497 | 9·746281 | 17 84 | 10·253719 | 10·058778 | 17 20 | 9·941222 | 26 | 30 |
| 9 | 36 | 9·687616 | 18 68 | 10·312384 | 9·746429 | 18 89 | 10·253571 | 10·058813 | 18 21 | 9·941187 | 24 | 51 |
| 30 | 38 | 9·687729 | 19 72 | 10·312271 | 9·746577 | 19 94 | 10·253423 | 10·058848 | 19 22 | 9·941152 | 22 | 30 |
| 10 | 40 | 9·687843 | 20 76 | 10·312157 | 9·746726 | 20 99 | 10·253274 | 10·058883 | 20 23 | 9·941117 | 20 | 50 |
| 30 | 42 | 9·687956 | 21 79 | 10·312044 | 9·746874 | 21 104 | 10·253126 | 10·058919 | 21 25 | 9·941081 | 18 | 30 |
| 11 | 44 | 9·688069 | 22 83 | 10·311931 | 9·747023 | 22 109 | 10·252977 | 10·058954 | 22 26 | 9·941046 | 16 | 49 |
| 30 | 46 | 9·688182 | 23 87 | 10·311818 | 9·747171 | 23 114 | 10·252829 | 10·058989 | 23 27 | 9·941011 | 14 | 30 |
| 12 | 48 | 9·688295 | 24 91 | 10·311705 | 9·747319 | 24 119 | 10·252681 | 10·059025 | 24 28 | 9·940975 | 12 | 48 |
| 30 | 50 | 9·688408 | 25 95 | 10·311592 | 9·747468 | 25 124 | 10·252532 | 10·059060 | 25 29 | 9·940940 | 10 | 30 |
| 13 | 52 | 9·688521 | 26 98 | 10·311479 | 9·747616 | 26 129 | 10·252384 | 10·059095 | 26 30 | 9·940905 | 8 | 47 |
| 30 | 54 | 9·688634 | 27 102 | 10·311366 | 9·747764 | 27 134 | 10·252236 | 10·059130 | 27 32 | 9·940870 | 6 | 30 |
| 14 | 56 | 9·688747 | 28 106 | 10·311253 | 9·747913 | 28 139 | 10·252087 | 10·059166 | 28 33 | 9·940834 | 4 | 46 |
| 30 | 58 | 9·688860 | 29 110 | 10·311140 | 9·748061 | 29 144 | 10·251939 | 10·059201 | 29 34 | 9·940799 | 2 | 30 |
| 15 | 57 | 9·688972 | 30 113 | 10·311028 | 9·748209 | 30 148 | 10·251791 | 10·059237 | 30 35 | 9·940763 | 3 | 45 |
| 30 | 2 | 9·689085 | 1 4 | 10·310915 | 9·748357 | 1 5 | 10·251643 | 10·059272 | 1 1 | 9·940728 | 58 | 30 |
| 16 | 4 | 9·689198 | 2 7 | 10·310802 | 9·748505 | 2 10 | 10·251495 | 10·059307 | 2 2 | 9·940693 | 56 | 44 |
| 30 | 6 | 9·689311 | 3 11 | 10·310689 | 9·748653 | 3 15 | 10·251347 | 10·059343 | 3 4 | 9·940657 | 54 | 30 |
| 17 | 8 | 9·689423 | 4 15 | 10·310577 | 9·748801 | 4 20 | 10·251199 | 10·059378 | 4 5 | 9·940622 | 52 | 43 |
| 30 | 10 | 9·689536 | 5 19 | 10·310464 | 9·748949 | 5 25 | 10·251051 | 10·059414 | 5 6 | 9·940586 | 50 | 30 |
| 18 | 12 | 9·689648 | 6 22 | 10·310352 | 9·749097 | 6 30 | 10·250903 | 10·059449 | 6 7 | 9·940551 | 48 | 42 |
| 30 | 14 | 9·689761 | 7 26 | 10·310239 | 9·749245 | 7 34 | 10·250755 | 10·059484 | 7 8 | 9·940516 | 46 | 30 |
| 19 | 16 | 9·689873 | 8 30 | 10·310127 | 9·749393 | 8 39 | 10·250607 | 10·059520 | 8 9 | 9·940480 | 44 | 41 |
| 30 | 18 | 9·689986 | 9 34 | 10·310014 | 9·749541 | 9 44 | 10·250459 | 10·059555 | 9 11 | 9·940445 | 42 | 30 |
| 20 | 20 | 9·690098 | 10 37 | 10·309902 | 9·749689 | 10 49 | 10·250311 | 10·059591 | 10 12 | 9·940409 | 40 | 40 |
| 30 | 22 | 9·690211 | 11 41 | 10·309789 | 9·749837 | 11 54 | 10·250163 | 10·059626 | 11 13 | 9·940374 | 38 | 30 |
| 21 | 24 | 9·690323 | 12 45 | 10·309677 | 9·749985 | 12 59 | 10·250015 | 10·059662 | 12 14 | 9·940338 | 36 | 39 |
| 30 | 26 | 9·690435 | 13 49 | 10·309565 | 9·750133 | 13 64 | 10·249867 | 10·059697 | 13 15 | 9·940303 | 34 | 30 |
| 22 | 28 | 9·690548 | 14 52 | 10·309452 | 9·750281 | 14 69 | 10·249719 | 10·059733 | 14 17 | 9·940267 | 32 | 38 |
| 30 | 30 | 9·690660 | 15 56 | 10·309340 | 9·750428 | 15 74 | 10·249572 | 10·059769 | 15 18 | 9·940231 | 30 | 30 |
| 23 | 32 | 9·690772 | 16 60 | 10·309228 | 9·750576 | 16 79 | 10·249424 | 10·059804 | 16 19 | 9·940196 | 28 | 37 |
| 30 | 34 | 9·690884 | 17 64 | 10·309116 | 9·750724 | 17 84 | 10·249276 | 10·059840 | 17 20 | 9·940160 | 26 | 30 |
| 24 | 36 | 9·690996 | 18 67 | 10·309004 | 9·750872 | 18 89 | 10·249128 | 10·059875 | 18 21 | 9·940125 | 24 | 36 |
| 30 | 38 | 9·691108 | 19 71 | 10·308892 | 9·751019 | 19 93 | 10·248981 | 10·059911 | 19 22 | 9·940089 | 22 | 30 |
| 25 | 40 | 9·691220 | 20 75 | 10·308780 | 9·751167 | 20 98 | 10·248833 | 10·059946 | 20 24 | 9·940054 | 20 | 35 |
| 30 | 42 | 9·691332 | 21 79 | 10·308668 | 9·751315 | 21 103 | 10·248685 | 10·059982 | 21 25 | 9·940018 | 18 | 30 |
| 26 | 44 | 9·691444 | 22 82 | 10·308556 | 9·751462 | 22 108 | 10·248538 | 10·060018 | 22 26 | 9·939982 | 16 | 34 |
| 30 | 46 | 9·691556 | 23 86 | 10·308444 | 9·751610 | 23 113 | 10·248390 | 10·060053 | 23 27 | 9·939947 | 14 | 30 |
| 27 | 48 | 9·691668 | 24 90 | 10·308332 | 9·751757 | 24 118 | 10·248243 | 10·060089 | 24 28 | 9·939911 | 12 | 33 |
| 30 | 50 | 9·691780 | 25 94 | 10·308220 | 9·751905 | 25 123 | 10·248095 | 10·060125 | 25 30 | 9·939875 | 10 | 30 |
| 28 | 52 | 9·691892 | 26 98 | 10·308108 | 9·752052 | 26 128 | 10·247948 | 10·060160 | 26 31 | 9·939840 | 8 | 32 |
| 30 | 54 | 9·692004 | 27 101 | 10·307996 | 9·752200 | 27 133 | 10·247800 | 10·060196 | 27 32 | 9·939804 | 6 | 30 |
| 29 | 56 | 9·692115 | 28 105 | 10·307885 | 9·752347 | 28 138 | 10·247653 | 10·060232 | 28 33 | 9·939768 | 4 | 31 |
| 30 | 58 | 9·692227 | 29 108 | 10·307773 | 9·752495 | 29 143 | 10·247505 | 10·060267 | 29 34 | 9·939733 | 2 | 30 |
| 30 | 58 | 9·692339 | 30 112 | 10·307661 | 9·752642 | 30 148 | 10·247358 | 10·060303 | 30 36 | 9·939697 | 0 | 30 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

60° — 4h 2m

## LOG. SINES. COSINES. &c.

1h 58m 29°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 9·692339 | | 10·307661 | 9·752642 | | 10·247358 | 10·060303 | | 9·939697 | 2 | 30 |
| 30 | 2 | 9·692450 | 1″ 4 | 10·307550 | 9·752789 | 1″ 5 | 10·247211 | 10·060339 | 1″ 1 | 9·939661 | 58 | 30 |
| 31 | 4 | 9·692562 | 2 7 | 10·307438 | 9·752937 | 2 10 | 10·247063 | 10·060375 | 2 2 | 9·939625 | 56 | 29 |
| 30 | 6 | 9·692674 | 3 11 | 10·307326 | 9·753084 | 3 15 | 10·246916 | 10·060410 | 3 4 | 9·939590 | 54 | 30 |
| 32 | 8 | 9·692785 | 4 15 | 10·307215 | 9·753231 | 4 20 | 10·246769 | 10·060446 | 4 5 | 9·939554 | 52 | 28 |
| 30 | 10 | 9·692897 | 5 18 | 10·307103 | 9·753379 | 5 25 | 10·246621 | 10·060482 | 5 6 | 9·939518 | 50 | 30 |
| 33 | 12 | 9·693008 | 6 22 | 10·306992 | 9·753526 | 6 29 | 10·246474 | 10·060518 | 6 7 | 9·939482 | 48 | 27 |
| 30 | 14 | 9·693119 | 7 26 | 10·306881 | 9·753673 | 7 34 | 10·246327 | 10·060554 | 7 8 | 9·939446 | 46 | 30 |
| 34 | 16 | 9·693231 | 8 30 | 10·306769 | 9·753820 | 8 39 | 10·246180 | 10·060590 | 8 10 | 9·939410 | 44 | 26 |
| 30 | 18 | 9·693342 | 9 33 | 10·306658 | 9·753967 | 9 44 | 10·246033 | 10·060625 | 9 11 | 9·939375 | 42 | 30 |
| 35 | 20 | 9·693453 | 10 37 | 10·306547 | 9·754115 | 10 49 | 10·245885 | 10·060661 | 10 12 | 9·939339 | 40 | 25 |
| 30 | 22 | 9·693565 | 11 41 | 10·306435 | 9·754262 | 11 54 | 10·245738 | 10·060697 | 11 13 | 9·939303 | 38 | 30 |
| 36 | 24 | 9·693676 | 12 44 | 10·306324 | 9·754409 | 12 59 | 10·245591 | 10·060733 | 12 14 | 9·939267 | 36 | 24 |
| 30 | 26 | 9·693787 | 13 48 | 10·306213 | 9·754556 | 13 64 | 10·245444 | 10·060769 | 13 15 | 9·939231 | 34 | 30 |
| 37 | 28 | 9·693898 | 14 52 | 10·306102 | 9·754703 | 14 69 | 10·245297 | 10·060805 | 14 17 | 9·939195 | 32 | 23 |
| 30 | 30 | 9·694009 | 15 56 | 10·305991 | 9·754850 | 15 73 | 10·245150 | 10·060841 | 15 18 | 9·939159 | 30 | 30 |
| 38 | 32 | 9·694120 | 16 59 | 10·305880 | 9·754997 | 16 78 | 10·245003 | 10·060877 | 16 19 | 9·939123 | 28 | 22 |
| 30 | 34 | 9·694231 | 17 63 | 10·305769 | 9·755144 | 17 83 | 10·244856 | 10·060913 | 17 20 | 9·939087 | 26 | 30 |
| 39 | 36 | 9·694342 | 18 67 | 10·305658 | 9·755291 | 18 88 | 10·244709 | 10·060948 | 18 22 | 9·939052 | 24 | 21 |
| 30 | 38 | 9·694453 | 19 70 | 10·305547 | 9·755438 | 19 93 | 10·244562 | 10·060984 | 19 23 | 9·939016 | 22 | 30 |
| 40 | 40 | 9·694564 | 20 74 | 10·305436 | 9·755585 | 20 98 | 10·244415 | 10·061020 | 20 24 | 9·938980 | 20 | 20 |
| 30 | 42 | 9·694675 | 21 78 | 10·305325 | 9·755731 | 21 103 | 10·244269 | 10·061056 | 21 25 | 9·938944 | 18 | 30 |
| 41 | 44 | 9·694786 | 22 81 | 10·305214 | 9·755878 | 22 108 | 10·244122 | 10·061092 | 22 26 | 9·938908 | 16 | 19 |
| 30 | 46 | 9·694897 | 23 85 | 10·305103 | 9·756025 | 23 113 | 10·243975 | 10·061128 | 23 28 | 9·938872 | 14 | 30 |
| 42 | 48 | 9·695007 | 24 89 | 10·304993 | 9·756172 | 24 118 | 10·243828 | 10·061164 | 24 29 | 9·938836 | 12 | 18 |
| 30 | 50 | 9·695118 | 25 93 | 10·304882 | 9·756319 | 25 122 | 10·243681 | 10·061200 | 25 30 | 9·938800 | 10 | 30 |
| 43 | 52 | 9·695229 | 26 97 | 10·304771 | 9·756465 | 26 127 | 10·243535 | 10·061237 | 26 31 | 9·938763 | 8 | 17 |
| 30 | 54 | 9·695339 | 27 100 | 10·304661 | 9·756612 | 27 132 | 10·243388 | 10·061273 | 27 32 | 9·938727 | 6 | 30 |
| 44 | 56 | 9·695450 | 28 104 | 10·304550 | 9·756759 | 28 137 | 10·243241 | 10·061309 | 28 34 | 9·938691 | 4 | 16 |
| 30 | 58 | 9·695561 | 29 107 | 10·304439 | 9·756905 | 29 142 | 10·243095 | 10·061345 | 29 35 | 9·938655 | 2 | 30 |
| 45 | 59 | 9·695671 | 30 111 | 10·304329 | 9·757052 | 30 147 | 10·242948 | 10·061381 | 30 36 | 9·938619 | 1 | 15 |
| 30 | 2 | 9·695782 | 1 4 | 10·304218 | 9·757199 | 1 5 | 10·242801 | 10·061417 | 1 1 | 9·938583 | 58 | 30 |
| 46 | 4 | 9·695892 | 2 7 | 10·304108 | 9·757345 | 2 10 | 10·242655 | 10·061453 | 2 2 | 9·938547 | 56 | 14 |
| 30 | 6 | 9·696003 | 3 11 | 10·303997 | 9·757492 | 3 15 | 10·242508 | 10·061489 | 3 4 | 9·938511 | 54 | 30 |
| 47 | 8 | 9·696113 | 4 15 | 10·303887 | 9·757638 | 4 19 | 10·242362 | 10·061525 | 4 5 | 9·938475 | 52 | 13 |
| 30 | 10 | 9·696223 | 5 18 | 10·303777 | 9·757785 | 5 24 | 10·242215 | 10·061561 | 5 6 | 9·938439 | 50 | 30 |
| 48 | 12 | 9·696334 | 6 22 | 10·303666 | 9·757931 | 6 29 | 10·242069 | 10·061598 | 6 7 | 9·938402 | 48 | 12 |
| 30 | 14 | 9·696444 | 7 26 | 10·303556 | 9·758078 | 7 34 | 10·241922 | 10·061634 | 7 8 | 9·938366 | 46 | 30 |
| 49 | 16 | 9·696554 | 8 29 | 10·303446 | 9·758224 | 8 39 | 10·241776 | 10·061670 | 8 10 | 9·938330 | 44 | 11 |
| 30 | 18 | 9·696664 | 9 33 | 10·303336 | 9·758371 | 9 44 | 10·241629 | 10·061706 | 9 11 | 9·938294 | 42 | 30 |
| 50 | 20 | 9·696775 | 10 37 | 10·303225 | 9·758517 | 10 49 | 10·241483 | 10·061742 | 10 12 | 9·938258 | 40 | 10 |
| 30 | 22 | 9·696885 | 11 40 | 10·303115 | 9·758663 | 11 54 | 10·241337 | 10·061779 | 11 13 | 9·938221 | 38 | 30 |
| 51 | 24 | 9·696995 | 12 44 | 10·303005 | 9·758810 | 12 58 | 10·241190 | 10·061815 | 12 14 | 9·938185 | 36 | 9 |
| 30 | 26 | 9·697105 | 13 48 | 10·302895 | 9·758956 | 13 63 | 10·241044 | 10·061851 | 13 16 | 9·938149 | 34 | 30 |
| 52 | 28 | 9·697215 | 14 51 | 10·302785 | 9·759102 | 14 68 | 10·240898 | 10·061887 | 14 17 | 9·938113 | 32 | 8 |
| 30 | 30 | 9·697325 | 15 55 | 10·302675 | 9·759248 | 15 73 | 10·240752 | 10·061924 | 15 18 | 9·938076 | 30 | 30 |
| 53 | 32 | 9·697435 | 16 59 | 10·302565 | 9·759395 | 16 78 | 10·240605 | 10·061960 | 16 19 | 9·938040 | 28 | 7 |
| 30 | 34 | 9·697545 | 17 62 | 10·302455 | 9·759541 | 17 83 | 10·240459 | 10·061996 | 17 20 | 9·938004 | 26 | 30 |
| 54 | 36 | 9·697654 | 18 66 | 10·302346 | 9·759687 | 18 88 | 10·240313 | 10·062033 | 18 22 | 9·937967 | 24 | 6 |
| 30 | 38 | 9·697764 | 19 70 | 10·302236 | 9·759833 | 19 93 | 10·240167 | 10·062069 | 19 23 | 9·937931 | 22 | 30 |
| 55 | 40 | 9·697874 | 20 73 | 10·302126 | 9·759979 | 20 97 | 10·240021 | 10·062105 | 20 24 | 9·937895 | 20 | 5 |
| 30 | 42 | 9·697984 | 21 77 | 10·302016 | 9·760126 | 21 102 | 10·239874 | 10·062142 | 21 25 | 9·937858 | 18 | 30 |
| 56 | 44 | 9·698094 | 22 81 | 10·301906 | 9·760272 | 22 107 | 10·239728 | 10·062178 | 22 26 | 9·937822 | 16 | 4 |
| 30 | 46 | 9·698203 | 23 84 | 10·301797 | 9·760418 | 23 112 | 10·239582 | 10·062214 | 23 28 | 9·937786 | 14 | 30 |
| 57 | 48 | 9·698313 | 24 88 | 10·301687 | 9·760564 | 24 117 | 10·239436 | 10·062251 | 24 29 | 9·937749 | 12 | 3 |
| 30 | 50 | 9·698423 | 25 92 | 10·301577 | 9·760710 | 25 122 | 10·239290 | 10·062287 | 25 30 | 9·937713 | 10 | 30 |
| 58 | 52 | 9·698532 | 26 95 | 10·301468 | 9·760856 | 26 127 | 10·239144 | 10·062324 | 26 31 | 9·937676 | 8 | 2 |
| 30 | 54 | 9·698642 | 27 99 | 10·301358 | 9·761002 | 27 131 | 10·238998 | 10·062360 | 27 32 | 9·937640 | 6 | 30 |
| 59 | 56 | 9·698751 | 28 103 | 10·301249 | 9·761148 | 28 136 | 10·238852 | 10·062396 | 28 34 | 9·937604 | 4 | 1 |
| 30 | 58 | 9·698861 | 29 106 | 10·301139 | 9·761293 | 29 141 | 10·238707 | 10·062433 | 29 35 | 9·937567 | 2 | 30 |
| 60 | 60 | 9·698970 | 30 110 | 10·301030 | 9·761439 | 30 146 | 10·238561 | 10·062469 | 30 36 | 9·937531 | 0 | 0 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

60° 4h 0m

## LOG. SINES, COSINES, &c.

$2^h\ 0^m$ — 30°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 9·698970 | | 10·301030 | 9·761439 | | 10·238561 | 10·062469 | | 9·937531 | 60 | 60 |
| 30 | 2 | 9·699079 | 1″ 4 | 10·300921 | 9·761585 | 1″ 5 | 10·238415 | 10·062506 | 1″ 1 | 9·937494 | 58 | 30 |
| 1 | 4 | 9·699189 | 2 7 | 10·300811 | 9·761731 | 2 10 | 10·238269 | 10·062542 | 2 2 | 9·937458 | 56 | 59 |
| 30 | 6 | 9·699298 | 3 11 | 10·300702 | 9·761877 | 3 15 | 10·238123 | 10·062579 | 3 4 | 9·937421 | 54 | 30 |
| 2 | 8 | 9·699407 | 4 14 | 10·300593 | 9·762023 | 4 19 | 10·237977 | 10·062615 | 4 5 | 9·937385 | 52 | 58 |
| 30 | 10 | 9·699517 | 5 18 | 10·300483 | 9·762168 | 5 24 | 10·237832 | 10·062652 | 5 6 | 9·937348 | 50 | 30 |
| 3 | 12 | 9·699626 | 6 22 | 10·300374 | 9·762314 | 6 29 | 10·237686 | 10·062688 | 6 7 | 9·937312 | 48 | 57 |
| 30 | 14 | 9·699735 | 7 25 | 10·300265 | 9·762460 | 7 34 | 10·237540 | 10·062725 | 7 9 | 9·937275 | 46 | 30 |
| 4 | 16 | 9·699844 | 8 29 | 10·300156 | 9·762606 | 8 39 | 10·237394 | 10·062762 | 8 10 | 9·937238 | 44 | 56 |
| 30 | 18 | 9·699953 | 9 33 | 10·300047 | 9·762751 | 9 44 | 10·237249 | 10·062798 | 9 11 | 9·937202 | 42 | 30 |
| 5 | 20 | 9·700062 | 10 36 | 10·299938 | 9·762877 | 10 48 | 10·237103 | 10·062835 | 10 12 | 9·937165 | 40 | 55 |
| 30 | 22 | 9·700171 | 11 40 | 10·299829 | 9·763043 | 11 53 | 10·236957 | 10·062871 | 11 13 | 9·937129 | 38 | 30 |
| 6 | 24 | 9·700280 | 12 44 | 10·299720 | 9·763188 | 12 58 | 10·236812 | 10·062908 | 12 15 | 9·937092 | 36 | 54 |
| 30 | 26 | 9·700389 | 13 47 | 10·299611 | 9·763334 | 13 63 | 10·236666 | 10·062944 | 13 16 | 9·937056 | 34 | 30 |
| 7 | 28 | 9·700498 | 14 51 | 10·299502 | 9·763479 | 14 68 | 10·236521 | 10·062981 | 14 17 | 9·937019 | 32 | 53 |
| 30 | 30 | 9·700607 | 15 54 | 10·299393 | 9·763625 | 15 73 | 10·236375 | 10·063018 | 15 18 | 9·936982 | 30 | 30 |
| 8 | 32 | 9·700716 | 16 58 | 10·299284 | 9·763770 | 16 78 | 10·236230 | 10·063054 | 16 20 | 9·936946 | 28 | 52 |
| 30 | 34 | 9·700825 | 17 62 | 10·299175 | 9·763916 | 17 82 | 10·236084 | 10·063091 | 17 21 | 9·936909 | 26 | 30 |
| 9 | 36 | 9·700933 | 18 65 | 10·299067 | 9·764061 | 18 87 | 10·235939 | 10·063128 | 18 22 | 9·936872 | 24 | 51 |
| 30 | 38 | 9·701042 | 19 69 | 10·298958 | 9·764207 | 19 92 | 10·235793 | 10·063164 | 19 23 | 9·936836 | 22 | 30 |
| 10 | 40 | 9·701151 | 20 72 | 10·298849 | 9·764352 | 20 97 | 10·235648 | 10·063201 | 20 24 | 9·936799 | 20 | 50 |
| 30 | 42 | 9·701259 | 21 76 | 10·298741 | 9·764497 | 21 102 | 10·235503 | 10·063238 | 21 26 | 9·936762 | 18 | 30 |
| 11 | 44 | 9·701368 | 22 80 | 10·298632 | 9·764643 | 22 107 | 10·235357 | 10·063275 | 22 27 | 9·936725 | 16 | 49 |
| 30 | 46 | 9·701477 | 23 83 | 10·298523 | 9·764788 | 23 112 | 10·235212 | 10·063311 | 23 28 | 9·936689 | 14 | 30 |
| 12 | 48 | 9·701585 | 24 87 | 10·298415 | 9·764933 | 24 116 | 10·235067 | 10·063348 | 24 29 | 9·936652 | 12 | 48 |
| 30 | 50 | 9·701694 | 25 91 | 10·298306 | 9·765079 | 25 121 | 10·234921 | 10·063385 | 25 31 | 9·936615 | 10 | 30 |
| 13 | 52 | 9·701802 | 26 94 | 10·298198 | 9·765224 | 26 126 | 10·234776 | 10·063422 | 26 32 | 9·936578 | 8 | 47 |
| 30 | 54 | 9·701911 | 27 98 | 10·298089 | 9·765369 | 27 131 | 10·234631 | 10·063458 | 27 33 | 9·936542 | 6 | 30 |
| 14 | 56 | 9·702019 | 28 101 | 10·297981 | 9·765514 | 28 136 | 10·234486 | 10·063495 | 28 34 | 9·936505 | 4 | 46 |
| 30 | 58 | 9·702127 | 29 105 | 10·297873 | 9·765660 | 29 141 | 10·234340 | 10·063532 | 29 35 | 9·936468 | 2 | 30 |
| 15 | 1 | 9·702236 | 30 109 | 10·297764 | 9·765805 | 30 145 | 10·234195 | 10·063569 | 30 37 | 9·936431 | 59 | 45 |
| 30 | 2 | 9·702344 | 1 4 | 10·297656 | 9·765950 | 1 5 | 10·234050 | 10·063606 | 1 1 | 9·936394 | 58 | 30 |
| 16 | 4 | 9·702452 | 2 7 | 10·297548 | 9·766095 | 2 10 | 10·233905 | 10·063643 | 2 2 | 9·936357 | 56 | 44 |
| 30 | 6 | 9·702561 | 3 11 | 10·297439 | 9·766240 | 3 14 | 10·233760 | 10·063680 | 3 4 | 9·936320 | 54 | 30 |
| 17 | 8 | 9·702669 | 4 14 | 10·297331 | 9·766385 | 4 19 | 10·233615 | 10·063716 | 4 5 | 9·936284 | 52 | 43 |
| 30 | 10 | 9·702777 | 5 18 | 10·297223 | 9·766530 | 5 24 | 10·233470 | 10·063753 | 5 6 | 9·936247 | 50 | 30 |
| 18 | 12 | 9·702885 | 6 22 | 10·297115 | 9·766675 | 6 29 | 10·233325 | 10·063790 | 6 7 | 9·936210 | 48 | 42 |
| 30 | 14 | 9·702993 | 7 25 | 10·297007 | 9·766820 | 7 34 | 10·233180 | 10·063827 | 7 9 | 9·936173 | 46 | 30 |
| 19 | 16 | 9·703101 | 8 29 | 10·296899 | 9·766965 | 8 39 | 10·233035 | 10·063864 | 8 10 | 9·936136 | 44 | 41 |
| 30 | 18 | 9·703209 | 9 32 | 10·296791 | 9·767110 | 9 43 | 10·232890 | 10·063901 | 9 11 | 9·936099 | 42 | 30 |
| 20 | 20 | 9·703317 | 10 36 | 10·296683 | 9·767255 | 10 48 | 10·232745 | 10·063938 | 10 12 | 9·936062 | 40 | 40 |
| 30 | 22 | 9·703425 | 11 39 | 10·296575 | 9·767400 | 11 53 | 10·232600 | 10·063975 | 11 14 | 9·936025 | 38 | 30 |
| 21 | 24 | 9·703533 | 12 43 | 10·296467 | 9·767545 | 12 58 | 10·232455 | 10·064012 | 12 15 | 9·935988 | 36 | 39 |
| 30 | 26 | 9·703641 | 13 47 | 10·296359 | 9·767690 | 13 63 | 10·232310 | 10·064049 | 13 16 | 9·935951 | 34 | 30 |
| 22 | 28 | 9·703749 | 14 50 | 10·296251 | 9·767834 | 14 68 | 10·232166 | 10·064086 | 14 17 | 9·935914 | 32 | 38 |
| 30 | 30 | 9·703856 | 15 54 | 10·296144 | 9·767979 | 15 72 | 10·232021 | 10·064123 | 15 18 | 9·935877 | 30 | 30 |
| 23 | 32 | 9·703964 | 16 57 | 10·296036 | 9·768124 | 16 77 | 10·231876 | 10·064160 | 16 20 | 9·935840 | 28 | 37 |
| 30 | 34 | 9·704072 | 17 61 | 10·295028 | 9·768269 | 17 82 | 10·231731 | 10·064197 | 17 21 | 9·935803 | 26 | 30 |
| 24 | 36 | 9·704179 | 18 64 | 10·295821 | 9·768414 | 18 87 | 10·231586 | 10·064234 | 18 22 | 9·935766 | 24 | 36 |
| 30 | 38 | 9·704287 | 19 68 | 10·295713 | 9·768558 | 19 92 | 10·231442 | 10·064271 | 19 24 | 9·935729 | 22 | 30 |
| 25 | 40 | 9·704395 | 20 72 | 10·295605 | 9·768703 | 20 97 | 10·231297 | 10·064308 | 20 25 | 9·935692 | 20 | 35 |
| 30 | 42 | 9·704502 | 21 75 | 10·295498 | 9·768848 | 21 101 | 10·231152 | 10·064345 | 21 26 | 9·935655 | 18 | 30 |
| 26 | 44 | 9·704610 | 22 79 | 10·295390 | 9·768992 | 22 106 | 10·231008 | 10·064382 | 22 27 | 9·935618 | 16 | 34 |
| 30 | 46 | 9·704717 | 23 83 | 10·295283 | 9·769137 | 23 111 | 10·230863 | 10·064419 | 23 28 | 9·935581 | 14 | 30 |
| 27 | 48 | 9·704825 | 24 86 | 10·295175 | 9·769281 | 24 116 | 10·230719 | 10·064457 | 24 30 | 9·935543 | 12 | 33 |
| 30 | 50 | 9·704932 | 25 90 | 10·295068 | 9·769426 | 25 121 | 10·230574 | 10·064494 | 25 31 | 9·935506 | 10 | 30 |
| 28 | 52 | 9·705040 | 26 93 | 10·294960 | 9·769571 | 26 126 | 10·230429 | 10·064531 | 26 32 | 9·935469 | 8 | 32 |
| 30 | 54 | 9·705147 | 27 97 | 10·294853 | 9·769715 | 27 130 | 10·230285 | 10·064568 | 27 33 | 9·935432 | 6 | 30 |
| 29 | 56 | 9·705254 | 28 100 | 10·294746 | 9·769860 | 28 135 | 10·230140 | 10·064605 | 28 35 | 9·935395 | 4 | 31 |
| 30 | 58 | 9·705362 | 29 104 | 10·294638 | 9·770004 | 29 140 | 10·229996 | 10·064642 | 29 36 | 9·935358 | 2 | 30 |
| 30 | 2 | 9·705469 | 30 108 | 10·294531 | 9·770148 | 30 145 | 10·229852 | 10·064680 | 30 37 | 9·935320 | 0 | 30 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

59° — $3^h\ 58^m$

## LOG. SINES, COSINES, &c.

2h 2m — 30°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 9·705469 | | 10·294531 | 9·770148 | | 10·229852 | 10·064680 | | 9·935320 | 58 | 30 |
| 30 | 2 | 9·705576 | 1″ 4 | 10·294424 | 9·770293 | 1″ 5 | 10·229707 | 10·064717 | 1″ 1 | 9·935283 | 58 | 30 |
| 31 | 4 | 9·705683 | 2 7 | 10·294317 | 9·770437 | 2 10 | 10·229563 | 10·064754 | 2 2 | 9·935246 | 56 | 29 |
| 30 | 6 | 9·705790 | 3 11 | 10·294210 | 9·770582 | 3 14 | 10·229418 | 10·064791 | 3 4 | 9·935209 | 54 | 30 |
| 32 | 8 | 9·705898 | 4 14 | 10·294102 | 9·770726 | 4 19 | 10·229274 | 10·064829 | 4 5 | 9·935171 | 52 | 28 |
| 30 | 10 | 9·706005 | 5 18 | 10·293995 | 9·770870 | 5 24 | 10·229130 | 10·064866 | 5 6 | 9·935134 | 50 | 30 |
| 33 | 12 | 9·706112 | 6 21 | 10·293888 | 9·771015 | 6 29 | 10·228985 | 10·064903 | 6 7 | 9·935097 | 48 | 27 |
| 30 | 14 | 9·706219 | 7 25 | 10·293781 | 9·771159 | 7 34 | 10·228841 | 10·064940 | 7 9 | 9·935060 | 46 | 30 |
| 34 | 16 | 9·706326 | 8 28 | 10·293674 | 9·771303 | 8 38 | 10·228697 | 10·064978 | 8 10 | 9·935022 | 44 | 26 |
| 30 | 18 | 9·706433 | 9 32 | 10·293567 | 9·771448 | 9 43 | 10·228552 | 10·065015 | 9 11 | 9·934985 | 42 | 30 |
| 35 | 20 | 9·706539 | 10 36 | 10·293461 | 9·771592 | 10 48 | 10·228408 | 10·065052 | 10 12 | 9·934948 | 40 | 25 |
| 30 | 22 | 9·706646 | 11 39 | 10·293354 | 9·771736 | 11 53 | 10·228264 | 10·065090 | 11 14 | 9·934910 | 38 | 30 |
| 36 | 24 | 9·706753 | 12 43 | 10·293247 | 9·771880 | 12 58 | 10·228120 | 10·065127 | 12 15 | 9·934873 | 36 | 24 |
| 30 | 26 | 9·706860 | 13 46 | 10·293140 | 9·772024 | 13 62 | 10·227976 | 10·065164 | 13 16 | 9·934836 | 34 | 30 |
| 37 | 28 | 9·706967 | 14 50 | 10·293033 | 9·772168 | 14 67 | 10·227832 | 10·065202 | 14 17 | 9·934798 | 32 | 23 |
| 30 | 30 | 9·707073 | 15 53 | 10·292927 | 9·772312 | 15 72 | 10·227688 | 10·065239 | 15 19 | 9·934761 | 30 | 30 |
| 38 | 32 | 9·707180 | 16 57 | 10·292820 | 9·772457 | 16 77 | 10·227543 | 10·065277 | 16 20 | 9·934723 | 28 | 22 |
| 30 | 34 | 9·707287 | 17 61 | 10·292713 | 9·772601 | 17 82 | 10·227399 | 10·065314 | 17 21 | 9·934686 | 26 | 30 |
| 39 | 36 | 9·707393 | 18 64 | 10·292607 | 9·772745 | 18 86 | 10·227255 | 10·065351 | 18 22 | 9·934649 | 24 | 21 |
| 30 | 38 | 9·707500 | 19 68 | 10·292500 | 9·772889 | 19 91 | 10·227111 | 10·065389 | 19 24 | 9·934611 | 22 | 30 |
| 40 | 40 | 9·707606 | 20 71 | 10·292394 | 9·773033 | 20 96 | 10·226967 | 10·065426 | 20 25 | 9·934574 | 20 | 20 |
| 30 | 42 | 9·707713 | 21 75 | 10·292287 | 9·773177 | 21 101 | 10·226823 | 10·065464 | 21 26 | 9·934536 | 18 | 30 |
| 41 | 44 | 9·707819 | 22 78 | 10·292181 | 9·773321 | 22 106 | 10·226679 | 10·065501 | 22 27 | 9·934499 | 16 | 19 |
| 30 | 46 | 9·707926 | 23 82 | 10·292074 | 9·773465 | 23 110 | 10·226535 | 10·065539 | 23 29 | 9·934461 | 14 | 30 |
| 42 | 48 | 9·708032 | 24 85 | 10·291968 | 9·773608 | 24 115 | 10·226392 | 10·065576 | 24 30 | 9·934424 | 12 | 18 |
| 30 | 50 | 9·708139 | 25 89 | 10·291861 | 9·773752 | 25 120 | 10·226248 | 10·065614 | 25 31 | 9·934386 | 10 | 30 |
| 43 | 52 | 9·708245 | 26 92 | 10·291755 | 9·773896 | 26 125 | 10·226104 | 10·065651 | 26 32 | 9·934349 | 8 | 17 |
| 30 | 54 | 9·708351 | 27 96 | 10·291649 | 9·774040 | 27 130 | 10·225960 | 10·065689 | 27 34 | 9·934311 | 6 | 30 |
| 44 | 56 | 9·708458 | 28 99 | 10·291542 | 9·774184 | 28 134 | 10·225816 | 10·065726 | 28 35 | 9·934274 | 4 | 16 |
| 30 | 58 | 9·708564 | 29 103 | 10·291436 | 9·774328 | 29 139 | 10·225672 | 10·065764 | 29 36 | 9·934236 | 2 | 30 |
| 45 | 3 | 9·708670 | 30 107 | 10·291330 | 9·774471 | 30 144 | 10·225529 | 10·065801 | 30 37 | 9·934199 | 57 | 15 |
| 30 | 2 | 9·708776 | 1 4 | 10·291224 | 9·774615 | 1 5 | 10·225385 | 10·065839 | 1 1 | 9·934161 | 58 | 30 |
| 46 | 4 | 9·708882 | 2 7 | 10·291118 | 9·774759 | 2 10 | 10·225241 | 10·065877 | 2 3 | 9·934123 | 56 | 14 |
| 30 | 6 | 9·708988 | 3 11 | 10·291012 | 9·774902 | 3 14 | 10·225098 | 10·065914 | 3 4 | 9·934086 | 54 | 30 |
| 47 | 8 | 9·709094 | 4 14 | 10·290906 | 9·775046 | 4 19 | 10·224954 | 10·065952 | 4 5 | 9·934048 | 52 | 13 |
| 30 | 10 | 9·709200 | 5 18 | 10·290800 | 9·775190 | 5 24 | 10·224810 | 10·065989 | 5 6 | 9·934011 | 50 | 30 |
| 48 | 12 | 9·709306 | 6 21 | 10·290694 | 9·775333 | 6 29 | 10·224667 | 10·066027 | 6 8 | 9·933973 | 48 | 12 |
| 30 | 14 | 9·709412 | 7 25 | 10·290588 | 9·775477 | 7 33 | 10·224523 | 10·066065 | 7 9 | 9·933935 | 46 | 30 |
| 49 | 16 | 9·709518 | 8 28 | 10·290482 | 9·775621 | 8 38 | 10·224379 | 10·066102 | 8 10 | 9·933898 | 44 | 11 |
| 30 | 18 | 9·709624 | 9 32 | 10·290376 | 9·775764 | 9 43 | 10·224236 | 10·066140 | 9 11 | 9·933860 | 42 | 30 |
| 50 | 20 | 9·709730 | 10 35 | 10·290270 | 9·775908 | 10 48 | 10·224092 | 10·066178 | 10 13 | 9·933822 | 40 | 10 |
| 30 | 22 | 9·709836 | 11 39 | 10·290164 | 9·776051 | 11 53 | 10·223949 | 10·066216 | 11 14 | 9·933784 | 38 | 30 |
| 51 | 24 | 9·709941 | 12 42 | 10·290059 | 9·776195 | 12 57 | 10·223805 | 10·066253 | 12 15 | 9·933747 | 36 | 9 |
| 30 | 26 | 9·710047 | 13 46 | 10·289953 | 9·776338 | 13 62 | 10·223662 | 10·066291 | 13 16 | 9·933709 | 34 | 30 |
| 52 | 28 | 9·710153 | 14 49 | 10·289847 | 9·776482 | 14 67 | 10·223518 | 10·066329 | 14 18 | 9·933671 | 32 | 8 |
| 30 | 30 | 9·710259 | 15 53 | 10·289741 | 9·776625 | 15 72 | 10·223375 | 10·066367 | 15 19 | 9·933633 | 30 | 30 |
| 53 | 32 | 9·710364 | 16 56 | 10·289636 | 9·776768 | 16 76 | 10·223232 | 10·066404 | 16 20 | 9·933596 | 28 | 7 |
| 30 | 34 | 9·710470 | 17 60 | 10·289530 | 9·776912 | 17 81 | 10·223088 | 10·066442 | 17 21 | 9·933558 | 26 | 30 |
| 54 | 36 | 9·710575 | 18 63 | 10·289425 | 9·777055 | 18 86 | 10·222945 | 10·066480 | 18 23 | 9·933520 | 24 | 6 |
| 30 | 38 | 9·710681 | 19 67 | 10·289319 | 9·777199 | 19 91 | 10·222801 | 10·066518 | 19 24 | 9·933482 | 22 | 30 |
| 55 | 40 | 9·710786 | 20 70 | 10·289214 | 9·777342 | 20 96 | 10·222658 | 10·066555 | 20 25 | 9·933445 | 20 | 5 |
| 30 | 42 | 9·710892 | 21 74 | 10·289108 | 9·777485 | 21 100 | 10·222515 | 10·066593 | 21 26 | 9·933407 | 18 | 30 |
| 56 | 44 | 9·710997 | 22 77 | 10·289003 | 9·777628 | 22 105 | 10·222372 | 10·066631 | 22 28 | 9·933369 | 16 | 4 |
| 30 | 46 | 9·711103 | 23 81 | 10·288897 | 9·777772 | 23 110 | 10·222228 | 10·066669 | 23 29 | 9·933331 | 14 | 30 |
| 57 | 48 | 9·711208 | 24 85 | 10·288792 | 9·777915 | 24 115 | 10·222085 | 10·066707 | 24 30 | 9·933293 | 12 | 3 |
| 30 | 50 | 9·711313 | 25 88 | 10·288687 | 9·778058 | 25 119 | 10·221942 | 10·066745 | 25 32 | 9·933255 | 10 | 30 |
| 58 | 52 | 9·711419 | 26 92 | 10·288581 | 9·778201 | 26 124 | 10·221799 | 10·066783 | 26 33 | 9·933217 | 8 | 2 |
| 30 | 54 | 9·711524 | 27 95 | 10·288476 | 9·778344 | 27 129 | 10·221656 | 10·066821 | 27 34 | 9·933179 | 6 | 30 |
| 59 | 56 | 9·711629 | 28 99 | 10·288371 | 9·778488 | 28 134 | 10·221512 | 10·066859 | 28 35 | 9·933141 | 4 | 1 |
| 30 | 58 | 9·711734 | 29 102 | 10·288266 | 9·778631 | 29 139 | 10·221369 | 10·066896 | 29 37 | 9·933104 | 2 | 30 |
| 60 | 4 | 9·711839 | 30 106 | 10·288161 | 9·778774 | 30 143 | 10·221226 | 10·066934 | 30 38 | 9·933066 | 0 | 0 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

59° — 3h 56m

LOG. SINES, COSINES, &c.

| 2h 4m | | | | | 31° | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
| 0 | 0 | 9·711839 | | 10·288161 | 9·778774 | | 10·221226 | 10·066934 | | 9·933066 | 56 | 60 |
| 30 | 2 | 9·711944 | 1″ 3 | 10·288056 | 9·778917 | 1″ 5 | 10·221083 | 10·066972 | 1″ 1 | 9·933028 | 58 | 30 |
| 1 | 4 | 9·712050 | 2 7 | 10·287950 | 9·779060 | 2 10 | 10·220940 | 10·067010 | 2 3 | 9·932990 | 56 | 59 |
| 30 | 6 | 9·712155 | 3 10 | 10·287845 | 9·779203 | 3 14 | 10·220797 | 10·067048 | 3 4 | 9·932952 | 54 | 30 |
| 2 | 8 | 9·712260 | 4 14 | 10·287740 | 9·779346 | 4 19 | 10·220654 | 10·067086 | 4 5 | 9·932914 | 52 | 58 |
| 30 | 10 | 9·712365 | 5 17 | 10·287635 | 9·779489 | 5 24 | 10·220511 | 10·067124 | 5 6 | 9·932876 | 50 | 30 |
| 3 | 12 | 9·712469 | 6 21 | 10·287531 | 9·779632 | 6 29 | 10·220368 | 10·067162 | 6 8 | 9·932838 | 48 | 57 |
| 30 | 14 | 9·712574 | 7 24 | 10·287426 | 9·779775 | 7 33 | 10·220225 | 10·067200 | 7 9 | 9·932800 | 46 | 30 |
| 4 | 16 | 9·712679 | 8 28 | 10·287321 | 9·779918 | 8 38 | 10·220082 | 10·067238 | 8 10 | 9·932762 | 44 | 56 |
| 30 | 18 | 9·712784 | 9 31 | 10·287216 | 9·780061 | 9 43 | 10·219939 | 10·067276 | 9 11 | 9·932724 | 42 | 30 |
| 5 | 20 | 9·712889 | 10 35 | 10·287111 | 9·780203 | 10 48 | 10·219797 | 10·067315 | 10 13 | 9·932685 | 40 | 55 |
| 30 | 22 | 9·712994 | 11 38 | 10·287006 | 9·780346 | 11 52 | 10·219654 | 10·067353 | 11 14 | 9·932647 | 38 | 30 |
| 6 | 24 | 9·713098 | 12 42 | 10·286902 | 9·780489 | 12 57 | 10·219511 | 10·067391 | 12 15 | 9·932609 | 36 | 54 |
| 30 | 26 | 9·713203 | 13 45 | 10·286797 | 9·780632 | 13 62 | 10·219368 | 10·067429 | 13 17 | 9·932571 | 34 | 30 |
| 7 | 28 | 9·713308 | 14 49 | 10·286692 | 9·780775 | 14 67 | 10·219225 | 10·067467 | 14 18 | 9·932533 | 32 | 53 |
| 30 | 30 | 9·713412 | 15 52 | 10·286588 | 9·780917 | 15 71 | 10·219083 | 10·067505 | 15 19 | 9·932495 | 30 | 30 |
| 8 | 32 | 9·713517 | 16 56 | 10·286483 | 9·781060 | 16 76 | 10·218940 | 10·067543 | 16 20 | 9·932457 | 28 | 52 |
| 30 | 34 | 9·713621 | 17 59 | 10·286379 | 9·781203 | 17 81 | 10·218797 | 10·067581 | 17 22 | 9·932419 | 26 | 30 |
| 9 | 36 | 9·713726 | 18 63 | 10·286274 | 9·781346 | 18 86 | 10·218654 | 10·067620 | 18 23 | 9·932380 | 24 | 51 |
| 30 | 38 | 9·713831 | 19 66 | 10·286169 | 9·781488 | 19 90 | 10·218512 | 10·067658 | 19 24 | 9·932342 | 22 | 30 |
| 10 | 40 | 9·713935 | 20 70 | 10·286065 | 9·781631 | 20 95 | 10·218369 | 10·067696 | 20 25 | 9·932304 | 20 | 50 |
| 30 | 42 | 9·714039 | 21 73 | 10·285961 | 9·781774 | 21 100 | 10·218226 | 10·067734 | 21 27 | 9·932266 | 18 | 30 |
| 11 | 44 | 9·714144 | 22 77 | 10·285856 | 9·781916 | 22 105 | 10·218084 | 10·067772 | 22 28 | 9·932228 | 16 | 49 |
| 30 | 46 | 9·714248 | 23 80 | 10·285752 | 9·782059 | 23 109 | 10·217941 | 10·067811 | 23 29 | 9·932189 | 14 | 30 |
| 12 | 48 | 9·714352 | 24 84 | 10·285648 | 9·782201 | 24 114 | 10·217799 | 10·067849 | 24 30 | 9·932151 | 12 | 48 |
| 30 | 50 | 9·714457 | 25 87 | 10·285543 | 9·782344 | 25 119 | 10·217656 | 10·067887 | 25 32 | 9·932113 | 10 | 30 |
| 13 | 52 | 9·714561 | 26 91 | 10·285439 | 9·782486 | 26 124 | 10·217514 | 10·067925 | 26 33 | 9·932075 | 8 | 47 |
| 30 | 54 | 9·714665 | 27 94 | 10·285335 | 9·782629 | 27 129 | 10·217371 | 10·067964 | 27 34 | 9·932036 | 6 | 30 |
| 14 | 56 | 9·714769 | 28 98 | 10·285231 | 9·782771 | 28 133 | 10·217229 | 10·068002 | 28 36 | 9·931998 | 4 | 46 |
| 30 | 58 | 9·714873 | 29 101 | 10·285127 | 9·782914 | 29 138 | 10·217086 | 10·068040 | 29 37 | 9·931960 | 2 | 30 |
| 15 | 5 | 9·714978 | 30 105 | 10·285022 | 9·783056 | 30 143 | 10·216944 | 10·068079 | 30 38 | 9·931921 | 55 | 45 |
| 30 | 2 | 9·715082 | 1 3 | 10·284918 | 9·783199 | 1 5 | 10·216801 | 10·068117 | 1 1 | 9·931883 | 58 | 30 |
| 16 | 4 | 9·715186 | 2 7 | 10·284814 | 9·783341 | 2 9 | 10·216659 | 10·068155 | 2 3 | 9·931845 | 56 | 44 |
| 30 | 6 | 9·715290 | 3 10 | 10·284710 | 9·783483 | 3 14 | 10·216517 | 10·068194 | 3 4 | 9·931806 | 54 | 30 |
| 17 | 8 | 9·715394 | 4 14 | 10·284606 | 9·783626 | 4 19 | 10·216374 | 10·068232 | 4 5 | 9·931768 | 52 | 43 |
| 30 | 10 | 9·715498 | 5 17 | 10·284502 | 9·783768 | 5 24 | 10·216232 | 10·068270 | 5 6 | 9·931730 | 50 | 30 |
| 18 | 12 | 9·715602 | 6 21 | 10·284398 | 9·783910 | 6 28 | 10·216090 | 10·068309 | 6 8 | 9·931691 | 48 | 42 |
| 30 | 14 | 9·715705 | 7 24 | 10·284295 | 9·784053 | 7 33 | 10·215947 | 10·068347 | 7 9 | 9·931653 | 46 | 30 |
| 19 | 16 | 9·715809 | 8 28 | 10·284191 | 9·784195 | 8 38 | 10·215805 | 10·068386 | 8 10 | 9·931614 | 44 | 41 |
| 30 | 18 | 9·715913 | 9 31 | 10·284087 | 9·784337 | 9 43 | 10·215663 | 10·068424 | 9 12 | 9·931576 | 42 | 30 |
| 20 | 20 | 9·716017 | 10 35 | 10·283983 | 9·784479 | 10 47 | 10·215521 | 10·068463 | 10 13 | 9·931537 | 40 | 40 |
| 30 | 22 | 9·716121 | 11 38 | 10·283879 | 9·784622 | 11 52 | 10·215378 | 10·068501 | 11 14 | 9·931499 | 38 | 30 |
| 21 | 24 | 9·716224 | 12 42 | 10·283776 | 9·784764 | 12 57 | 10·215236 | 10·068540 | 12 15 | 9·931460 | 36 | 39 |
| 30 | 26 | 9·716328 | 13 45 | 10·283672 | 9·784906 | 13 62 | 10·215094 | 10·068578 | 13 17 | 9·931422 | 34 | 30 |
| 22 | 28 | 9·716432 | 14 49 | 10·283568 | 9·785048 | 14 66 | 10·214952 | 10·068617 | 14 18 | 9·931383 | 32 | 38 |
| 30 | 30 | 9·716535 | 15 52 | 10·283465 | 9·785190 | 15 71 | 10·214810 | 10·068655 | 15 19 | 9·931345 | 30 | 30 |
| 23 | 32 | 9·716639 | 16 56 | 10·283361 | 9·785332 | 16 76 | 10·214668 | 10·068694 | 16 21 | 9·931306 | 28 | 37 |
| 30 | 34 | 9·716742 | 17 59 | 10·283258 | 9·785474 | 17 81 | 10·214526 | 10·068732 | 17 22 | 9·931268 | 26 | 30 |
| 24 | 36 | 9·716846 | 18 63 | 10·283154 | 9·785616 | 18 85 | 10·214384 | 10·068771 | 18 23 | 9·931229 | 24 | 36 |
| 30 | 38 | 9·716949 | 19 66 | 10·283051 | 9·785758 | 19 90 | 10·214242 | 10·068809 | 19 24 | 9·931191 | 22 | 30 |
| 25 | 40 | 9·717053 | 20 69 | 10·282947 | 9·785900 | 20 95 | 10·214100 | 10·068848 | 20 26 | 9·931152 | 20 | 35 |
| 30 | 42 | 9·717156 | 21 72 | 10·282844 | 9·786042 | 21 100 | 10·213958 | 10·068886 | 21 27 | 9·931114 | 18 | 30 |
| 26 | 44 | 9·717259 | 22 76 | 10·282741 | 9·786184 | 22 104 | 10·213816 | 10·068925 | 22 28 | 9·931075 | 16 | 34 |
| 30 | 46 | 9·717363 | 23 79 | 10·282637 | 9·786326 | 23 109 | 10·213674 | 10·068964 | 23 30 | 9·931036 | 14 | 30 |
| 27 | 48 | 9·717466 | 24 83 | 10·282534 | 9·786468 | 24 114 | 10·213532 | 10·069002 | 24 31 | 9·930998 | 12 | 33 |
| 30 | 50 | 9·717569 | 25 86 | 10·282431 | 9·786610 | 25 118 | 10·213390 | 10·069041 | 25 32 | 9·930959 | 10 | 30 |
| 28 | 52 | 9·717673 | 26 90 | 10·282327 | 9·786752 | 26 123 | 10·213248 | 10·069079 | 26 33 | 9·930921 | 8 | 32 |
| 30 | 54 | 9·717776 | 27 93 | 10·282224 | 9·786894 | 27 128 | 10·213106 | 10·069118 | 27 35 | 9·930882 | 6 | 30 |
| 29 | 56 | 9·717879 | 28 97 | 10·282121 | 9·787036 | 28 133 | 10·212964 | 10·069157 | 28 36 | 9·930843 | 4 | 31 |
| 30 | 58 | 9·717982 | 29 100 | 10·282018 | 9·787178 | 29 137 | 10·212822 | 10·069196 | 29 37 | 9·930804 | 2 | 30 |
| 30 | 6 | 9·718085 | 30 104 | 10·281915 | 9·787319 | 30 142 | 10·212681 | 10·069234 | 30 39 | 9·930766 | 0 | 30 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |
| | | | | | 58° | | | | | 3h 54m | | |

## LOG. SINES, COSINES, &c.

$2^h\ 6^m$ 31°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 9·718085 | | 10·281915 | 9·787319 | | 10·212681 | 10·069234 | | 9·930766 | 60 | 30 |
| 30 | 2 | 9·718188 | 1″ 3 | 10·281812 | 9·787461 | 1″ 5 | 10·212539 | 10·069273 | 1″ 1 | 9·930727 | 58 | 30 |
| 31 | 4 | 9·718291 | 2 7 | 10·281709 | 9·787603 | 2 9 | 10·212397 | 10·069312 | 2 3 | 9·930688 | 56 | 29 |
| 30 | 6 | 9·718394 | 3 10 | 10·281606 | 9·787745 | 3 14 | 10·212255 | 10·069350 | 3 4 | 9·930650 | 54 | 30 |
| 32 | 8 | 9·718497 | 4 14 | 10·281503 | 9·787886 | 4 19 | 10·212114 | 10·069389 | 4 5 | 9·930611 | 52 | 28 |
| 30 | 10 | 9·718600 | 5 17 | 10·281400 | 9·788028 | 5 24 | 10·211972 | 10·069428 | 5 6 | 9·930572 | 50 | 30 |
| 33 | 12 | 9·718703 | 6 20 | 10·281297 | 9·788170 | 6 28 | 10·211830 | 10·069467 | 6 8 | 9·930533 | 48 | 27 |
| 30 | 14 | 9·718806 | 7 24 | 10·281194 | 9·788311 | 7 33 | 10·211689 | 10·069506 | 7 9 | 9·930495 | 46 | 30 |
| 34 | 16 | 9·718909 | 8 27 | 10·281091 | 9·788453 | 8 38 | 10·211547 | 10·069544 | 8 10 | 9·930456 | 44 | 26 |
| 30 | 18 | 9·719011 | 9 31 | 10·280989 | 9·788595 | 9 42 | 10·211405 | 10·069583 | 9 12 | 9·930417 | 42 | 30 |
| 35 | 20 | 9·719114 | 10 34 | 10·280886 | 9·788736 | 10 47 | 10·211264 | 10·069622 | 10 13 | 9·930378 | 40 | 25 |
| 30 | 22 | 9·719217 | 11 38 | 10·280783 | 9·788878 | 11 52 | 10·211122 | 10·069661 | 11 14 | 9·930339 | 38 | 30 |
| 36 | 24 | 9·719320 | 12 41 | 10·280680 | 9·789019 | 12 57 | 10·210981 | 10·069700 | 12 16 | 9·930300 | 36 | 24 |
| 30 | 26 | 9·719422 | 13 44 | 10·280578 | 9·789161 | 13 61 | 10·210839 | 10·069739 | 13 17 | 9·930262 | 34 | 30 |
| 37 | 28 | 9·719525 | 14 48 | 10·280475 | 9·789302 | 14 66 | 10·210698 | 10·069777 | 14 18 | 9·930223 | 32 | 23 |
| 30 | 30 | 9·719627 | 15 51 | 10·280372 | 9·789444 | 15 71 | 10·210556 | 10·069816 | 15 20 | 9·930184 | 30 | 30 |
| 38 | 32 | 9·719730 | 16 55 | 10·280270 | 9·789585 | 16 75 | 10·210415 | 10·069855 | 16 21 | 9·930145 | 28 | 22 |
| 30 | 34 | 9·719833 | 17 58 | 10·280167 | 9·789727 | 17 80 | 10·210273 | 10·069894 | 17 22 | 9·930106 | 26 | 30 |
| 39 | 36 | 9·719935 | 18 62 | 10·280065 | 9·789868 | 18 85 | 10·210132 | 10·069933 | 18 23 | 9·930067 | 24 | 21 |
| 30 | 38 | 9·720038 | 19 65 | 10·279962 | 9·790009 | 19 89 | 10·209991 | 10·069972 | 19 25 | 9·930028 | 22 | 30 |
| 40 | 40 | 9·720140 | 20 68 | 10·279860 | 9·790151 | 20 94 | 10·209849 | 10·070011 | 20 26 | 9·929989 | 20 | 20 |
| 30 | 42 | 9·720242 | 21 72 | 10·279758 | 9·790292 | 21 99 | 10·209708 | 10·070050 | 21 27 | 9·929950 | 18 | 30 |
| 41 | 44 | 9·720345 | 22 75 | 10·279655 | 9·790434 | 22 104 | 10·209566 | 10·070089 | 22 29 | 9·929911 | 16 | 19 |
| 30 | 46 | 9·720447 | 23 79 | 10·279553 | 9·790575 | 23 108 | 10·209425 | 10·070128 | 23 30 | 9·929872 | 14 | 30 |
| 42 | 48 | 9·720549 | 24 82 | 10·279451 | 9·790716 | 24 113 | 10·209284 | 10·070167 | 24 31 | 9·929833 | 12 | 18 |
| 30 | 50 | 9·720652 | 25 86 | 10·279348 | 9·790857 | 25 118 | 10·209143 | 10·070206 | 25 32 | 9·929794 | 10 | 30 |
| 43 | 52 | 9·720754 | 26 89 | 10·279246 | 9·790999 | 26 122 | 10·209001 | 10·070245 | 26 34 | 9·929755 | 8 | 17 |
| 30 | 54 | 9·720856 | 27 92 | 10·279144 | 9·791140 | 27 127 | 10·208860 | 10·070284 | 27 35 | 9·929716 | 6 | 30 |
| 44 | 56 | 9·720958 | 28 96 | 10·279042 | 9·791281 | 28 132 | 10·208719 | 10·070323 | 28 36 | 9·929677 | 4 | 16 |
| 30 | 58 | 9·721060 | 29 99 | 10·278940 | 9·791422 | 29 137 | 10·208578 | 10·070362 | 29 38 | 9·929638 | 2 | 30 |
| 45 | 0 | 9·721162 | 30 103 | 10·278838 | 9·791563 | 30 141 | 10·208437 | 10·070401 | 30 39 | 9·929599 | 60 | 15 |
| 30 | 2 | 9·721264 | 1 3 | 10·278736 | 9·791705 | 1 5 | 10·208295 | 10·070440 | 1 1 | 9·929560 | 58 | 30 |
| 46 | 4 | 9·721366 | 2 7 | 10·278634 | 9·791846 | 2 9 | 10·208154 | 10·070479 | 2 3 | 9·929521 | 56 | 14 |
| 30 | 6 | 9·721468 | 3 10 | 10·278532 | 9·791987 | 3 14 | 10·208013 | 10·070510 | 3 4 | 9·929482 | 54 | 30 |
| 47 | 8 | 9·721570 | 4 14 | 10·278430 | 9·792128 | 4 19 | 10·207872 | 10·070558 | 4 5 | 9·929442 | 52 | 13 |
| 30 | 10 | 9·721672 | 5 17 | 10·278328 | 9·792269 | 5 23 | 10·207731 | 10·070597 | 5 6 | 9·929403 | 50 | 30 |
| 48 | 12 | 9·721774 | 6 20 | 10·278226 | 9·792410 | 6 28 | 10·207590 | 10·070636 | 6 8 | 9·929364 | 48 | 12 |
| 30 | 14 | 9·721876 | 7 24 | 10·278124 | 9·792551 | 7 33 | 10·207449 | 10·070675 | 7 9 | 9·929325 | 46 | 30 |
| 49 | 16 | 9·721978 | 8 27 | 10·278022 | 9·792692 | 8 38 | 10·207308 | 10·070714 | 8 10 | 9·929286 | 44 | 11 |
| 30 | 18 | 9·722080 | 9 30 | 10·277920 | 9·792833 | 9 42 | 10·207167 | 10·070754 | 9 12 | 9·929247 | 42 | 30 |
| 50 | 20 | 9·722181 | 10 34 | 10·277819 | 9·792974 | 10 47 | 10·207026 | 10·070793 | 10 13 | 9·929207 | 40 | 10 |
| 30 | 22 | 9·722283 | 11 37 | 10·277717 | 9·793115 | 11 52 | 10·206885 | 10·070832 | 11 14 | 9·929168 | 38 | 30 |
| 51 | 24 | 9·722385 | 12 41 | 10·277615 | 9·793256 | 12 56 | 10·206744 | 10·070871 | 12 16 | 9·929129 | 36 | 9 |
| 30 | 26 | 9·722487 | 13 44 | 10·277513 | 9·793397 | 13 61 | 10·206603 | 10·070910 | 13 17 | 9·929090 | 34 | 30 |
| 52 | 28 | 9·722588 | 14 48 | 10·277412 | 9·793538 | 14 66 | 10·206462 | 10·070950 | 14 18 | 9·929050 | 32 | 8 |
| 30 | 30 | 9·722690 | 15 51 | 10·277310 | 9·793679 | 15 70 | 10·206321 | 10·070989 | 15 20 | 9·929011 | 30 | 30 |
| 53 | 32 | 9·722791 | 16 55 | 10·277209 | 9·793819 | 16 75 | 10·206181 | 10·071028 | 16 21 | 9·928972 | 28 | 7 |
| 30 | 34 | 9·722893 | 17 58 | 10·277107 | 9·793960 | 17 80 | 10·206040 | 10·071068 | 17 22 | 9·928933 | 26 | 30 |
| 54 | 36 | 9·722994 | 18 61 | 10·277006 | 9·794101 | 18 84 | 10·205899 | 10·071107 | 18 24 | 9·928893 | 24 | 6 |
| 30 | 38 | 9·723096 | 19 64 | 10·276904 | 9·794242 | 19 89 | 10·205758 | 10·071146 | 19 25 | 9·928854 | 22 | 30 |
| 55 | 40 | 9·723197 | 20 68 | 10·276803 | 9·794383 | 20 94 | 10·205617 | 10·071185 | 20 26 | 9·928815 | 20 | 5 |
| 30 | 42 | 9·723299 | 21 71 | 10·276701 | 9·794523 | 21 98 | 10·205477 | 10·071225 | 21 28 | 9·928775 | 18 | 30 |
| 56 | 44 | 9·723400 | 22 75 | 10·276600 | 9·794664 | 22 103 | 10·205336 | 10·071264 | 22 29 | 9·928736 | 16 | 4 |
| 30 | 46 | 9·723501 | 23 78 | 10·276499 | 9·794805 | 23 108 | 10·205195 | 10·071304 | 23 30 | 9·928696 | 14 | 30 |
| 57 | 48 | 9·723603 | 24 82 | 10·276397 | 9·794946 | 24 113 | 10·205054 | 10·071343 | 24 31 | 9·928657 | 12 | 3 |
| 30 | 50 | 9·723704 | 25 85 | 10·276296 | 9·795086 | 25 117 | 10·204914 | 10·071382 | 25 33 | 9·928618 | 10 | 30 |
| 58 | 52 | 9·723805 | 26 89 | 10·276195 | 9·795227 | 26 122 | 10·204773 | 10·071422 | 26 34 | 9·928578 | 8 | 2 |
| 30 | 54 | 9·723906 | 27 92 | 10·276094 | 9·795367 | 27 127 | 10·204633 | 10·071461 | 27 35 | 9·928539 | 6 | 30 |
| 59 | 56 | 9·724007 | 28 95 | 10·275993 | 9·795508 | 28 131 | 10·204492 | 10·071501 | 28 37 | 9·928499 | 4 | 1 |
| 30 | 58 | 9·724109 | 29 98 | 10·275891 | 9·795649 | 29 136 | 10·204351 | 10·071540 | 29 38 | 9·928460 | 2 | 30 |
| 60 | 0 | 9·724210 | 30 102 | 10·275790 | 9·795789 | 30 141 | 10·204211 | 10·071580 | 30 39 | 9·928420 | 0 | 0 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

58° $3^h\ 52^m$

## LOG. SINES, COSINES. &c.

2h 8m — 32°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 9·724210 | | 10·275790 | 9·795789 | | 10·204211 | 10·071580 | | 9·928420 | 52 | 60 |
| 30 | 2 | 9·724311 | 1″ 3 | 10·275689 | 9·795930 | 1″ 5 | 10·204070 | 10·071619 | 1″ 1 | 9·928381 | 58 | 30 |
| 1 | 4 | 9·724412 | 2 7 | 10·275588 | 9·796070 | 2 9 | 10·203930 | 10·071658 | 2 3 | 9·928342 | 56 | 59 |
| 30 | 6 | 9·724513 | 3 10 | 10·275487 | 9·796211 | 3 14 | 10·203789 | 10·071698 | 3 4 | 9·928302 | 54 | 30 |
| 2 | 8 | 9·724614 | 4 13 | 10·275386 | 9·796351 | 4 19 | 10·203649 | 10·071737 | 4 5 | 9·928263 | 52 | 58 |
| 30 | 10 | 9·724715 | 5 17 | 10·275285 | 9·796492 | 5 23 | 10·203508 | 10·071777 | 5 7 | 9·928223 | 50 | 30 |
| 3 | 12 | 9·724816 | 6 20 | 10·275184 | 9·796632 | 6 28 | 10·203368 | 10·071817 | 6 8 | 9·928183 | 48 | 57 |
| 30 | 14 | 9·724917 | 7 23 | 10·275083 | 9·796773 | 7 33 | 10·203227 | 10·071856 | 7 9 | 9·928144 | 46 | 30 |
| 4 | 16 | 9·725017 | 8 27 | 10·274983 | 9·796913 | 8 37 | 10·203087 | 10·071896 | 8 11 | 9·928104 | 44 | 56 |
| 30 | 18 | 9·725118 | 9 30 | 10·274882 | 9·797053 | 9 42 | 10·202947 | 10·071935 | 9 12 | 9·928065 | 42 | 30 |
| 5 | 20 | 9·725219 | 10 34 | 10·274781 | 9·797194 | 10 47 | 10·202806 | 10·071975 | 10 13 | 9·928025 | 40 | 55 |
| 30 | 22 | 9·725320 | 11 37 | 10·274680 | 9·797334 | 11 51 | 10·202666 | 10·072015 | 11 15 | 9·927986 | 38 | 30 |
| 6 | 24 | 9·725420 | 12 40 | 10·274580 | 9·797475 | 12 56 | 10·202526 | 10·072054 | 12 16 | 9·927946 | 36 | 54 |
| 30 | 26 | 9·725521 | 13 44 | 10·274479 | 9·797615 | 13 61 | 10·202385 | 10·072094 | 13 17 | 9·927906 | 34 | 30 |
| 7 | 28 | 9·725622 | 14 47 | 10·274378 | 9·797755 | 14 65 | 10·202245 | 10·072133 | 14 18 | 9·927867 | 32 | 53 |
| 30 | 30 | 9·725722 | 15 50 | 10·274278 | 9·797895 | 15 70 | 10·202105 | 10·072173 | 15 20 | 9·927827 | 30 | 30 |
| 8 | 32 | 9·725823 | 16 54 | 10·274177 | 9·798036 | 16 75 | 10·201964 | 10·072213 | 16 21 | 9·927787 | 28 | 52 |
| 30 | 34 | 9·725923 | 17 57 | 10·274076 | 9·798176 | 17 79 | 10·201824 | 10·072252 | 17 22 | 9·927748 | 26 | 30 |
| 9 | 36 | 9·726024 | 18 61 | 10·273976 | 9·798316 | 18 84 | 10·201684 | 10·072292 | 18 24 | 9·927708 | 24 | 51 |
| 30 | 38 | 9·726124 | 19 64 | 10·273875 | 9·798456 | 19 89 | 10·201544 | 10·072332 | 19 25 | 9·927668 | 22 | 30 |
| 10 | 40 | 9·726225 | 20 67 | 10·273775 | 9·798596 | 20 93 | 10·201404 | 10·072371 | 20 26 | 9·927629 | 20 | 50 |
| 30 | 42 | 9·726325 | 21 70 | 10·273675 | 9·798737 | 21 98 | 10·201264 | 10·072411 | 21 28 | 9·927589 | 18 | 30 |
| 11 | 44 | 9·726426 | 22 74 | 10·273574 | 9·798877 | 22 103 | 10·201123 | 10·072451 | 22 29 | 9·927549 | 16 | 49 |
| 30 | 46 | 9·726526 | 23 77 | 10·273474 | 9·799017 | 23 107 | 10·200983 | 10·072491 | 23 30 | 9·927509 | 14 | 30 |
| 12 | 48 | 9·726626 | 24 80 | 10·273374 | 9·799157 | 24 112 | 10·200843 | 10·072530 | 24 32 | 9·927470 | 12 | 48 |
| 30 | 50 | 9·726727 | 25 84 | 10·273273 | 9·799297 | 25 117 | 10·200703 | 10·072570 | 25 33 | 9·927430 | 10 | 30 |
| 13 | 52 | 9·726827 | 26 87 | 10·273173 | 9·799437 | 26 122 | 10·200563 | 10·072610 | 26 34 | 9·927390 | 8 | 47 |
| 30 | 54 | 9·726927 | 27 90 | 10·273073 | 9·799577 | 27 126 | 10·200423 | 10·072650 | 27 36 | 9·927350 | 6 | 30 |
| 14 | 56 | 9·727027 | 28 94 | 10·272973 | 9·799717 | 28 131 | 10·200283 | 10·072690 | 28 37 | 9·927310 | 4 | 46 |
| 30 | 58 | 9·727128 | 29 97 | 10·272872 | 9·799857 | 29 136 | 10·200143 | 10·072730 | 29 38 | 9·927270 | 2 | 30 |
| 15 | 0 | 9·727228 | 30 101 | 10·272772 | 9·799997 | 30 140 | 10·200003 | 10·072769 | 30 40 | 9·927231 | 51 | 45 |
| 30 | 2 | 9·727328 | 1 3 | 10·272672 | 9·800137 | 1 5 | 10·199863 | 10·072809 | 1 1 | 9·927191 | 58 | 30 |
| 16 | 4 | 9·727428 | 2 7 | 10·272572 | 9·800277 | 2 9 | 10·199723 | 10·072849 | 2 3 | 9·927151 | 56 | 44 |
| 30 | 6 | 9·727528 | 3 10 | 10·272472 | 9·800417 | 3 14 | 10·199583 | 10·072889 | 3 4 | 9·927111 | 54 | 30 |
| 17 | 8 | 9·727628 | 4 13 | 10·272372 | 9·800557 | 4 19 | 10·199443 | 10·072929 | 4 5 | 9·927071 | 52 | 43 |
| 30 | 10 | 9·727728 | 5 17 | 10·272272 | 9·800697 | 5 23 | 10·199303 | 10·072969 | 5 7 | 9·927031 | 50 | 30 |
| 18 | 12 | 9·727828 | 6 20 | 10·272172 | 9·800836 | 6 28 | 10·199164 | 10·073009 | 6 8 | 9·926991 | 48 | 42 |
| 30 | 14 | 9·727928 | 7 23 | 10·272072 | 9·800976 | 7 33 | 10·199024 | 10·073049 | 7 9 | 9·926951 | 46 | 30 |
| 19 | 16 | 9·728027 | 8 27 | 10·271972 | 9·801116 | 8 37 | 10·198884 | 10·073089 | 8 11 | 9·926911 | 44 | 41 |
| 30 | 18 | 9·728127 | 9 30 | 10·271873 | 9·801256 | 9 42 | 10·198744 | 10·073129 | 9 12 | 9·926871 | 42 | 30 |
| 20 | 20 | 9·728227 | 10 33 | 10·271773 | 9·801396 | 10 46 | 10·198604 | 10·073169 | 10 13 | 9·926831 | 40 | 40 |
| 30 | 22 | 9·728327 | 11 37 | 10·271673 | 9·801535 | 11 51 | 10·198465 | 10·073209 | 11 15 | 9·926791 | 38 | 30 |
| 21 | 24 | 9·728427 | 12 40 | 10·271573 | 9·801675 | 12 56 | 10·198325 | 10·073249 | 12 16 | 9·926751 | 36 | 39 |
| 30 | 26 | 9·728526 | 13 43 | 10·271474 | 9·801815 | 13 60 | 10·198185 | 10·073289 | 13 17 | 9·926711 | 34 | 30 |
| 22 | 28 | 9·728626 | 14 47 | 10·271374 | 9·801955 | 14 65 | 10·198045 | 10·073329 | 14 19 | 9·926671 | 32 | 38 |
| 30 | 30 | 9·728726 | 15 50 | 10·271274 | 9·802094 | 15 70 | 10·197906 | 10·073369 | 15 20 | 9·926631 | 30 | 30 |
| 23 | 32 | 9·728825 | 16 53 | 10·271175 | 9·802234 | 16 74 | 10·197766 | 10·073409 | 16 21 | 9·926591 | 28 | 37 |
| 30 | 34 | 9·728925 | 17 56 | 10·271075 | 9·802374 | 17 79 | 10·197626 | 10·073449 | 17 23 | 9·926551 | 26 | 30 |
| 24 | 36 | 9·729024 | 18 59 | 10·270976 | 9·802513 | 18 84 | 10·197487 | 10·073489 | 18 24 | 9·926511 | 24 | 36 |
| 30 | 38 | 9·729124 | 19 63 | 10·270876 | 9·802653 | 19 88 | 10·197347 | 10·073529 | 19 25 | 9·926471 | 22 | 30 |
| 25 | 40 | 9·729223 | 20 66 | 10·270777 | 9·802792 | 20 93 | 10·197208 | 10·073569 | 20 27 | 9·926431 | 20 | 35 |
| 30 | 42 | 9·729323 | 21 70 | 10·270677 | 9·802932 | 21 98 | 10·197068 | 10·073609 | 21 28 | 9·926391 | 18 | 30 |
| 26 | 44 | 9·729422 | 22 73 | 10·270578 | 9·803072 | 22 102 | 10·196928 | 10·073649 | 22 29 | 9·926351 | 16 | 34 |
| 30 | 46 | 9·729522 | 23 76 | 10·270478 | 9·803211 | 23 107 | 10·196789 | 10·073689 | 23 31 | 9·926311 | 14 | 30 |
| 27 | 48 | 9·729621 | 24 80 | 10·270379 | 9·803351 | 24 112 | 10·196649 | 10·073730 | 24 32 | 9·926270 | 12 | 33 |
| 30 | 50 | 9·729720 | 25 83 | 10·270280 | 9·803490 | 25 116 | 10·196510 | 10·073770 | 25 33 | 9·926230 | 10 | 30 |
| 28 | 52 | 9·729820 | 26 86 | 10·270180 | 9·803630 | 26 121 | 10·196370 | 10·073810 | 26 35 | 9·926190 | 8 | 32 |
| 30 | 54 | 9·729919 | 27 90 | 10·270081 | 9·803769 | 27 126 | 10·196231 | 10·073850 | 27 36 | 9·926150 | 6 | 30 |
| 29 | 56 | 9·730018 | 28 93 | 10·269982 | 9·803909 | 28 130 | 10·196091 | 10·073890 | 28 38 | 9·926110 | 4 | 31 |
| 30 | 58 | 9·730117 | 29 96 | 10·269883 | 9·804048 | 29 135 | 10·195952 | 10·073931 | 29 39 | 9·926069 | 2 | 30 |
| 30 | 10 | 9·730217 | 30 100 | 10·269784 | 9·804187 | 30 139 | 10·195813 | 10·073971 | 30 40 | 9·926029 | 0 | 30 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

57° — 3h 50m

## LOG. SINES, COSINES, &c.

$2^h\ 10^m$ | 32°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 9·730217 | | 10·269783 | 9·804187 | | 10·195813 | 10·073971 | | 9·926029 | 50 | 30 |
| 30 | 2 | 9·730316 | 1″ 3 | 10·269684 | 9·804327 | 1″ 5 | 10·195673 | 10·074011 | 1″ 1 | 9·925989 | 58 | 30 |
| 31 | 4 | 9·730415 | 2 7 | 10·269585 | 9·804466 | 2 9 | 10·195534 | 10·074051 | 2 3 | 9·925949 | 56 | 29 |
| 30 | 6 | 9·730514 | 3 10 | 10·269486 | 9·804605 | 3 14 | 10·195395 | 10·074092 | 3 4 | 9·925908 | 54 | 30 |
| 32 | 8 | 9·730613 | 4 13 | 10·269387 | 9·804745 | 4 19 | 10·195255 | 10·074132 | 4 5 | 9·925868 | 52 | 28 |
| 30 | 10 | 9·730712 | 5 16 | 10·269288 | 9·804884 | 5 23 | 10·195116 | 10·074172 | 5 7 | 9·925828 | 50 | 30 |
| 33 | 12 | 9·730811 | 6 20 | 10·269189 | 9·805023 | 6 28 | 10·194977 | 10·074212 | 6 8 | 9·925788 | 48 | 27 |
| 30 | 14 | 9·730910 | 7 23 | 10·269090 | 9·805163 | 7 32 | 10·194837 | 10·074253 | 7 9 | 9·925747 | 46 | 30 |
| 34 | 16 | 9·731009 | 8 26 | 10·268991 | 9·805302 | 8 37 | 10·194698 | 10·074293 | 8 11 | 9·925707 | 44 | 26 |
| 30 | 18 | 9·731108 | 9 30 | 10·268892 | 9·805441 | 9 42 | 10·194559 | 10·074333 | 9 12 | 9·925667 | 42 | 30 |
| 35 | 20 | 9·731206 | 10 33 | 10·268794 | 9·805580 | 10 46 | 10·194420 | 10·074374 | 10 13 | 9·925626 | 40 | 25 |
| 30 | 22 | 9·731305 | 11 36 | 10·268695 | 9·805719 | 11 51 | 10·194281 | 10·074414 | 11 15 | 9·925586 | 38 | 30 |
| 36 | 24 | 9·731404 | 12 40 | 10·268596 | 9·805859 | 12 56 | 10·194141 | 10·074455 | 12 16 | 9·925545 | 36 | 24 |
| 30 | 26 | 9·731503 | 13 43 | 10·268497 | 9·805998 | 13 60 | 10·194002 | 10·074495 | 13 18 | 9·925505 | 34 | 30 |
| 37 | 28 | 9·731602 | 14 46 | 10·268398 | 9·806137 | 14 65 | 10·193863 | 10·074535 | 14 19 | 9·925465 | 32 | 23 |
| 30 | 30 | 9·731700 | 15 49 | 10·268300 | 9·806276 | 15 70 | 10·193724 | 10·074576 | 15 20 | 9·925424 | 30 | 30 |
| 38 | 32 | 9·731799 | 16 53 | 10·268201 | 9·806415 | 16 74 | 10·193585 | 10·074616 | 16 22 | 9·925384 | 28 | 22 |
| 30 | 34 | 9·731897 | 17 56 | 10·268102 | 9·806554 | 17 79 | 10·193446 | 10·074657 | 17 23 | 9·925343 | 26 | 30 |
| 39 | 36 | 9·731996 | 18 59 | 10·268004 | 9·806693 | 18 83 | 10·193307 | 10·074697 | 18 24 | 9·925303 | 24 | 21 |
| 30 | 38 | 9·732095 | 19 63 | 10·267905 | 9·806832 | 19 88 | 10·193168 | 10·074738 | 19 26 | 9·925262 | 22 | 30 |
| 40 | 40 | 9·732193 | 20 66 | 10·267807 | 9·806971 | 20 93 | 10·193029 | 10·074778 | 20 27 | 9·925222 | 20 | 20 |
| 30 | 42 | 9·732292 | 21 69 | 10·267708 | 9·807110 | 21 97 | 10·192890 | 10·074819 | 21 28 | 9·925181 | 18 | 30 |
| 41 | 44 | 9·732390 | 22 73 | 10·267610 | 9·807249 | 22 102 | 10·192751 | 10·074859 | 22 30 | 9·925141 | 16 | 19 |
| 30 | 46 | 9·732489 | 23 76 | 10·267511 | 9·807388 | 23 107 | 10·192612 | 10·074900 | 23 31 | 9·925100 | 14 | 30 |
| 42 | 48 | 9·732587 | 24 79 | 10·267413 | 9·807527 | 24 111 | 10·192473 | 10·074940 | 24 32 | 9·925060 | 12 | 18 |
| 30 | 50 | 9·732685 | 25 82 | 10·267315 | 9·807666 | 25 116 | 10·192334 | 10·074981 | 25 34 | 9·925019 | 10 | 30 |
| 43 | 52 | 9·732784 | 26 86 | 10·267216 | 9·807805 | 26 121 | 10·192195 | 10·075021 | 26 35 | 9·924979 | 8 | 17 |
| 30 | 54 | 9·732882 | 27 89 | 10·267118 | 9·807944 | 27 125 | 10·192056 | 10·075062 | 27 36 | 9·924938 | 6 | 30 |
| 44 | 56 | 9·732980 | 28 92 | 10·267020 | 9·808083 | 28 130 | 10·191917 | 10·075103 | 28 38 | 9·924897 | 4 | 16 |
| 30 | 58 | 9·733079 | 29 95 | 10·266921 | 9·808222 | 29 134 | 10·191778 | 10·075143 | 29 39 | 9·924857 | 2 | 30 |
| 45 | 11 | 9·733177 | 30 99 | 10·266823 | 9·808361 | 30 139 | 10·191639 | 10·075184 | 30 40 | 9·924816 | 49 | 15 |
| 30 | 2 | 9·733275 | 1 3 | 10·266725 | 9·808499 | 1 5 | 10·191501 | 10·075224 | 1 1 | 9·924776 | 58 | 30 |
| 46 | 4 | 9·733373 | 2 6 | 10·266627 | 9·808638 | 2 9 | 10·191362 | 10·075265 | 2 3 | 9·924735 | 56 | 14 |
| 30 | 6 | 9·733471 | 3 10 | 10·266529 | 9·808777 | 3 14 | 10·191223 | 10·075306 | 3 4 | 9·924694 | 54 | 30 |
| 47 | 8 | 9·733569 | 4 13 | 10·266431 | 9·808916 | 4 18 | 10·191084 | 10·075346 | 4 5 | 9·924654 | 52 | 13 |
| 30 | 10 | 9·733667 | 5 16 | 10·266333 | 9·809055 | 5 23 | 10·190945 | 10·075387 | 5 7 | 9·924613 | 50 | 30 |
| 48 | 12 | 9·733765 | 6 20 | 10·266235 | 9·809193 | 6 28 | 10·190807 | 10·075428 | 6 8 | 9·924572 | 48 | 12 |
| 30 | 14 | 9·733863 | 7 23 | 10·266137 | 9·809332 | 7 32 | 10·190668 | 10·075469 | 7 10 | 9·924531 | 46 | 30 |
| 49 | 16 | 9·733961 | 8 26 | 10·266039 | 9·809471 | 8 37 | 10·190529 | 10·075509 | 8 11 | 9·924491 | 44 | 11 |
| 30 | 18 | 9·734059 | 9 29 | 10·265941 | 9·809609 | 9 42 | 10·190391 | 10·075550 | 9 12 | 9·924450 | 42 | 30 |
| 50 | 20 | 9·734157 | 10 33 | 10·265843 | 9·809748 | 10 46 | 10·190252 | 10·075591 | 10 14 | 9·924409 | 40 | 10 |
| 30 | 22 | 9·734255 | 11 36 | 10·265745 | 9·809887 | 11 51 | 10·190113 | 10·075632 | 11 15 | 9·924368 | 38 | 30 |
| 51 | 24 | 9·734353 | 12 39 | 10·265647 | 9·810025 | 12 55 | 10·189975 | 10·075672 | 12 16 | 9·924328 | 36 | 9 |
| 30 | 26 | 9·734451 | 13 42 | 10·265549 | 9·810164 | 13 60 | 10·189836 | 10·075713 | 13 18 | 9·924287 | 34 | 30 |
| 52 | 28 | 9·734549 | 14 46 | 10·265451 | 9·810302 | 14 65 | 10·189698 | 10·075754 | 14 19 | 9·924246 | 32 | 8 |
| 30 | 30 | 9·734646 | 15 49 | 10·265354 | 9·810441 | 15 69 | 10·189559 | 10·075795 | 15 20 | 9·924205 | 30 | 30 |
| 53 | 32 | 9·734744 | 16 52 | 10·265256 | 9·810580 | 16 74 | 10·189420 | 10·075836 | 16 22 | 9·924164 | 28 | 7 |
| 30 | 34 | 9·734842 | 17 55 | 10·265158 | 9·810718 | 17 79 | 10·189282 | 10·075876 | 17 23 | 9·924124 | 26 | 30 |
| 54 | 36 | 9·734939 | 18 59 | 10·265061 | 9·810857 | 18 83 | 10·189143 | 10·075917 | 18 24 | 9·924083 | 24 | 6 |
| 30 | 38 | 9·735037 | 19 62 | 10·264963 | 9·810995 | 19 88 | 10·189005 | 10·075958 | 19 26 | 9·924042 | 22 | 30 |
| 55 | 40 | 9·735135 | 20 65 | 10·264865 | 9·811134 | 20 92 | 10·188866 | 10·075999 | 20 27 | 9·924001 | 20 | 5 |
| 30 | 42 | 9·735232 | 21 68 | 10·264768 | 9·811272 | 21 97 | 10·188728 | 10·076040 | 21 29 | 9·923960 | 18 | 30 |
| 56 | 44 | 9·735330 | 22 72 | 10·264670 | 9·811410 | 22 102 | 10·188590 | 10·076081 | 22 30 | 9·923919 | 16 | 4 |
| 30 | 46 | 9·735427 | 23 75 | 10·264573 | 9·811549 | 23 106 | 10·188451 | 10·076122 | 23 31 | 9·923878 | 14 | 30 |
| 57 | 48 | 9·735525 | 24 78 | 10·264475 | 9·811687 | 24 111 | 10·188313 | 10·076163 | 24 33 | 9·923837 | 12 | 3 |
| 30 | 50 | 9·735622 | 25 82 | 10·264378 | 9·811826 | 25 116 | 10·188174 | 10·076204 | 25 34 | 9·923796 | 10 | 30 |
| 58 | 52 | 9·735719 | 26 85 | 10·264281 | 9·811964 | 26 120 | 10·188036 | 10·076245 | 26 35 | 9·923755 | 8 | 2 |
| 30 | 54 | 9·735817 | 27 88 | 10·264183 | 9·812102 | 27 125 | 10·187898 | 10·076286 | 27 37 | 9·923714 | 6 | 30 |
| 59 | 56 | 9·735914 | 28 91 | 10·264086 | 9·812241 | 28 129 | 10·187759 | 10·076327 | 28 38 | 9·923673 | 4 | 1 |
| 30 | 58 | 9·736011 | 29 95 | 10·263989 | 9·812379 | 29 134 | 10·187621 | 10·076368 | 29 39 | 9·923632 | 2 | 30 |
| 60 | 12 | 9·736109 | 30 98 | 10·263891 | 9·812517 | 30 139 | 10·187483 | 10·076409 | 30 41 | 9·923591 | 0 | 0 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

57° | $3^h\ 48^m$

## LOG. SINES, COSINES, &c.

2h 12m — 33°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 9·736109 | | 10·263891 | 9·812517 | | 10·187483 | 10·076409 | | 9·923591 | 48 | 60 |
| 30 | 2 | 9·736206 | 1″ 3 | 10·263794 | 9·812656 | 1″ 5 | 10·187344 | 10·076450 | 1″ 1 | 9·923550 | 58 | 30 |
| 1 | 4 | 9·736303 | 2 6 | 10·263697 | 9·812794 | 2 9 | 10·187206 | 10·076491 | 2 3 | 9·923509 | 56 | 59 |
| 30 | 6 | 9·736400 | 3 10 | 10·263600 | 9·812932 | 3 14 | 10·187068 | 10·076532 | 3 4 | 9·923468 | 54 | 30 |
| 2 | 8 | 9·736498 | 4 13 | 10·263502 | 9·813070 | 4 18 | 10·186930 | 10·076573 | 4 5 | 9·923427 | 52 | 58 |
| 30 | 10 | 9·736595 | 5 16 | 10·263405 | 9·813209 | 5 23 | 10·186791 | 10·076614 | 5 7 | 9·923386 | 50 | 30 |
| 3 | 12 | 9·736692 | 6 19 | 10·263308 | 9·813347 | 6 28 | 10·186653 | 10·076655 | 6 8 | 9·923345 | 48 | 57 |
| 30 | 14 | 9·736789 | 7 23 | 10·263211 | 9·813485 | 7 32 | 10·186515 | 10·076696 | 7 10 | 9·923304 | 46 | 30 |
| 4 | 16 | 9·736886 | 8 26 | 10·263114 | 9·813623 | 8 37 | 10·186377 | 10·076737 | 8 11 | 9·923263 | 44 | 56 |
| 30 | 18 | 9·736983 | 9 29 | 10·263017 | 9·813761 | 9 41 | 10·186239 | 10·076778 | 9 12 | 9·923222 | 42 | 30 |
| 5 | 20 | 9·737080 | 10 32 | 10·262920 | 9·813899 | 10 46 | 10·186101 | 10·076819 | 10 14 | 9·923181 | 40 | 55 |
| 30 | 22 | 9·737177 | 11 36 | 10·262823 | 9·814037 | 11 51 | 10·185963 | 10·076861 | 11 15 | 9·923139 | 38 | 30 |
| 6 | 24 | 9·737274 | 12 39 | 10·262726 | 9·814176 | 12 55 | 10·185824 | 10·076902 | 12 17 | 9·923098 | 36 | 54 |
| 30 | 26 | 9·737371 | 13 42 | 10·262629 | 9·814314 | 13 60 | 10·185686 | 10·076943 | 13 18 | 9·923057 | 34 | 30 |
| 7 | 28 | 9·737467 | 14 45 | 10·262533 | 9·814452 | 14 64 | 10·185548 | 10·076984 | 14 19 | 9·923016 | 32 | 53 |
| 30 | 30 | 9·737564 | 15 48 | 10·262436 | 9·814590 | 15 69 | 10·185410 | 10·077025 | 15 21 | 9·922975 | 30 | 30 |
| 8 | 32 | 9·737661 | 16 51 | 10·262339 | 9·814728 | 16 74 | 10·185272 | 10·077067 | 16 22 | 9·92293[illegible] | 28 | 52 |
| 30 | 34 | 9·737758 | 17 55 | 10·262242 | 9·814866 | 17 78 | 10·185134 | 10·077108 | 17 23 | 9·922892 | 26 | 30 |
| 9 | 36 | 9·737855 | 18 58 | 10·262145 | 9·815004 | 18 83 | 10·184996 | 10·077149 | 18 25 | 9·922851 | 24 | 51 |
| 30 | 38 | 9·737951 | 19 61 | 10·262049 | 9·815142 | 19 87 | 10·184858 | 10·077190 | 19 26 | 9·922810 | 22 | 30 |
| 10 | 40 | 9·738048 | 20 64 | 10·261952 | 9·815280 | 20 92 | 10·184720 | 10·077232 | 20 27 | 9·922768 | 20 | 50 |
| 30 | 42 | 9·738145 | 21 68 | 10·261855 | 9·815417 | 21 97 | 10·184583 | 10·077273 | 21 29 | 9·922727 | 18 | 30 |
| 11 | 44 | 9·738241 | 22 71 | 10·261759 | 9·815555 | 22 101 | 10·184445 | 10·077314 | 22 30 | 9·922686 | 16 | 49 |
| 30 | 46 | 9·738338 | 23 74 | 10·261662 | 9·815693 | 23 106 | 10·184307 | 10·077356 | 23 32 | 9·922644 | 14 | 30 |
| 12 | 48 | 9·738434 | 24 77 | 10·261566 | 9·815831 | 24 110 | 10·184169 | 10·077397 | 24 33 | 9·922603 | 12 | 48 |
| 30 | 50 | 9·738531 | 25 81 | 10·261469 | 9·815969 | 25 115 | 10·184031 | 10·077438 | 25 34 | 9·922562 | 10 | 30 |
| 13 | 52 | 9·738627 | 26 84 | 10·261373 | 9·816107 | 26 120 | 10·183893 | 10·077480 | 26 36 | 9·922520 | 8 | 47 |
| 30 | 54 | 9·738724 | 27 87 | 10·261276 | 9·816245 | 27 124 | 10·183755 | 10·077521 | 27 37 | 9·922479 | 6 | 30 |
| 14 | 56 | 9·738820 | 28 90 | 10·261180 | 9·816382 | 28 129 | 10·183618 | 10·077562 | 28 38 | 9·922438 | 4 | 46 |
| 30 | 58 | 9·738917 | 29 94 | 10·261083 | 9·816520 | 29 133 | 10·183480 | 10·077604 | 29 40 | 9·922396 | 2 | 30 |
| 15 | 13 | 9·739013 | 30 97 | 10·260987 | 9·816658 | 30 138 | 10·183342 | 10·077645 | 30 41 | 9·922355 | 47 | 45 |
| 30 | 2 | 9·739109 | 1 3 | 10·260891 | 9·816796 | 1 5 | 10·183204 | 10·077687 | 1 1 | 9·922313 | 58 | 30 |
| 16 | 4 | 9·739206 | 2 6 | 10·260794 | 9·816933 | 2 9 | 10·183067 | 10·077728 | 2 3 | 9·922272 | 56 | 44 |
| 30 | 6 | 9·739302 | 3 10 | 10·260698 | 9·817071 | 3 14 | 10·182929 | 10·077769 | 3 4 | 9·922231 | 54 | 30 |
| 17 | 8 | 9·739398 | 4 13 | 10·260602 | 9·817209 | 4 18 | 10·182791 | 10·077811 | 4 6 | 9·922189 | 52 | 43 |
| 30 | 10 | 9·739494 | 5 16 | 10·260506 | 9·817347 | 5 23 | 10·182653 | 10·077852 | 5 7 | 9·922148 | 50 | 30 |
| 18 | 12 | 9·739590 | 6 19 | 10·260410 | 9·817484 | 6 27 | 10·182516 | 10·077894 | 6 8 | 9·922106 | 48 | 42 |
| 30 | 14 | 9·739687 | 7 22 | 10·260313 | 9·817622 | 7 32 | 10·182378 | 10·077935 | 7 10 | 9·922065 | 46 | 30 |
| 19 | 16 | 9·739783 | 8 26 | 10·260217 | 9·817759 | 8 37 | 10·182241 | 10·077977 | 8 11 | 9·922023 | 44 | 41 |
| 30 | 18 | 9·739879 | 9 29 | 10·260121 | 9·817897 | 9 41 | 10·182103 | 10·078018 | 9 13 | 9·921982 | 42 | 30 |
| 20 | 20 | 9·739975 | 10 32 | 10·260025 | 9·818035 | 10 46 | 10·181965 | 10·078060 | 10 14 | 9·921940 | 40 | 40 |
| 30 | 22 | 9·740071 | 11 35 | 10·259929 | 9·818172 | 11 50 | 10·181828 | 10·078101 | 11 15 | 9·921899 | 38 | 30 |
| 21 | 24 | 9·740167 | 12 38 | 10·259833 | 9·818310 | 12 55 | 10·181690 | 10·078143 | 12 17 | 9·921857 | 36 | 39 |
| 30 | 26 | 9·740263 | 13 42 | 10·259737 | 9·818447 | 13 60 | 10·181553 | 10·078185 | 13 18 | 9·921815 | 34 | 30 |
| 22 | 28 | 9·740359 | 14 45 | 10·259641 | 9·818585 | 14 64 | 10·181415 | 10·078226 | 14 19 | 9·921774 | 32 | 38 |
| 30 | 30 | 9·740455 | 15 48 | 10·259545 | 9·818722 | 15 69 | 10·181278 | 10·078268 | 15 21 | 9·921732 | 30 | 30 |
| 23 | 32 | 9·740550 | 16 51 | 10·259450 | 9·818860 | 16 73 | 10·181140 | 10·078309 | 16 22 | 9·921691 | 28 | 37 |
| 30 | 34 | 9·740646 | 17 54 | 10·259354 | 9·818997 | 17 78 | 10·181003 | 10·078351 | 17 24 | 9·921649 | 26 | 30 |
| 24 | 36 | 9·740742 | 18 57 | 10·259258 | 9·819135 | 18 82 | 10·180865 | 10·078393 | 18 25 | 9·921607 | 24 | 36 |
| 30 | 38 | 9·740838 | 19 61 | 10·259162 | 9·819272 | 19 87 | 10·180728 | 10·078434 | 19 26 | 9·921566 | 22 | 30 |
| 25 | 40 | 9·740934 | 20 64 | 10·259066 | 9·819410 | 20 92 | 10·180590 | 10·078476 | 20 28 | 9·921524 | 20 | 35 |
| 30 | 42 | 9·741029 | 21 67 | 10·258971 | 9·819547 | 21 96 | 10·180453 | 10·078518 | 21 29 | 9·921482 | 18 | 30 |
| 26 | 44 | 9·741125 | 22 70 | 10·258875 | 9·819684 | 22 101 | 10·180316 | 10·078559 | 22 31 | 9·921441 | 16 | 34 |
| 30 | 46 | 9·741221 | 23 74 | 10·258779 | 9·819822 | 23 105 | 10·180178 | 10·078601 | 23 32 | 9·921399 | 14 | 30 |
| 27 | 48 | 9·741316 | 24 77 | 10·258684 | 9·819959 | 24 110 | 10·180041 | 10·078643 | 24 33 | 9·921357 | 12 | 33 |
| 30 | 50 | 9·741412 | 25 80 | 10·258588 | 9·820096 | 25 114 | 10·179904 | 10·078685 | 25 35 | 9·921315 | 10 | 30 |
| 28 | 52 | 9·741508 | 26 83 | 10·258492 | 9·820234 | 26 119 | 10·179766 | 10·078726 | 26 36 | 9·921274 | 8 | 32 |
| 30 | 54 | 9·741603 | 27 86 | 10·258397 | 9·820371 | 27 124 | 10·179629 | 10·078768 | 27 38 | 9·921232 | 6 | 30 |
| 29 | 56 | 9·741699 | 28 89 | 10·258301 | 9·820508 | 28 128 | 10·179492 | 10·078810 | 28 39 | 9·921190 | 4 | 31 |
| 30 | 58 | 9·741794 | 29 93 | 10·258206 | 9·820646 | 29 133 | 10·179354 | 10·078852 | 29 40 | 9·921148 | 2 | 30 |
| 30 | 14 | 9·741889 | 30 96 | 10·258111 | 9·820783 | 30 137 | 10·179217 | 10·078893 | 30 42 | 9·921107 | 0 | 30 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

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LOG. SINES, COSINES, &c.

2ʰ 14ᵐ 33°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 9·741889 | | 10·258111 | 9·820783 | | 10·179217 | 10·078893 | | 9·921107 | 46 | 30 |
| 30 | 2 | 9·741985 | 1″ 3 | 10·258015 | 9·820920 | 1″ 5 | 10·179080 | 10·078935 | 1″ 1 | 9·921065 | 58 | 30 |
| 31 | 4 | 9·742080 | 2 6 | 10·257920 | 9·821057 | 2 9 | 10·178943 | 10·078977 | 2 3 | 9·921023 | 56 | 29 |
| 30 | 6 | 9·742176 | 3 9 | 10·257824 | 9·821195 | 3 14 | 10·178805 | 10·079019 | 3 4 | 9·920981 | 54 | 30 |
| 32 | 8 | 9·742271 | 4 13 | 10·257729 | 9·821332 | 4 18 | 10·178668 | 10·079061 | 4 6 | 9·920939 | 52 | 28 |
| 30 | 10 | 9·742366 | 5 16 | 10·257634 | 9·821469 | 5 23 | 10·178531 | 10·079103 | 5 7 | 9·920897 | 50 | 30 |
| 33 | 12 | 9·742462 | 6 19 | 10·257538 | 9·821606 | 6 27 | 10·178394 | 10·079144 | 6 8 | 9·920856 | 48 | 27 |
| 30 | 14 | 9·742557 | 7 22 | 10·257443 | 9·821743 | 7 32 | 10·178257 | 10·079186 | 7 10 | 9·920814 | 46 | 30 |
| 34 | 16 | 9·742652 | 8 25 | 10·257348 | 9·821880 | 8 37 | 10·178120 | 10·079228 | 8 11 | 9·920772 | 44 | 26 |
| 30 | 18 | 9·742747 | 9 28 | 10·257253 | 9·822017 | 9 41 | 10·177983 | 10·079270 | 9 13 | 9·920730 | 42 | 30 |
| 35 | 20 | 9·742842 | 10 32 | 10·257158 | 9·822154 | 10 46 | 10·177846 | 10·079312 | 10 14 | 9·920688 | 40 | 25 |
| 30 | 22 | 9·742937 | 11 35 | 10·257063 | 9·822292 | 11 50 | 10·177708 | 10·079354 | 11 15 | 9·920646 | 38 | 30 |
| 36 | 24 | 9·743033 | 12 38 | 10·256967 | 9·822429 | 12 55 | 10·177571 | 10·079396 | 12 17 | 9·920604 | 36 | 24 |
| 30 | 26 | 9·743128 | 13 41 | 10·256872 | 9·822566 | 13 59 | 10·177434 | 10·079438 | 13 18 | 9·920562 | 34 | 30 |
| 37 | 28 | 9·743223 | 14 44 | 10·256777 | 9·822703 | 14 64 | 10·177297 | 10·079480 | 14 20 | 9·920520 | 32 | 23 |
| 30 | 30 | 9·743318 | 15 48 | 10·256682 | 9·822840 | 15 69 | 10·177160 | 10·079522 | 15 21 | 9·920478 | 30 | 30 |
| 38 | 32 | 9·743413 | 16 51 | 10·256587 | 9·822977 | 16 73 | 10·177023 | 10·079564 | 16 22 | 9·920436 | 28 | 22 |
| 30 | 34 | 9·743508 | 17 54 | 10·256492 | 9·823114 | 17 78 | 10·176886 | 10·079606 | 17 24 | 9·920394 | 26 | 30 |
| 39 | 36 | 9·743602 | 18 57 | 10·256398 | 9·823251 | 18 82 | 10·176749 | 10·079648 | 18 25 | 9·920352 | 24 | 21 |
| 30 | 38 | 9·743697 | 19 60 | 10·256303 | 9·823387 | 19 87 | 10·176613 | 10·079690 | 19 27 | 9·920310 | 22 | 30 |
| 40 | 40 | 9·743792 | 20 63 | 10·256208 | 9·823524 | 20 91 | 10·176476 | 10·079732 | 20 28 | 9·920268 | 20 | 20 |
| 30 | 42 | 9·743887 | 21 67 | 10·256113 | 9·823661 | 21 96 | 10·176339 | 10·079774 | 21 29 | 9·920226 | 18 | 30 |
| 41 | 44 | 9·743982 | 22 70 | 10·256018 | 9·823798 | 22 101 | 10·176202 | 10·079816 | 22 31 | 9·920184 | 16 | 19 |
| 30 | 46 | 9·744077 | 23 73 | 10·255923 | 9·823935 | 23 105 | 10·176065 | 10·079859 | 23 32 | 9·920141 | 14 | 30 |
| 42 | 48 | 9·744171 | 24 76 | 10·255829 | 9·824072 | 24 110 | 10·175928 | 10·079901 | 24 34 | 9·920099 | 12 | 18 |
| 30 | 50 | 9·744266 | 25 79 | 10·255734 | 9·824209 | 25 114 | 10·175791 | 10·079943 | 25 35 | 9·920057 | 10 | 30 |
| 43 | 52 | 9·744361 | 26 82 | 10·255639 | 9·824345 | 26 119 | 10·175655 | 10·079985 | 26 36 | 9·920015 | 8 | 17 |
| 30 | 54 | 9·744455 | 27 86 | 10·255545 | 9·824482 | 27 123 | 10·175518 | 10·080027 | 27 38 | 9·919973 | 6 | 30 |
| 44 | 56 | 9·744550 | 28 89 | 10·255450 | 9·824619 | 28 128 | 10·175381 | 10·080069 | 28 39 | 9·919931 | 4 | 16 |
| 30 | 58 | 9·744644 | 29 92 | 10·255356 | 9·824756 | 29 133 | 10·175244 | 10·080111 | 29 41 | 9·919889 | 2 | 30 |
| 45 | 15 | 9·744739 | 30 95 | 10·255261 | 9·824893 | 30 137 | 10·175107 | 10·080154 | 30 42 | 9·919846 | 45 | 15 |
| 30 | 2 | 9·744833 | 1 3 | 10·255167 | 9·825029 | 1 5 | 10·174971 | 10·080196 | 1 1 | 9·919804 | 58 | 30 |
| 46 | 4 | 9·744928 | 2 6 | 10·255072 | 9·825166 | 2 9 | 10·174834 | 10·080238 | 2 3 | 9·919762 | 56 | 14 |
| 30 | 6 | 9·745022 | 3 9 | 10·254978 | 9·825303 | 3 14 | 10·174697 | 10·080280 | 3 4 | 9·919720 | 54 | 30 |
| 47 | 8 | 9·745117 | 4 13 | 10·254883 | 9·825439 | 4 18 | 10·174561 | 10·080323 | 4 6 | 9·919677 | 52 | 13 |
| 30 | 10 | 9·745211 | 5 16 | 10·254789 | 9·825576 | 5 23 | 10·174424 | 10·080365 | 5 7 | 9·919635 | 50 | 30 |
| 48 | 12 | 9·745306 | 6 19 | 10·254694 | 9·825713 | 6 27 | 10·174287 | 10·080407 | 6 8 | 9·919593 | 48 | 12 |
| 30 | 14 | 9·745400 | 7 22 | 10·254600 | 9·825849 | 7 32 | 10·174151 | 10·080449 | 7 10 | 9·919551 | 46 | 30 |
| 49 | 16 | 9·745494 | 8 25 | 10·254506 | 9·825986 | 8 36 | 10·174014 | 10·080492 | 8 11 | 9·919508 | 44 | 11 |
| 30 | 18 | 9·745589 | 9 28 | 10·254411 | 9·826123 | 9 41 | 10·173877 | 10·080534 | 9 13 | 9·919466 | 42 | 30 |
| 50 | 20 | 9·745683 | 10 31 | 10·254317 | 9·826259 | 10 45 | 10·173741 | 10·080576 | 10 14 | 9·919424 | 40 | 10 |
| 30 | 22 | 9·745777 | 11 35 | 10·254223 | 9·826396 | 11 50 | 10·173604 | 10·080619 | 11 16 | 9·919381 | 38 | 30 |
| 51 | 24 | 9·745871 | 12 38 | 10·254129 | 9·826532 | 12 55 | 10·173468 | 10·080661 | 12 17 | 9·919339 | 36 | 9 |
| 30 | 26 | 9·745965 | 13 41 | 10·254035 | 9·826669 | 13 59 | 10·173331 | 10·080703 | 13 18 | 9·919297 | 34 | 30 |
| 52 | 28 | 9·746060 | 14 44 | 10·253940 | 9·826805 | 14 64 | 10·173195 | 10·080746 | 14 20 | 9·919254 | 32 | 8 |
| 30 | 30 | 9·746154 | 15 47 | 10·253846 | 9·826942 | 15 68 | 10·173058 | 10·080788 | 15 21 | 9·919212 | 30 | 30 |
| 53 | 32 | 9·746248 | 16 50 | 10·253752 | 9·827078 | 16 73 | 10·172922 | 10·080831 | 16 23 | 9·919169 | 28 | 7 |
| 30 | 34 | 9·746342 | 17 53 | 10·253658 | 9·827215 | 17 77 | 10·172785 | 10·080873 | 17 24 | 9·919127 | 26 | 30 |
| 54 | 36 | 9·746436 | 18 56 | 10·253564 | 9·827351 | 18 82 | 10·172649 | 10·080915 | 18 25 | 9·919085 | 24 | 6 |
| 30 | 38 | 9·746530 | 19 60 | 10·253470 | 9·827488 | 19 86 | 10·172512 | 10·080958 | 19 27 | 9·919042 | 22 | 30 |
| 55 | 40 | 9·746624 | 20 63 | 10·253376 | 9·827624 | 20 91 | 10·172376 | 10·081000 | 20 28 | 9·919000 | 20 | 5 |
| 30 | 42 | 9·746718 | 21 66 | 10·253282 | 9·827761 | 21 96 | 10·172239 | 10·081043 | 21 30 | 9·918957 | 18 | 30 |
| 56 | 44 | 9·746812 | 22 69 | 10·253188 | 9·827897 | 22 100 | 10·172103 | 10·081085 | 22 31 | 9·918915 | 16 | 4 |
| 30 | 46 | 9·746905 | 23 72 | 10·253095 | 9·828033 | 23 105 | 10·171967 | 10·081128 | 23 32 | 9·918872 | 14 | 30 |
| 57 | 48 | 9·746999 | 24 75 | 10·253001 | 9·828170 | 24 109 | 10·171830 | 10·081170 | 24 34 | 9·918830 | 12 | 3 |
| 30 | 50 | 9·747093 | 25 79 | 10·252907 | 9·828306 | 25 114 | 10·171694 | 10·081213 | 25 35 | 9·918787 | 10 | 30 |
| 58 | 52 | 9·747187 | 26 82 | 10·252813 | 9·828442 | 26 118 | 10·171558 | 10·081255 | 26 37 | 9·918745 | 8 | 2 |
| 30 | 54 | 9·747281 | 27 85 | 10·252719 | 9·828579 | 27 123 | 10·171421 | 10·081298 | 27 38 | 9·918702 | 6 | 30 |
| 59 | 56 | 9·747374 | 28 88 | 10·252626 | 9·828715 | 28 127 | 10·171285 | 10·081341 | 28 39 | 9·918659 | 4 | 1 |
| 30 | 58 | 9·747468 | 29 91 | 10·252532 | 9·828851 | 29 132 | 10·171149 | 10·081383 | 29 41 | 9·918617 | 2 | 30 |
| 60 | 16 | 9·747562 | 30 94 | 10·252438 | 9·828987 | 30 136 | 10·171013 | 10·081426 | 30 42 | 9·918574 | 0 | 0 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

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## LOG. SINES, COSINES, &c.

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| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 9·747562 | | 10·252438 | 9·828987 | | 10·171013 | 10·081426 | | 9·918574 | 0 | 60 |
| 30 | 2 | 9·747655 | 1″ 3 | 10·252345 | 9·829124 | 1″ 5 | 10·170876 | 10·081468 | 1″ 1 | 9·918532 | 58 | 30 |
| 1 | 4 | 9·747749 | 2 6 | 10·252251 | 9·829260 | 2 9 | 10·170740 | 10·081511 | 2 3 | 9·918489 | 56 | 59 |
| 30 | 6 | 9·747842 | 3 9 | 10·252158 | 9·829396 | 3 14 | 10·170604 | 10·081554 | 3 4 | 9·918446 | 54 | 30 |
| 2 | 8 | 9·747936 | 4 12 | 10·252064 | 9·829532 | 4 18 | 10·170468 | 10·081596 | 4 6 | 9·918404 | 52 | 58 |
| 30 | 10 | 9·748030 | 5 16 | 10·251970 | 9·829669 | 5 23 | 10·170331 | 10·081639 | 5 7 | 9·918361 | 50 | 30 |
| 3 | 12 | 9·748123 | 6 19 | 10·251877 | 9·829805 | 6 27 | 10·170195 | 10·081682 | 6 9 | 9·918318 | 48 | 57 |
| 30 | 14 | 9·748216 | 7 22 | 10·251784 | 9·829941 | 7 32 | 10·170059 | 10·081724 | 7 10 | 9·918276 | 46 | 30 |
| 4 | 16 | 9·748310 | 8 25 | 10·251690 | 9·830077 | 8 36 | 10·169923 | 10·081767 | 8 11 | 9·918233 | 44 | 56 |
| 30 | 18 | 9·748403 | 9 28 | 10·251597 | 9·830213 | 9 41 | 10·169787 | 10·081810 | 9 13 | 9·918190 | 42 | 30 |
| 5 | 20 | 9·748497 | 10 31 | 10·251503 | 9·830349 | 10 45 | 10·169651 | 10·081853 | 10 14 | 9·918147 | 40 | 55 |
| 30 | 22 | 9·748590 | 11 34 | 10·251410 | 9·830485 | 11 50 | 10·169515 | 10·081895 | 11 16 | 9·918105 | 38 | 30 |
| 6 | 24 | 9·748683 | 12 37 | 10·251317 | 9·830621 | 12 54 | 10·169379 | 10·081938 | 12 17 | 9·918062 | 36 | 54 |
| 30 | 26 | 9·748777 | 13 40 | 10·251223 | 9·830757 | 13 59 | 10·169243 | 10·081981 | 13 19 | 9·918019 | 34 | 30 |
| 7 | 28 | 9·748870 | 14 43 | 10·251130 | 9·830893 | 14 63 | 10·169107 | 10·082024 | 14 20 | 9·917976 | 32 | 53 |
| 30 | 30 | 9·748963 | 15 47 | 10·251037 | 9·831029 | 15 68 | 10·168971 | 10·082066 | 15 21 | 9·917934 | 30 | 30 |
| 8 | 32 | 9·749056 | 16 50 | 10·250944 | 9·831165 | 16 72 | 10·168835 | 10·082109 | 16 23 | 9·917891 | 28 | 52 |
| 30 | 34 | 9·749149 | 17 53 | 10·250851 | 9·831301 | 17 77 | 10·168699 | 10·082152 | 17 24 | 9·917848 | 26 | 30 |
| 9 | 36 | 9·749243 | 18 56 | 10·250757 | 9·831437 | 18 82 | 10·168563 | 10·082195 | 18 26 | 9·917805 | 24 | 51 |
| 30 | 38 | 9·749336 | 19 59 | 10·250664 | 9·831573 | 19 86 | 10·168427 | 10·082238 | 19 27 | 9·917762 | 22 | 30 |
| 10 | 40 | 9·749429 | 20 62 | 10·250571 | 9·831709 | 20 91 | 10·168291 | 10·082281 | 20 29 | 9·917719 | 20 | 50 |
| 30 | 42 | 9·749522 | 21 65 | 10·250478 | 9·831845 | 21 95 | 10·168155 | 10·082324 | 21 30 | 9·917677 | 18 | 30 |
| 11 | 44 | 9·749615 | 22 68 | 10·250385 | 9·831981 | 22 100 | 10·168019 | 10·082366 | 22 31 | 9·917634 | 16 | 49 |
| 30 | 46 | 9·749708 | 23 72 | 10·250292 | 9·832117 | 23 104 | 10·167883 | 10·082409 | 23 33 | 9·917591 | 14 | 30 |
| 12 | 48 | 9·749801 | 24 75 | 10·250199 | 9·832253 | 24 109 | 10·167747 | 10·082452 | 24 34 | 9·917548 | 12 | 48 |
| 30 | 50 | 9·749894 | 25 78 | 10·250106 | 9·832389 | 25 113 | 10·167611 | 10·082495 | 25 36 | 9·917505 | 10 | 30 |
| 13 | 52 | 9·749987 | 26 81 | 10·250013 | 9·832525 | 26 118 | 10·167475 | 10·082538 | 26 37 | 9·917462 | 8 | 47 |
| 30 | 54 | 9·750079 | 27 84 | 10·249921 | 9·832660 | 27 122 | 10·167340 | 10·082581 | 27 39 | 9·917419 | 6 | 30 |
| 14 | 56 | 9·750172 | 28 87 | 10·249828 | 9·832796 | 28 127 | 10·167204 | 10·082624 | 28 40 | 9·917376 | 4 | 46 |
| 30 | 58 | 9·750265 | 29 90 | 10·249735 | 9·832932 | 29 131 | 10·167068 | 10·082667 | 29 41 | 9·917333 | 2 | 30 |
| 15 | 2 7 | 9·750358 | 30 93 | 10·249642 | 9·833068 | 30 136 | 10·166932 | 10·082710 | 30 43 | 9·917290 | 0 | 45 |
| 30 | 2 | 9·750451 | 1 3 | 10·249549 | 9·833204 | 1 5 | 10·166796 | 10·082753 | 1 1 | 9·917247 | 58 | 30 |
| 16 | 4 | 9·750543 | 2 6 | 10·249457 | 9·833339 | 2 9 | 10·166661 | 10·082796 | 2 3 | 9·917204 | 56 | 44 |
| 30 | 6 | 9·750636 | 3 9 | 10·249364 | 9·833475 | 3 14 | 10·166525 | 10·082839 | 3 4 | 9·917161 | 54 | 30 |
| 17 | 8 | 9·750729 | 4 12 | 10·249271 | 9·833611 | 4 18 | 10·166389 | 10·082882 | 4 6 | 9·917118 | 52 | 43 |
| 30 | 10 | 9·750821 | 5 15 | 10·249179 | 9·833747 | 5 23 | 10·166253 | 10·082925 | 5 7 | 9·917075 | 50 | 30 |
| 18 | 12 | 9·750914 | 6 18 | 10·249086 | 9·833882 | 6 27 | 10·166118 | 10·082968 | 6 9 | 9·917032 | 48 | 42 |
| 30 | 14 | 9·751007 | 7 21 | 10·248993 | 9·834018 | 7 32 | 10·165982 | 10·083011 | 7 10 | 9·916989 | 46 | 30 |
| 19 | 16 | 9·751099 | 8 25 | 10·248901 | 9·834154 | 8 36 | 10·165846 | 10·083054 | 8 12 | 9·916946 | 44 | 41 |
| 30 | 18 | 9·751192 | 9 28 | 10·248808 | 9·834289 | 9 41 | 10·165711 | 10·083098 | 9 13 | 9·916902 | 42 | 30 |
| 20 | 20 | 9·751284 | 10 31 | 10·248716 | 9·834425 | 10 45 | 10·165575 | 10·083141 | 10 14 | 9·916859 | 40 | 40 |
| 30 | 22 | 9·751377 | 11 34 | 10·248623 | 9·834561 | 11 50 | 10·165440 | 10·083184 | 11 16 | 9·916816 | 38 | 30 |
| 21 | 24 | 9·751469 | 12 37 | 10·248531 | 9·834696 | 12 54 | 10·165304 | 10·083227 | 12 17 | 9·916773 | 36 | 39 |
| 30 | 26 | 9·751561 | 13 40 | 10·248439 | 9·834832 | 13 59 | 10·165168 | 10·083270 | 13 19 | 9·916730 | 34 | 30 |
| 22 | 28 | 9·751654 | 14 43 | 10·248346 | 9·834967 | 14 63 | 10·165033 | 10·083313 | 14 20 | 9·916687 | 32 | 38 |
| 30 | 30 | 9·751746 | 15 46 | 10·248254 | 9·835103 | 15 68 | 10·164897 | 10·083357 | 15 22 | 9·916643 | 30 | 30 |
| 23 | 32 | 9·751839 | 16 49 | 10·248161 | 9·835238 | 16 72 | 10·164762 | 10·083400 | 16 23 | 9·916600 | 28 | 37 |
| 30 | 34 | 9·751931 | 17 52 | 10·248069 | 9·835374 | 17 77 | 10·164626 | 10·083443 | 17 24 | 9·916557 | 26 | 30 |
| 24 | 36 | 9·752023 | 18 55 | 10·247977 | 9·835509 | 18 81 | 10·164491 | 10·083486 | 18 26 | 9·916514 | 24 | 36 |
| 30 | 38 | 9·752115 | 19 59 | 10·247885 | 9·835645 | 19 86 | 10·164355 | 10·083530 | 19 27 | 9·916470 | 22 | 30 |
| 25 | 40 | 9·752208 | 20 62 | 10·247792 | 9·835780 | 20 90 | 10·164220 | 10·083573 | 20 29 | 9·916427 | 20 | 35 |
| 30 | 42 | 9·752300 | 21 65 | 10·247700 | 9·835916 | 21 95 | 10·164084 | 10·083616 | 21 30 | 9·916384 | 18 | 30 |
| 26 | 41 | 9·752392 | 22 68 | 10·247608 | 9·836051 | 22 99 | 10·163949 | 10·083659 | 22 32 | 9·916341 | 16 | 34 |
| 30 | 46 | 9·752484 | 23 71 | 10·247516 | 9·836187 | 23 104 | 10·163813 | 10·083703 | 23 33 | 9·916297 | 14 | 30 |
| 27 | 48 | 9·752576 | 24 74 | 10·247424 | 9·836322 | 24 108 | 10·163678 | 10·083746 | 24 35 | 9·916254 | 12 | 33 |
| 30 | 50 | 9·752668 | 25 77 | 10·247332 | 9·836458 | 25 113 | 10·163542 | 10·083789 | 25 36 | 9·916211 | 10 | 30 |
| 28 | 52 | 9·752760 | 26 80 | 10·247240 | 9·836593 | 26 118 | 10·163407 | 10·083833 | 26 37 | 9·916167 | 8 | 32 |
| 30 | 54 | 9·752852 | 27 83 | 10·247148 | 9·836728 | 27 122 | 10·163272 | 10·083876 | 27 39 | 9·916124 | 6 | 30 |
| 29 | 56 | 9·752944 | 28 86 | 10·247056 | 9·836864 | 28 127 | 10·163136 | 10·083920 | 28 40 | 9·916081 | 4 | 31 |
| 30 | 58 | 9·753036 | 29 89 | 10·246964 | 9·836999 | 29 131 | 10·163001 | 10·083963 | 29 42 | 9·916037 | 2 | 30 |
| 30 | 2 8 | 9·753128 | 30 92 | 10·246872 | 9·837134 | 30 136 | 10·162866 | 10·084006 | 30 43 | 9·915994 | 0 | 30 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

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## LOG. SINES, COSINES, &c.

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| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 9·753128 | | 10·246872 | 9·837134 | | 10·162866 | 10·084006 | | 9·915994 | 42 | 30 |
| 30 | 2 | 9·753220 | 1″ 3 | 10·246780 | 9·837270 | 1″ 4 | 10·162730 | 10·084050 | 1″ 1 | 9·915950 | 58 | 30 |
| 31 | 4 | 9·753312 | 2 6 | 10·246688 | 9·837405 | 2 9 | 10·162595 | 10·084093 | 2 3 | 9·915907 | 56 | 29 |
| 30 | 6 | 9·753404 | 3 9 | 10·246596 | 9·837540 | 3 13 | 10·162460 | 10·084137 | 3 4 | 9·915863 | 54 | 30 |
| 32 | 8 | 9·753495 | 4 12 | 10·246505 | 9·837675 | 4 18 | 10·162325 | 10·084180 | 4 6 | 9·915820 | 52 | 28 |
| 30 | 10 | 9·753587 | 5 15 | 10·246413 | 9·837811 | 5 22 | 10·162189 | 10·084224 | 5 7 | 9·915776 | 50 | 30 |
| 33 | 12 | 9·753679 | 6 18 | 10·246321 | 9·837946 | 6 27 | 10·162054 | 10·084267 | 6 9 | 9·915733 | 48 | 27 |
| 30 | 14 | 9·753771 | 7 21 | 10·246229 | 9·838081 | 7 31 | 10·161919 | 10·084311 | 7 10 | 9·915689 | 46 | 30 |
| 34 | 16 | 9·753862 | 8 24 | 10·246138 | 9·838216 | 8 36 | 10·161784 | 10·084354 | 8 12 | 9·915646 | 44 | 26 |
| 30 | 18 | 9·753954 | 9 27 | 10·246046 | 9·838352 | 9 40 | 10·161648 | 10·084398 | 9 13 | 9·915602 | 42 | 30 |
| 35 | 20 | 9·754046 | 10 30 | 10·245954 | 9·838487 | 10 45 | 10·161513 | 10·084441 | 10 15 | 9·915559 | 40 | 25 |
| 30 | 22 | 9·754137 | 11 34 | 10·245863 | 9·838622 | 11 49 | 10·161378 | 10·084485 | 11 16 | 9·915515 | 38 | 30 |
| 36 | 24 | 9·754229 | 12 37 | 10·245771 | 9·838757 | 12 54 | 10·161243 | 10·084528 | 12 17 | 9·915472 | 36 | 24 |
| 30 | 26 | 9·754320 | 13 40 | 10·245680 | 9·838892 | 13 58 | 10·161108 | 10·084572 | 13 19 | 9·915428 | 34 | 30 |
| 37 | 28 | 9·754412 | 14 43 | 10·245588 | 9·839027 | 14 63 | 10·160973 | 10·084615 | 14 20 | 9·915385 | 32 | 23 |
| 30 | 30 | 9·754503 | 15 46 | 10·245497 | 9·839162 | 15 67 | 10·160838 | 10·084659 | 15 22 | 9·915341 | 30 | 30 |
| 38 | 32 | 9·754595 | 16 49 | 10·245405 | 9·839297 | 16 72 | 10·160703 | 10·084703 | 16 23 | 9·915297 | 28 | 22 |
| 30 | 34 | 9·754686 | 17 52 | 10·245314 | 9·839433 | 17 76 | 10·160567 | 10·084746 | 17 25 | 9·915254 | 26 | 30 |
| 39 | 36 | 9·754778 | 18 55 | 10·245222 | 9·839568 | 18 81 | 10·160432 | 10·084790 | 18 26 | 9·915210 | 24 | 21 |
| 30 | 38 | 9·754869 | 19 58 | 10·245131 | 9·839703 | 19 85 | 10·160297 | 10·084834 | 19 28 | 9·915166 | 22 | 30 |
| 40 | 40 | 9·754960 | 20 61 | 10·245040 | 9·839838 | 20 90 | 10·160162 | 10·084877 | 20 29 | 9·915123 | 20 | 20 |
| 30 | 42 | 9·755052 | 21 64 | 10·244948 | 9·839973 | 21 94 | 10·160027 | 10·084921 | 21 30 | 9·915079 | 18 | 30 |
| 41 | 44 | 9·755143 | 22 67 | 10·244857 | 9·840108 | 22 99 | 10·159892 | 10·084965 | 22 32 | 9·915035 | 16 | 19 |
| 30 | 46 | 9·755234 | 23 70 | 10·244766 | 9·840243 | 23 103 | 10·159757 | 10·085008 | 23 33 | 9·914992 | 14 | 30 |
| 42 | 48 | 9·755326 | 24 73 | 10·244674 | 9·840378 | 24 108 | 10·159622 | 10·085052 | 24 35 | 9·914948 | 12 | 18 |
| 30 | 50 | 9·755417 | 25 76 | 10·244583 | 9·840513 | 25 112 | 10·159487 | 10·085096 | 25 36 | 9·914904 | 10 | 30 |
| 43 | 52 | 9·755508 | 26 79 | 10·244492 | 9·840648 | 26 117 | 10·159352 | 10·085140 | 26 38 | 9·914860 | 8 | 17 |
| 30 | 54 | 9·755599 | 27 82 | 10·244401 | 9·840782 | 27 121 | 10·159218 | 10·085183 | 27 39 | 9·914817 | 6 | 30 |
| 44 | 56 | 9·755690 | 28 85 | 10·244310 | 9·840917 | 28 126 | 10·159083 | 10·085227 | 28 40 | 9·914773 | 4 | 16 |
| 30 | 58 | 9·755781 | 29 88 | 10·244219 | 9·841052 | 29 130 | 10·158948 | 10·085271 | 29 42 | 9·914729 | 2 | 30 |
| 45 | 19 | 9·755872 | 30 91 | 10·244128 | 9·841187 | 30 135 | 10·158813 | 10·085315 | 30 44 | 9·914685 | 41 | 15 |
| 30 | 2 | 9·755963 | 1 3 | 10·244037 | 9·841322 | 1 4 | 10·158678 | 10·085359 | 1 1 | 9·914641 | 58 | 30 |
| 46 | 4 | 9·756054 | 2 6 | 10·243946 | 9·841457 | 2 9 | 10·158543 | 10·085402 | 2 3 | 9·914598 | 56 | 14 |
| 30 | 6 | 9·756145 | 3 9 | 10·243855 | 9·841592 | 3 13 | 10·158408 | 10·085446 | 3 4 | 9·914554 | 54 | 30 |
| 47 | 8 | 9·756236 | 4 12 | 10·243764 | 9·841727 | 4 18 | 10·158273 | 10·085490 | 4 6 | 9·914510 | 52 | 13 |
| 30 | 10 | 9·756327 | 5 15 | 10·243673 | 9·841861 | 5 22 | 10·158139 | 10·085534 | 5 7 | 9·914466 | 50 | 30 |
| 48 | 12 | 9·756418 | 6 18 | 10·243582 | 9·841996 | 6 27 | 10·158004 | 10·085578 | 6 9 | 9·914422 | 48 | 12 |
| 30 | 14 | 9·756509 | 7 21 | 10·243491 | 9·842131 | 7 31 | 10·157869 | 10·085622 | 7 10 | 9·914378 | 46 | 30 |
| 49 | 16 | 9·756600 | 8 24 | 10·243400 | 9·842266 | 8 36 | 10·157734 | 10·085666 | 8 12 | 9·914334 | 44 | 11 |
| 30 | 18 | 9·756691 | 9 27 | 10·243309 | 9·842400 | 9 40 | 10·157600 | 10·085710 | 9 13 | 9·914290 | 42 | 30 |
| 50 | 20 | 9·756782 | 10 30 | 10·243218 | 9·842535 | 10 45 | 10·157465 | 10·085754 | 10 15 | 9·914246 | 40 | 10 |
| 30 | 22 | 9·756872 | 11 33 | 10·243128 | 9·842670 | 11 49 | 10·157330 | 10·085798 | 11 16 | 9·914202 | 38 | 30 |
| 51 | 24 | 9·756963 | 12 36 | 10·243037 | 9·842805 | 12 54 | 10·157195 | 10·085842 | 12 18 | 9·914158 | 36 | 9 |
| 30 | 26 | 9·757054 | 13 39 | 10·242946 | 9·842939 | 13 58 | 10·157061 | 10·085886 | 13 19 | 9·914114 | 34 | 30 |
| 52 | 28 | 9·757144 | 14 42 | 10·242856 | 9·843074 | 14 63 | 10·156926 | 10·085930 | 14 21 | 9·914070 | 32 | 8 |
| 30 | 30 | 9·757235 | 15 45 | 10·242765 | 9·843209 | 15 67 | 10·156791 | 10·085974 | 15 22 | 9·914026 | 30 | 30 |
| 53 | 32 | 9·757326 | 16 48 | 10·242674 | 9·843343 | 16 72 | 10·156657 | 10·086018 | 16 24 | 9·913982 | 28 | 7 |
| 30 | 34 | 9·757416 | 17 51 | 10·242584 | 9·843478 | 17 76 | 10·156522 | 10·086062 | 17 25 | 9·913938 | 26 | 30 |
| 54 | 36 | 9·757507 | 18 54 | 10·242493 | 9·843612 | 18 81 | 10·156388 | 10·086106 | 18 26 | 9·913894 | 24 | 6 |
| 30 | 38 | 9·757597 | 19 57 | 10·242403 | 9·843747 | 19 85 | 10·156253 | 10·086150 | 19 28 | 9·913850 | 22 | 30 |
| 55 | 40 | 9·757688 | 20 60 | 10·242312 | 9·843882 | 20 90 | 10·156118 | 10·086194 | 20 29 | 9·913806 | 20 | 5 |
| 30 | 42 | 9·757778 | 21 63 | 10·242222 | 9·844016 | 21 94 | 10·155984 | 10·086238 | 21 31 | 9·913762 | 18 | 30 |
| 56 | 44 | 9·757869 | 22 66 | 10·242131 | 9·844151 | 22 99 | 10·155849 | 10·086282 | 22 32 | 9·913718 | 16 | 4 |
| 30 | 46 | 9·757959 | 23 69 | 10·242041 | 9·844285 | 23 103 | 10·155715 | 10·086326 | 23 34 | 9·913674 | 14 | 30 |
| 57 | 48 | 9·758050 | 24 72 | 10·241950 | 9·844420 | 24 108 | 10·155580 | 10·086370 | 24 35 | 9·913630 | 12 | 3 |
| 30 | 50 | 9·758140 | 25 76 | 10·241860 | 9·844554 | 25 112 | 10·155446 | 10·086415 | 25 37 | 9·913585 | 10 | 30 |
| 58 | 52 | 9·758230 | 26 79 | 10·241770 | 9·844689 | 26 117 | 10·155311 | 10·086459 | 26 38 | 9·913541 | 8 | 2 |
| 30 | 54 | 9·758321 | 27 82 | 10·241679 | 9·844823 | 27 121 | 10·155177 | 10·086503 | 27 40 | 9·913497 | 6 | 30 |
| 59 | 56 | 9·758411 | 28 85 | 10·241589 | 9·844958 | 28 126 | 10·155042 | 10·086547 | 28 41 | 9·913453 | 4 | 1 |
| 30 | 58 | 9·758501 | 29 88 | 10·241499 | 9·845092 | 29 130 | 10·154908 | 10·086591 | 29 43 | 9·913409 | 2 | 30 |
| 60 | 20 | 9·758591 | 30 91 | 10·241409 | 9·845227 | 30 135 | 10·154773 | 10·086635 | 30 44 | 9·913365 | 0 | 0 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

55° 3ʰ 40ᵐ

## LOG. SINES, COSINES, &c.

2h 20m — 35°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 9·758591 | | 10·241409 | 9·845227 | | 10·154773 | 10·086635 | | 9·913365 | 40 | 60 |
| 30 | 2 | 9·758681 | 1″ 3 | 10·241319 | 9·845361 | 1″ 4 | 10·154639 | 10·086680 | 1″ 1 | 9·913320 | 58 | 30 |
| 1 | 4 | 9·758772 | 2 6 | 10·241228 | 9·845496 | 2 9 | 10·154504 | 10·086724 | 2 3 | 9·913276 | 56 | 59 |
| 30 | 6 | 9·758862 | 3 9 | 10·241138 | 9·845630 | 3 13 | 10·154370 | 10·086768 | 3 4 | 9·913232 | 54 | 30 |
| 2 | 8 | 9·758952 | 4 12 | 10·241048 | 9·845764 | 4 18 | 10·154236 | 10·086813 | 4 6 | 9·913187 | 52 | 58 |
| 30 | 10 | 9·759042 | 5 15 | 10·240958 | 9·845899 | 5 22 | 10·154101 | 10·086857 | 5 7 | 9·913143 | 50 | 30 |
| 3 | 12 | 9·759132 | 6 18 | 10·240868 | 9·846033 | 6 27 | 10·153967 | 10·086901 | 6 9 | 9·913099 | 48 | 57 |
| 30 | 14 | 9·759222 | 7 21 | 10·240778 | 9·846168 | 7 31 | 10·153832 | 10·086945 | 7 10 | 9·913055 | 46 | 30 |
| 4 | 16 | 9·759312 | 8 24 | 10·240688 | 9·846302 | 8 36 | 10·153698 | 10·086990 | 8 12 | 9·913010 | 44 | 56 |
| 30 | 18 | 9·759402 | 9 27 | 10·240598 | 9·846436 | 9 40 | 10·153564 | 10·087034 | 9 13 | 9·912966 | 42 | 30 |
| 5 | 20 | 9·759492 | 10 30 | 10·240508 | 9·846570 | 10 45 | 10·153430 | 10·087078 | 10 15 | 9·912922 | 40 | 55 |
| 30 | 22 | 9·759582 | 11 33 | 10·240418 | 9·846705 | 11 49 | 10·153295 | 10·087123 | 11 16 | 9·912877 | 38 | 30 |
| 6 | 24 | 9·759672 | 12 36 | 10·240328 | 9·846839 | 12 54 | 10·153161 | 10·087167 | 12 18 | 9·912833 | 36 | 54 |
| 30 | 26 | 9·759762 | 13 39 | 10·240238 | 9·846973 | 13 58 | 10·153027 | 10·087212 | 13 19 | 9·912788 | 34 | 30 |
| 7 | 28 | 9·759852 | 14 42 | 10·240148 | 9·847108 | 14 63 | 10·152892 | 10·087256 | 14 21 | 9·912744 | 32 | 53 |
| 30 | 30 | 9·759941 | 15 45 | 10·240059 | 9·847242 | 15 67 | 10·152758 | 10·087300 | 15 22 | 9·912700 | 30 | 30 |
| 8 | 32 | 9·760031 | 16 48 | 10·239969 | 9·847376 | 16 72 | 10·152624 | 10·087345 | 16 24 | 9·912655 | 28 | 52 |
| 30 | 34 | 9·760121 | 17 51 | 10·239879 | 9·847510 | 17 76 | 10·152490 | 10·087389 | 17 25 | 9·912611 | 26 | 30 |
| 9 | 36 | 9·760211 | 18 54 | 10·239789 | 9·847644 | 18 80 | 10·152356 | 10·087434 | 18 27 | 9·912566 | 24 | 51 |
| 30 | 38 | 9·760300 | 19 57 | 10·239700 | 9·847779 | 19 85 | 10·152221 | 10·087478 | 19 28 | 9·912522 | 22 | 30 |
| 10 | 40 | 9·760390 | 20 60 | 10·239610 | 9·847913 | 20 89 | 10·152087 | 10·087523 | 20 30 | 9·912477 | 20 | 50 |
| 30 | 42 | 9·760480 | 21 63 | 10·239520 | 9·848047 | 21 94 | 10·151953 | 10·087567 | 21 31 | 9·912433 | 18 | 30 |
| 11 | 44 | 9·760569 | 22 66 | 10·239431 | 9·848181 | 22 98 | 10·151819 | 10·087612 | 22 33 | 9·912388 | 16 | 49 |
| 30 | 46 | 9·760659 | 23 69 | 10·239341 | 9·848315 | 23 103 | 10·151685 | 10·087656 | 23 34 | 9·912344 | 14 | 30 |
| 12 | 48 | 9·760748 | 24 72 | 10·239252 | 9·848449 | 24 107 | 10·151551 | 10·087701 | 24 36 | 9·912299 | 12 | 48 |
| 30 | 50 | 9·760838 | 25 75 | 10·239162 | 9·848583 | 25 112 | 10·151417 | 10·087746 | 25 37 | 9·912255 | 10 | 30 |
| 13 | 52 | 9·760927 | 26 78 | 10·239073 | 9·848717 | 26 116 | 10·151283 | 10·087790 | 26 38 | 9·912210 | 8 | 47 |
| 40 | 54 | 9·761017 | 27 81 | 10·238983 | 9·848851 | 27 121 | 10·151149 | 10·087835 | 27 40 | 9·912165 | 6 | 30 |
| 14 | 56 | 9·761106 | 28 84 | 10·238894 | 9·848986 | 28 125 | 10·151014 | 10·087879 | 28 41 | 9·912121 | 4 | 46 |
| 30 | 58 | 9·761196 | 29 87 | 10·238804 | 9·849120 | 29 130 | 10·150880 | 10·087924 | 29 43 | 9·912076 | 2 | 30 |
| 15 | 21 | 9·761285 | 30 90 | 10·238715 | 9·849254 | 30 134 | 10·150746 | 10·087969 | 30 44 | 9·912031 | 39 | 45 |
| 30 | 2 | 9·761374 | 1 3 | 10·238626 | 9·849388 | 1 4 | 10·150612 | 10·088013 | 1 1 | 9·911987 | 58 | 30 |
| 16 | 4 | 9·761464 | 2 6 | 10·238536 | 9·849522 | 2 9 | 10·150478 | 10·088058 | 2 3 | 9·911942 | 56 | 44 |
| 30 | 6 | 9·761553 | 3 9 | 10·238447 | 9·849656 | 3 13 | 10·150344 | 10·088103 | 3 4 | 9·911897 | 54 | 30 |
| 17 | 8 | 9·761642 | 4 12 | 10·238358 | 9·849790 | 4 18 | 10·150210 | 10·088147 | 4 6 | 9·911853 | 52 | 43 |
| 30 | 10 | 9·761732 | 5 15 | 10·238268 | 9·849924 | 5 22 | 10·150076 | 10·088192 | 5 7 | 9·911808 | 50 | 30 |
| 18 | 12 | 9·761821 | 6 18 | 10·238179 | 9·850057 | 6 27 | 10·149943 | 10·088237 | 6 9 | 9·911763 | 48 | 42 |
| 30 | 14 | 9·761910 | 7 21 | 10·238090 | 9·850191 | 7 31 | 10·149809 | 10·088281 | 7 10 | 9·911719 | 46 | 30 |
| 19 | 16 | 9·761999 | 8 24 | 10·238001 | 9·850325 | 8 36 | 10·149675 | 10·088326 | 8 12 | 9·911674 | 44 | 41 |
| 30 | 18 | 9·762088 | 9 27 | 10·237912 | 9·850459 | 9 40 | 10·149541 | 10·088371 | 9 13 | 9·911629 | 42 | 30 |
| 20 | 20 | 9·762177 | 10 30 | 10·237823 | 9·850593 | 10 45 | 10·149407 | 10·088416 | 10 15 | 9·911584 | 40 | 40 |
| 30 | 22 | 9·762267 | 11 33 | 10·237733 | 9·850727 | 11 49 | 10·149273 | 10·088460 | 11 16 | 9·911540 | 38 | 30 |
| 21 | 24 | 9·762356 | 12 36 | 10·237644 | 9·850861 | 12 54 | 10·149139 | 10·088505 | 12 18 | 9·911495 | 36 | 39 |
| 30 | 26 | 9·762445 | 13 39 | 10·237555 | 9·850995 | 13 58 | 10·149005 | 10·088550 | 13 19 | 9·911450 | 34 | 30 |
| 22 | 28 | 9·762534 | 14 41 | 10·237466 | 9·851129 | 14 62 | 10·148871 | 10·088595 | 14 21 | 9·911405 | 32 | 38 |
| 30 | 30 | 9·762623 | 15 44 | 10·237377 | 9·851262 | 15 67 | 10·148738 | 10·088640 | 15 22 | 9·911360 | 30 | 30 |
| 23 | 32 | 9·762712 | 16 47 | 10·237288 | 9·851396 | 16 71 | 10·148604 | 10·088685 | 16 24 | 9·911315 | 28 | 37 |
| 30 | 34 | 9·762801 | 17 50 | 10·237199 | 9·851530 | 17 76 | 10·148470 | 10·088729 | 17 25 | 9·911271 | 26 | 30 |
| 24 | 36 | 9·762889 | 18 53 | 10·237111 | 9·851664 | 18 80 | 10·148336 | 10·088774 | 18 27 | 9·911226 | 24 | 36 |
| 30 | 38 | 9·762978 | 19 56 | 10·237022 | 9·851797 | 19 85 | 10·148203 | 10·088819 | 19 28 | 9·911181 | 22 | 30 |
| 25 | 40 | 9·763067 | 20 59 | 10·236933 | 9·851931 | 20 89 | 10·148069 | 10·088864 | 20 30 | 9·911136 | 20 | 35 |
| 30 | 42 | 9·763156 | 21 62 | 10·236844 | 9·852065 | 21 94 | 10·147935 | 10·088909 | 21 31 | 9·911091 | 18 | 30 |
| 26 | 44 | 9·763245 | 22 65 | 10·236755 | 9·852199 | 22 98 | 10·147801 | 10·088954 | 22 33 | 9·911046 | 16 | 34 |
| 30 | 46 | 9·763333 | 23 68 | 10·236667 | 9·852332 | 23 103 | 10·147668 | 10·088999 | 23 34 | 9·911001 | 14 | 30 |
| 27 | 48 | 9·763422 | 24 71 | 10·236578 | 9·852466 | 24 107 | 10·147534 | 10·089044 | 24 36 | 9·910956 | 12 | 33 |
| 30 | 50 | 9·763511 | 25 74 | 10·236489 | 9·852600 | 25 111 | 10·147400 | 10·089089 | 25 37 | 9·910911 | 10 | 30 |
| 28 | 52 | 9·763600 | 26 77 | 10·236400 | 9·852733 | 26 116 | 10·147267 | 10·089134 | 26 39 | 9·910866 | 8 | 32 |
| 30 | 54 | 9·763688 | 27 80 | 10·236312 | 9·852867 | 27 120 | 10·147133 | 10·089179 | 27 40 | 9·910821 | 6 | 30 |
| 29 | 56 | 9·763777 | 28 83 | 10·236223 | 9·853001 | 28 125 | 10·146999 | 10·089224 | 28 42 | 9·910776 | 4 | 31 |
| 30 | 58 | 9·763865 | 29 86 | 10·236135 | 9·853134 | 29 129 | 10·146866 | 10·089269 | 29 43 | 9·910731 | 2 | 30 |
| 30 | 22 | 9·763954 | 30 89 | 10·236046 | 9·853268 | 30 134 | 10·146732 | 10·089314 | 30 45 | 9·910686 | 0 | 30 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

54° — 3h 38m

## LOG. SINES, COSINES, &c.

2h 22m — 35°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 9·763954 | | 10·236046 | 9·853268 | | 10·146732 | 10·089314 | | 9·910686 | 38 | 30 |
| 30 | 2 | 9·764043 | 1″ 3 | 10·235957 | 9·853402 | 1″ 4 | 10·146598 | 10·089359 | 1″ 2 | 9·910641 | 58 | 30 |
| 31 | 4 | 9·764131 | 2 6 | 10·235869 | 9·853535 | 2 9 | 10·146465 | 10·089404 | 2 3 | 9·910596 | 56 | 29 |
| 30 | 6 | 9·764220 | 3 9 | 10·235780 | 9·853669 | 3 13 | 10·146331 | 10·089449 | 3 5 | 9·910551 | 54 | 30 |
| 32 | 8 | 9·764308 | 4 12 | 10·235692 | 9·853802 | 4 18 | 10·146198 | 10·089494 | 4 6 | 9·910506 | 52 | 28 |
| 30 | 10 | 9·764396 | 5 15 | 10·235604 | 9·853936 | 5 22 | 10·146064 | 10·089539 | 5 8 | 9·910461 | 50 | 30 |
| 33 | 12 | 9·764485 | 6 18 | 10·235515 | 9·854069 | 6 27 | 10·145931 | 10·089585 | 6 9 | 9·910415 | 48 | 27 |
| 30 | 14 | 9·764573 | 7 21 | 10·235427 | 9·854203 | 7 31 | 10·145797 | 10·089630 | 7 11 | 9·910370 | 46 | 30 |
| 34 | 16 | 9·764662 | 8 24 | 10·235338 | 9·854336 | 8 36 | 10·145664 | 10·089675 | 8 12 | 9·910325 | 44 | 26 |
| 30 | 18 | 9·764750 | 9 26 | 10·235250 | 9·854470 | 9 40 | 10·145530 | 10·089720 | 9 14 | 9·910280 | 42 | 30 |
| 35 | 20 | 9·764838 | 10 29 | 10·235162 | 9·854603 | 10 44 | 10·145397 | 10·089765 | 10 15 | 9·910235 | 40 | 25 |
| 30 | 22 | 9·764926 | 11 32 | 10·235074 | 9·854737 | 11 49 | 10·145263 | 10·089810 | 11 17 | 9·910190 | 38 | 30 |
| 36 | 24 | 9·765015 | 12 35 | 10·234985 | 9·854870 | 12 53 | 10·145130 | 10·089856 | 12 18 | 9·910144 | 36 | 24 |
| 30 | 26 | 9·765103 | 13 38 | 10·234897 | 9·855004 | 13 58 | 10·144996 | 10·089901 | 13 20 | 9·910099 | 34 | 30 |
| 37 | 28 | 9·765191 | 14 41 | 10·234809 | 9·855137 | 14 62 | 10·144863 | 10·089946 | 14 21 | 9·910054 | 32 | 23 |
| 30 | 30 | 9·765279 | 15 44 | 10·234721 | 9·855271 | 15 67 | 10·144729 | 10·089991 | 15 23 | 9·910009 | 30 | 30 |
| 38 | 32 | 9·765367 | 16 47 | 10·234633 | 9·855404 | 16 71 | 10·144596 | 10·090037 | 16 24 | 9·909963 | 28 | 22 |
| 30 | 34 | 9·765456 | 17 50 | 10·234544 | 9·855537 | 17 76 | 10·144463 | 10·090082 | 17 26 | 9·909918 | 26 | 30 |
| 39 | 36 | 9·765544 | 18 53 | 10·234456 | 9·855671 | 18 80 | 10·144329 | 10·090127 | 18 27 | 9·909873 | 24 | 21 |
| 30 | 38 | 9·765632 | 19 56 | 10·234368 | 9·855804 | 19 85 | 10·144196 | 10·090173 | 19 29 | 9·909827 | 22 | 30 |
| 40 | 40 | 9·765720 | 20 59 | 10·234280 | 9·855938 | 20 89 | 10·144062 | 10·090218 | 20 30 | 9·909782 | 20 | 20 |
| 30 | 42 | 9·765808 | 21 62 | 10·234192 | 9·856071 | 21 93 | 10·143929 | 10·090263 | 21 32 | 9·909737 | 18 | 30 |
| 41 | 44 | 9·765896 | 22 65 | 10·234104 | 9·856204 | 22 98 | 10·143796 | 10·090309 | 22 33 | 9·909691 | 16 | 19 |
| 30 | 46 | 9·765984 | 23 68 | 10·234016 | 9·856338 | 23 102 | 10·143662 | 10·090354 | 23 35 | 9·909646 | 14 | 30 |
| 42 | 48 | 9·766072 | 24 71 | 10·233928 | 9·856471 | 24 107 | 10·143529 | 10·090399 | 24 36 | 9·909601 | 12 | 18 |
| 30 | 50 | 9·766159 | 25 74 | 10·233841 | 9·856604 | 25 111 | 10·143396 | 10·090445 | 25 38 | 9·909555 | 10 | 30 |
| 43 | 52 | 9·766247 | 26 76 | 10·233753 | 9·856737 | 26 116 | 10·143263 | 10·090490 | 26 39 | 9·909510 | 8 | 17 |
| 30 | 54 | 9·766335 | 27 79 | 10·233665 | 9·856871 | 27 120 | 10·143129 | 10·090536 | 27 41 | 9·909464 | 6 | 30 |
| 44 | 56 | 9·766423 | 28 82 | 10·233577 | 9·857004 | 28 125 | 10·142996 | 10·090581 | 28 42 | 9·909419 | 4 | 16 |
| 30 | 58 | 9·766511 | 29 85 | 10·233489 | 9·857137 | 29 129 | 10·142863 | 10·090626 | 29 44 | 9·909374 | 2 | 30 |
| 45 | 23 | 9·766598 | 30 88 | 10·233402 | 9·857270 | 30 133 | 10·142730 | 10·090672 | 30 45 | 9·909328 | 37 | 15 |
| 30 | 2 | 9·766686 | 1 3 | 10·233314 | 9·857404 | 1 4 | 10·142596 | 10·090717 | 1 2 | 9·909283 | 58 | 30 |
| 46 | 4 | 9·766774 | 2 6 | 10·233226 | 9·857537 | 2 9 | 10·142463 | 10·090763 | 2 3 | 9·909237 | 56 | 14 |
| 30 | 6 | 9·766862 | 3 9 | 10·233138 | 9·857670 | 3 13 | 10·142330 | 10·090808 | 3 5 | 9·909192 | 54 | 30 |
| 47 | 8 | 9·766949 | 4 12 | 10·233051 | 9·857803 | 4 18 | 10·142197 | 10·090854 | 4 6 | 9·909146 | 52 | 13 |
| 30 | 10 | 9·767037 | 5 15 | 10·232963 | 9·857936 | 5 22 | 10·142064 | 10·090899 | 5 8 | 9·909101 | 50 | 30 |
| 48 | 12 | 9·767124 | 6 17 | 10·232876 | 9·858069 | 6 27 | 10·141931 | 10·090945 | 6 9 | 9·909055 | 48 | 12 |
| 30 | 14 | 9·767212 | 7 20 | 10·232788 | 9·858203 | 7 31 | 10·141797 | 10·090991 | 7 11 | 9·909009 | 46 | 30 |
| 49 | 16 | 9·767300 | 8 23 | 10·232700 | 9·858336 | 8 35 | 10·141664 | 10·091036 | 8 12 | 9·908964 | 44 | 11 |
| 30 | 18 | 9·767387 | 9 26 | 10·232613 | 9·858469 | 9 40 | 10·141531 | 10·091082 | 9 14 | 9·908918 | 42 | 30 |
| 50 | 20 | 9·767475 | 10 29 | 10·232525 | 9·858602 | 10 44 | 10·141398 | 10·091127 | 10 15 | 9·908872 | 40 | 10 |
| 30 | 22 | 9·767562 | 11 32 | 10·232438 | 9·858735 | 11 49 | 10·141265 | 10·091173 | 11 17 | 9·908827 | 38 | 30 |
| 51 | 24 | 9·767649 | 12 35 | 10·232351 | 9·858868 | 12 53 | 10·141132 | 10·091219 | 12 18 | 9·908781 | 36 | 9 |
| 30 | 26 | 9·767737 | 13 38 | 10·232263 | 9·859001 | 13 58 | 10·140999 | 10·091264 | 13 20 | 9·908736 | 34 | 30 |
| 52 | 28 | 9·767824 | 14 41 | 10·232176 | 9·859134 | 14 62 | 10·140866 | 10·091310 | 14 21 | 9·908690 | 32 | 8 |
| 30 | 30 | 9·767912 | 15 44 | 10·232088 | 9·859267 | 15 66 | 10·140733 | 10·091356 | 15 23 | 9·908644 | 30 | 30 |
| 53 | 32 | 9·767999 | 16 47 | 10·232001 | 9·859400 | 16 71 | 10·140600 | 10·091401 | 16 24 | 9·908599 | 28 | 7 |
| 30 | 34 | 9·768086 | 17 49 | 10·231914 | 9·859533 | 17 75 | 10·140467 | 10·091447 | 17 26 | 9·908553 | 26 | 30 |
| 54 | 36 | 9·768173 | 18 52 | 10·231827 | 9·859666 | 18 80 | 10·140334 | 10·091493 | 18 27 | 9·908507 | 24 | 6 |
| 30 | 38 | 9·768261 | 19 55 | 10·231739 | 9·859799 | 19 84 | 10·140201 | 10·091538 | 19 29 | 9·908462 | 22 | 30 |
| 55 | 40 | 9·768348 | 20 58 | 10·231652 | 9·859932 | 20 89 | 10·140068 | 10·091584 | 20 30 | 9·908416 | 20 | 5 |
| 30 | 42 | 9·768435 | 21 61 | 10·231565 | 9·860065 | 21 93 | 10·139935 | 10·091630 | 21 32 | 9·908370 | 18 | 30 |
| 56 | 44 | 9·768522 | 22 64 | 10·231478 | 9·860198 | 22 97 | 10·139802 | 10·091676 | 22 34 | 9·908324 | 16 | 4 |
| 30 | 46 | 9·768609 | 23 67 | 10·231391 | 9·860331 | 23 102 | 10·139669 | 10·091721 | 23 35 | 9·908279 | 14 | 30 |
| 57 | 48 | 9·768697 | 24 70 | 10·231303 | 9·860464 | 24 106 | 10·139536 | 10·091767 | 24 36 | 9·908233 | 12 | 3 |
| 30 | 50 | 9·768784 | 25 73 | 10·231216 | 9·860597 | 25 111 | 10·139403 | 10·091813 | 25 38 | 9·908187 | 10 | 30 |
| 58 | 52 | 9·768871 | 26 76 | 10·231129 | 9·860730 | 26 115 | 10·139270 | 10·091859 | 26 40 | 9·908141 | 8 | 2 |
| 30 | 54 | 9·768958 | 27 79 | 10·231042 | 9·860862 | 27 120 | 10·139138 | 10·091905 | 27 41 | 9·908095 | 6 | 30 |
| 59 | 56 | 9·769045 | 28 81 | 10·230955 | 9·860995 | 28 124 | 10·139005 | 10·091951 | 28 43 | 9·908049 | 4 | 1 |
| 30 | 58 | 9·769132 | 29 84 | 10·230868 | 9·861128 | 29 128 | 10·138872 | 10·091997 | 29 44 | 9·908003 | 2 | 30 |
| 60 | 24 | 9·769219 | 30 87 | 10·230781 | 9·861261 | 30 133 | 10·138739 | 10·092042 | 30 46 | 9·907958 | 0 | 0 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

54° — 3h 36m

## LOG. SINES, COSINES, &c.

2h 24m — 36°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 9·769219 | | 10·230781 | 9·861261 | | 10·138739 | 10·092042 | | 9·907958 | 36 | 60 |
| 30 | 2 | 9·769306 | 1″ 3 | 10·230694 | 9·861394 | 1″ 4 | 10·138606 | 10·092088 | 1″ 2 | 9·907912 | 58 | 30 |
| 1 | 4 | 9·769393 | 2 6 | 10·230607 | 9·861527 | 2 9 | 10·138473 | 10·092134 | 2 3 | 9·907866 | 56 | 59 |
| 30 | 6 | 9·769479 | 3 9 | 10·230521 | 9·861659 | 3 13 | 10·138341 | 10·092180 | 3 5 | 9·907820 | 54 | 30 |
| 2 | 8 | 9·769566 | 4 12 | 10·230434 | 9·861792 | 4 18 | 10·138208 | 10·092226 | 4 6 | 9·907774 | 52 | 58 |
| 30 | 10 | 9·769653 | 5 14 | 10·230347 | 9·861925 | 5 22 | 10·138075 | 10·092272 | 5 8 | 9·907728 | 50 | 30 |
| 3 | 12 | 9·769740 | 6 17 | 10·230260 | 9·862058 | 6 27 | 10·137942 | 10·092318 | 6 9 | 9·907682 | 48 | 57 |
| 30 | 14 | 9·769827 | 7 20 | 10·230173 | 9·862191 | 7 31 | 10·137809 | 10·092364 | 7 11 | 9·907636 | 46 | 30 |
| 4 | 16 | 9·769913 | 8 23 | 10·230087 | 9·862323 | 8 35 | 10·137677 | 10·092410 | 8 12 | 9·907590 | 44 | 56 |
| 30 | 18 | 9·770000 | 9 26 | 10·230000 | 9·862456 | 9 40 | 10·137544 | 10·092456 | 9 14 | 9·907544 | 42 | 30 |
| 5 | 20 | 9·770087 | 10 29 | 10·229913 | 9·862589 | 10 44 | 10·137411 | 10·092502 | 10 15 | 9·907498 | 40 | 55 |
| 30 | 22 | 9·770173 | 11 32 | 10·229827 | 9·862721 | 11 49 | 10·137279 | 10·092548 | 11 17 | 9·907452 | 38 | 30 |
| 6 | 24 | 9·770260 | 12 35 | 10·229740 | 9·862854 | 12 53 | 10·137146 | 10·092594 | 12 18 | 9·907406 | 36 | 54 |
| 30 | 26 | 9·770347 | 13 37 | 10·229653 | 9·862987 | 13 57 | 10·137013 | 10·092640 | 13 20 | 9·907360 | 34 | 30 |
| 7 | 28 | 9·770433 | 14 40 | 10·229567 | 9·863119 | 14 62 | 10·136881 | 10·092686 | 14 21 | 9·907314 | 32 | 53 |
| 30 | 30 | 9·770520 | 15 43 | 10·229480 | 9·863252 | 15 66 | 10·136748 | 10·092732 | 15 23 | 9·907268 | 30 | 30 |
| 8 | 32 | 9·770606 | 16 46 | 10·229394 | 9·863385 | 16 71 | 10·136615 | 10·092778 | 16 25 | 9·907222 | 28 | 52 |
| 30 | 34 | 9·770693 | 17 49 | 10·229307 | 9·863517 | 17 75 | 10·136483 | 10·092825 | 17 26 | 9·907175 | 26 | 30 |
| 9 | 36 | 9·770779 | 18 52 | 10·229221 | 9·863650 | 18 80 | 10·136350 | 10·092871 | 18 28 | 9·907129 | 24 | 51 |
| 30 | 38 | 9·770866 | 19 55 | 10·229134 | 9·863783 | 19 84 | 10·136217 | 10·092917 | 19 29 | 9·907083 | 22 | 30 |
| 10 | 40 | 9·770952 | 20 58 | 10·229048 | 9·863915 | 20 88 | 10·136085 | 10·092963 | 20 31 | 9·907037 | 20 | 50 |
| 30 | 42 | 9·771039 | 21 60 | 10·228961 | 9·864048 | 21 93 | 10·135952 | 10·093009 | 21 32 | 9·906991 | 18 | 30 |
| 11 | 44 | 9·771125 | 22 63 | 10·228875 | 9·864180 | 22 97 | 10·135820 | 10·093055 | 22 34 | 9·906945 | 16 | 49 |
| 30 | 46 | 9·771211 | 23 66 | 10·228789 | 9·864313 | 23 102 | 10·135687 | 10·093102 | 23 35 | 9·906898 | 14 | 30 |
| 12 | 48 | 9·771298 | 24 69 | 10·228702 | 9·864445 | 24 106 | 10·135555 | 10·093148 | 24 37 | 9·906852 | 12 | 48 |
| 30 | 50 | 9·771384 | 25 72 | 10·228616 | 9·864578 | 25 110 | 10·135422 | 10·093194 | 25 38 | 9·906806 | 10 | 30 |
| 13 | 52 | 9·771470 | 26 75 | 10·228530 | 9·864710 | 26 115 | 10·135290 | 10·093240 | 26 40 | 9·906760 | 8 | 47 |
| 30 | 54 | 9·771556 | 27 78 | 10·228444 | 9·864843 | 27 119 | 10·135157 | 10·093287 | 27 41 | 9·906713 | 6 | 30 |
| 14 | 56 | 9·771643 | 28 81 | 10·228357 | 9·864975 | 28 124 | 10·135025 | 10·093333 | 28 43 | 9·906667 | 4 | 46 |
| 30 | 58 | 9·771729 | 29 84 | 10·228271 | 9·865108 | 29 128 | 10·134892 | 10·093379 | 29 45 | 9·906621 | 2 | 30 |
| 15 | 25 | 9·771815 | 30 86 | 10·228185 | 9·865240 | 30 133 | 10·134760 | 10·093425 | 30 46 | 9·906575 | 35 | 45 |
| 30 | 2 | 9·771901 | 1 3 | 10·228099 | 9·865373 | 1 4 | 10·134627 | 10·093472 | 1 2 | 9·906528 | 58 | 30 |
| 16 | 4 | 9·771987 | 2 6 | 10·228013 | 9·865505 | 2 9 | 10·134495 | 10·093518 | 2 3 | 9·906482 | 56 | 44 |
| 30 | 6 | 9·772073 | 3 9 | 10·227927 | 9·865638 | 3 13 | 10·134362 | 10·093564 | 3 5 | 9·906436 | 54 | 30 |
| 17 | 8 | 9·772159 | 4 11 | 10·227841 | 9·865770 | 4 18 | 10·134230 | 10·093611 | 4 6 | 9·906389 | 52 | 43 |
| 30 | 10 | 9·772245 | 5 14 | 10·227755 | 9·865903 | 5 22 | 10·134097 | 10·093657 | 5 8 | 9·906343 | 50 | 30 |
| 18 | 12 | 9·772331 | 6 17 | 10·227669 | 9·866035 | 6 26 | 10·133965 | 10·093704 | 6 9 | 9·906296 | 48 | 42 |
| 30 | 14 | 9·772417 | 7 20 | 10·227583 | 9·866167 | 7 31 | 10·133833 | 10·093750 | 7 11 | 9·906250 | 46 | 30 |
| 19 | 16 | 9·772503 | 8 23 | 10·227497 | 9·866300 | 8 35 | 10·133700 | 10·093796 | 8 12 | 9·906204 | 44 | 41 |
| 30 | 18 | 9·772589 | 9 26 | 10·227411 | 9·866432 | 9 40 | 10·133568 | 10·093843 | 9 14 | 9·906157 | 42 | 30 |
| 20 | 20 | 9·772675 | 10 29 | 10·227325 | 9·866564 | 10 44 | 10·133436 | 10·093889 | 10 15 | 9·906111 | 40 | 40 |
| 30 | 22 | 9·772761 | 11 32 | 10·227239 | 9·866697 | 11 49 | 10·133303 | 10·093936 | 11 17 | 9·906064 | 38 | 30 |
| 21 | 24 | 9·772847 | 12 34 | 10·227153 | 9·866829 | 12 53 | 10·133171 | 10·093982 | 12 19 | 9·906018 | 36 | 39 |
| 30 | 26 | 9·772933 | 13 37 | 10·227067 | 9·866961 | 13 57 | 10·133039 | 10·094029 | 13 20 | 9·905971 | 34 | 30 |
| 22 | 28 | 9·773018 | 14 40 | 10·226982 | 9·867094 | 14 62 | 10·132906 | 10·094075 | 14 22 | 9·905925 | 32 | 38 |
| 30 | 30 | 9·773104 | 15 43 | 10·226896 | 9·867226 | 15 66 | 10·132774 | 10·094122 | 15 23 | 9·905878 | 30 | 30 |
| 23 | 32 | 9·773190 | 16 46 | 10·226810 | 9·867358 | 16 71 | 10·132642 | 10·094168 | 16 25 | 9·905832 | 28 | 37 |
| 30 | 34 | 9·773276 | 17 49 | 10·226724 | 9·867491 | 17 75 | 10·132509 | 10·094215 | 17 26 | 9·905785 | 26 | 30 |
| 24 | 36 | 9·773361 | 18 51 | 10·226639 | 9·867623 | 18 79 | 10·132377 | 10·094261 | 18 28 | 9·905739 | 24 | 36 |
| 30 | 38 | 9·773447 | 19 54 | 10·226553 | 9·867755 | 19 84 | 10·132245 | 10·094308 | 19 29 | 9·905692 | 22 | 30 |
| 25 | 40 | 9·773533 | 20 57 | 10·226467 | 9·867887 | 20 88 | 10·132113 | 10·094355 | 20 31 | 9·905645 | 20 | 35 |
| 30 | 42 | 9·773618 | 21 60 | 10·226382 | 9·868019 | 21 93 | 10·131981 | 10·094401 | 21 33 | 9·905599 | 18 | 30 |
| 26 | 44 | 9·773704 | 22 63 | 10·226296 | 9·868152 | 22 97 | 10·131848 | 10·094448 | 22 34 | 9·905552 | 16 | 34 |
| 30 | 46 | 9·773789 | 23 66 | 10·226211 | 9·868284 | 23 101 | 10·131716 | 10·094494 | 23 36 | 9·905506 | 14 | 30 |
| 27 | 48 | 9·773875 | 24 69 | 10·226125 | 9·868416 | 24 106 | 10·131584 | 10·094541 | 24 37 | 9·905459 | 12 | 33 |
| 30 | 50 | 9·773960 | 25 72 | 10·226040 | 9·868548 | 25 110 | 10·131452 | 10·094588 | 25 39 | 9·905412 | 10 | 30 |
| 28 | 52 | 9·774046 | 26 74 | 10·225954 | 9·868680 | 26 115 | 10·131320 | 10·094634 | 26 40 | 9·905366 | 8 | 32 |
| 30 | 54 | 9·774131 | 27 77 | 10·225869 | 9·868813 | 27 119 | 10·131187 | 10·094681 | 27 42 | 9·905319 | 6 | 30 |
| 29 | 56 | 9·774217 | 28 80 | 10·225783 | 9·868945 | 28 123 | 10·131055 | 10·094728 | 28 43 | 9·905272 | 4 | 31 |
| 30 | 58 | 9·774302 | 29 83 | 10·225698 | 9·869077 | 29 128 | 10·130923 | 10·094775 | 29 45 | 9·905225 | 2 | 30 |
| 30 | 26 | 9·774388 | 30 86 | 10·225612 | 9·869209 | 30 132 | 10·130791 | 10·094821 | 30 46 | 9·905179 | 0 | 30 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

53° — 3h 34m

## LOG. SINES, COSINES, &c.

2ʰ 26ᵐ — 36°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 9·774388 | | 10·225612 | 9·869209 | | 10·130791 | 10·094821 | | 9·905179 | 34 | 30 |
| 30 | 2 | 9·774473 | 1″ 3 | 10·225527 | 9·869341 | 1″ 4 | 10·130659 | 10·094868 | 1″ 2 | 9·905132 | 58 | 30 |
| 31 | 4 | 9·774558 | 2 6 | 10·225442 | 9·869473 | 2 9 | 10·130527 | 10·094915 | 2 3 | 9·905085 | 56 | 29 |
| 30 | 6 | 9·774644 | 3 8 | 10·225356 | 9·869605 | 3 13 | 10·130395 | 10·094962 | 3 5 | 9·905038 | 54 | 30 |
| 32 | 8 | 9·774729 | 4 11 | 10·225271 | 9·869737 | 4 18 | 10·130263 | 10·095008 | 4 6 | 9·904992 | 52 | 28 |
| 30 | 10 | 9·774814 | 5 14 | 10·225186 | 9·869869 | 5 22 | 10·130131 | 10·095055 | 5 8 | 9·904945 | 50 | 30 |
| 33 | 12 | 9·774899 | 6 17 | 10·225101 | 9·870001 | 6 26 | 10·129999 | 10·095102 | 6 9 | 9·904898 | 48 | 27 |
| 30 | 14 | 9·774985 | 7 20 | 10·225015 | 9·870133 | 7 31 | 10·129867 | 10·095149 | 7 11 | 9·904851 | 46 | 30 |
| 34 | 16 | 9·775070 | 8 23 | 10·224930 | 9·870265 | 8 35 | 10·129735 | 10·095196 | 8 13 | 9·904804 | 44 | 26 |
| 30 | 18 | 9·775155 | 9 25 | 10·224845 | 9·870397 | 9 40 | 10·129603 | 10·095243 | 9 14 | 9·904757 | 42 | 30 |
| 35 | 20 | 9·775240 | 10 28 | 10·224760 | 9·870529 | 10 44 | 10·129471 | 10·095289 | 10 16 | 9·904711 | 40 | 25 |
| 30 | 22 | 9·775325 | 11 31 | 10·224675 | 9·870661 | 11 48 | 10·129339 | 10·095336 | 11 17 | 9·904664 | 38 | 30 |
| 36 | 24 | 9·775410 | 12 34 | 10·224590 | 9·870793 | 12 53 | 10·129207 | 10·095383 | 12 19 | 9·904617 | 36 | 24 |
| 30 | 26 | 9·775495 | 13 37 | 10·224505 | 9·870925 | 13 57 | 10·129075 | 10·095430 | 13 20 | 9·904570 | 34 | 30 |
| 37 | 28 | 9·775580 | 14 40 | 10·224420 | 9·871057 | 14 62 | 10·128943 | 10·095477 | 14 22 | 9·904523 | 32 | 23 |
| 30 | 30 | 9·775665 | 15 42 | 10·224335 | 9·871189 | 15 66 | 10·128811 | 10·095524 | 15 24 | 9·904476 | 30 | 30 |
| 38 | 32 | 9·775750 | 16 45 | 10·224250 | 9·871321 | 16 70 | 10·128679 | 10·095571 | 16 25 | 9·904429 | 28 | 22 |
| 30 | 34 | 9·775835 | 17 48 | 10·224165 | 9·871453 | 17 75 | 10·128547 | 10·095618 | 17 27 | 9·904382 | 26 | 30 |
| 39 | 36 | 9·775920 | 18 51 | 10·224080 | 9·871585 | 18 79 | 10·128415 | 10·095665 | 18 28 | 9·904335 | 24 | 21 |
| 30 | 38 | 9·776005 | 19 54 | 10·223995 | 9·871717 | 19 84 | 10·128283 | 10·095712 | 19 30 | 9·904288 | 22 | 30 |
| 40 | 40 | 9·776090 | 20 57 | 10·223910 | 9·871849 | 20 88 | 10·128151 | 10·095759 | 20 31 | 9·904241 | 20 | 20 |
| 30 | 42 | 9·776175 | 21 59 | 10·223825 | 9·871980 | 21 92 | 10·128020 | 10·095806 | 21 33 | 9·904194 | 18 | 30 |
| 41 | 44 | 9·776259 | 22 62 | 10·223741 | 9·872112 | 22 97 | 10·127888 | 10·095853 | 22 34 | 9·904147 | 16 | 19 |
| 30 | 46 | 9·776344 | 23 65 | 10·223656 | 9·872244 | 23 101 | 10·127756 | 10·095900 | 23 36 | 9·904100 | 14 | 30 |
| 42 | 48 | 9·776429 | 24 68 | 10·223571 | 9·872376 | 24 106 | 10·127624 | 10·095947 | 24 38 | 9·904053 | 12 | 18 |
| 30 | 50 | 9·776514 | 25 71 | 10·223486 | 9·872508 | 25 110 | 10·127492 | 10·095994 | 25 39 | 9·904006 | 10 | 30 |
| 43 | 52 | 9·776598 | 26 74 | 10·223402 | 9·872640 | 26 114 | 10·127360 | 10·096041 | 26 41 | 9·903959 | 8 | 17 |
| 30 | 54 | 9·776683 | 27 76 | 10·223317 | 9·872771 | 27 119 | 10·127229 | 10·096088 | 27 42 | 9·903912 | 6 | 30 |
| 44 | 56 | 9·776768 | 28 79 | 10·223232 | 9·872903 | 28 123 | 10·127097 | 10·096136 | 28 44 | 9·903864 | 4 | 16 |
| 30 | 58 | 9·776852 | 29 82 | 10·223148 | 9·873035 | 29 128 | 10·126965 | 10·096183 | 29 46 | 9·903817 | 2 | 30 |
| 45 | **27** | 9·776937 | 30 85 | 10·223063 | 9·873167 | 30 132 | 10·126833 | 10·096230 | 30 47 | 9·903770 | **33** | 15 |
| 30 | 2 | 9·777021 | 1 3 | 10·222979 | 9·873299 | 1 4 | 10·126701 | 10·096277 | 1 2 | 9·903723 | 58 | 30 |
| 46 | 4 | 9·777106 | 2 6 | 10·222894 | 9·873430 | 2 9 | 10·126570 | 10·096324 | 2 3 | 9·903676 | 56 | 14 |
| 30 | 6 | 9·777191 | 3 8 | 10·222809 | 9·873562 | 3 13 | 10·126438 | 10·096371 | 3 5 | 9·903629 | 54 | 30 |
| 47 | 8 | 9·777275 | 4 11 | 10·222725 | 9·873694 | 4 18 | 10·126306 | 10·096419 | 4 6 | 9·903581 | 52 | 13 |
| 30 | 10 | 9·777359 | 5 14 | 10·222641 | 9·873825 | 5 22 | 10·126175 | 10·096466 | 5 8 | 9·903534 | 50 | 30 |
| 48 | 12 | 9·777444 | 6 17 | 10·222556 | 9·873957 | 6 26 | 10·126043 | 10·096513 | 6 9 | 9·903487 | 48 | 12 |
| 30 | 14 | 9·777528 | 7 20 | 10·222472 | 9·874089 | 7 31 | 10·125911 | 10·096560 | 7 11 | 9·903440 | 46 | 30 |
| 49 | 16 | 9·777613 | 8 22 | 10·222387 | 9·874220 | 8 35 | 10·125780 | 10·096608 | 8 13 | 9·903392 | 44 | 11 |
| 30 | 18 | 9·777697 | 9 25 | 10·222303 | 9·874352 | 9 40 | 10·125648 | 10·096655 | 9 14 | 9·903345 | 42 | 30 |
| 50 | 20 | 9·777781 | 10 28 | 10·222219 | 9·874484 | 10 44 | 10·125516 | 10·096702 | 10 16 | 9·903298 | 40 | 10 |
| 30 | 22 | 9·777866 | 11 31 | 10·222134 | 9·874615 | 11 48 | 10·125385 | 10·096750 | 11 17 | 9·903250 | 38 | 30 |
| 51 | 24 | 9·777950 | 12 34 | 10·222050 | 9·874747 | 12 53 | 10·125253 | 10·096797 | 12 19 | 9·903203 | 36 | 9 |
| 30 | 26 | 9·778034 | 13 37 | 10·221966 | 9·874879 | 13 57 | 10·125121 | 10·096844 | 13 21 | 9·903156 | 34 | 30 |
| 52 | 28 | 9·778119 | 14 40 | 10·221881 | 9·875010 | 14 61 | 10·124990 | 10·096892 | 14 22 | 9·903108 | 32 | 8 |
| 30 | 30 | 9·778203 | 15 42 | 10·221797 | 9·875142 | 15 66 | 10·124858 | 10·096939 | 15 24 | 9·903061 | 30 | 30 |
| 53 | 32 | 9·778287 | 16 45 | 10·221713 | 9·875273 | 16 70 | 10·124727 | 10·096986 | 16 25 | 9·903014 | 28 | 7 |
| 30 | 34 | 9·778371 | 17 48 | 10·221629 | 9·875405 | 17 75 | 10·124595 | 10·097034 | 17 27 | 9·902966 | 26 | 30 |
| 54 | 36 | 9·778455 | 18 51 | 10·221545 | 9·875537 | 18 79 | 10·124463 | 10·097081 | 18 28 | 9·902919 | 24 | 6 |
| 30 | 38 | 9·778539 | 19 53 | 10·221461 | 9·875668 | 19 83 | 10·124332 | 10·097129 | 19 30 | 9·902871 | 22 | 30 |
| 55 | 40 | 9·778624 | 20 56 | 10·221376 | 9·875800 | 20 88 | 10·124200 | 10·097176 | 20 32 | 9·902824 | 20 | 5 |
| 30 | 42 | 9·778708 | 21 59 | 10·221292 | 9·875931 | 21 92 | 10·124069 | 10·097224 | 21 33 | 9·902776 | 18 | 30 |
| 56 | 44 | 9·778792 | 22 62 | 10·221208 | 9·876063 | 22 97 | 10·123937 | 10·097271 | 22 35 | 9·902729 | 16 | 4 |
| 30 | 46 | 9·778876 | 23 65 | 10·221124 | 9·876194 | 23 101 | 10·123806 | 10·097319 | 23 36 | 9·902681 | 14 | 30 |
| 57 | 48 | 9·778960 | 24 67 | 10·221040 | 9·876326 | 24 105 | 10·123674 | 10·097366 | 24 38 | 9·902634 | 12 | 3 |
| 30 | 50 | 9·779044 | 25 70 | 10·220956 | 9·876457 | 25 110 | 10·123543 | 10·097414 | 25 39 | 9·902586 | 10 | 30 |
| 58 | 52 | 9·779128 | 26 73 | 10·220872 | 9·876589 | 26 114 | 10·123411 | 10·097461 | 26 41 | 9·902539 | 8 | 2 |
| 30 | 54 | 9·779211 | 27 76 | 10·220789 | 9·876720 | 27 119 | 10·123280 | 10·097509 | 27 43 | 9·902491 | 6 | 30 |
| 50 | 56 | 9·779295 | 28 79 | 10·220705 | 9·876852 | 28 123 | 10·123148 | 10·097556 | 28 44 | 9·902444 | 4 | 1 |
| 30 | 58 | 9·779379 | 29 81 | 10·220621 | 9·876983 | 29 127 | 10·123017 | 10·097604 | 29 46 | 9·902396 | 2 | 30 |
| 60 | **28** | 9·779463 | 30 84 | 10·220537 | 9·877114 | 30 132 | 10·122886 | 10·097651 | 30 47 | 9·902349 | 0 | 0 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

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## LOG. SINES, COSINES, &c.

2ʰ 28ᵐ — 37°

| ′ ″ | m. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 9·779463 | | 10·220537 | 9·877114 | | 10·122886 | 10·097651 | | 9·902349 | 32 | 60 |
| 30 | 2 | 9·779547 | 1″ 3 | 10·220453 | 9·877246 | 1 4 | 10·122754 | 10·097699 | 1″ 2 | 9·902301 | 58 | 30 |
| 1 | 4 | 9·779631 | 2 6 | 10·220369 | 9·877377 | 2 9 | 10·122623 | 10·097747 | 2 3 | 9·902253 | 56 | 59 |
| 30 | 6 | 9·779714 | 3 8 | 10·220286 | 9·877509 | 3 13 | 10·122491 | 10·097794 | 3 5 | 9·902206 | 54 | 30 |
| 2 | 8 | 9·779798 | 4 11 | 10·220202 | 9·877640 | 4 17 | 10·122360 | 10·097842 | 4 6 | 9·902158 | 52 | 58 |
| 30 | 10 | 9·779882 | 5 14 | 10·220118 | 9·877771 | 5 22 | 10·122229 | 10·097890 | 5 8 | 9·902110 | 50 | 30 |
| 3 | 12 | 9·779966 | 6 17 | 10·220034 | 9·877903 | 6 26 | 10·122097 | 10·097937 | 6 10 | 9·902063 | 48 | 57 |
| 30 | 14 | 9·780049 | 7 19 | 10·219951 | 9·878034 | 7 31 | 10·121966 | 10·097985 | 7 11 | 9·902015 | 46 | 30 |
| 4 | 16 | 9·780133 | 8 22 | 10·219867 | 9·878165 | 8 35 | 10·121835 | 10·098033 | 8 13 | 9·901967 | 44 | 56 |
| 30 | 18 | 9·780216 | 9 25 | 10·219784 | 9·878297 | 9 39 | 10·121703 | 10·098080 | 9 14 | 9·901920 | 42 | 30 |
| 5 | 20 | 9·780300 | 10 28 | 10·219700 | 9·878428 | 10 44 | 10·121572 | 10·098128 | 10 16 | 9·901872 | 40 | 55 |
| 30 | 22 | 9·780384 | 11 31 | 10·219616 | 9·878559 | 11 48 | 10·121441 | 10·098176 | 11 18 | 9·901824 | 38 | 30 |
| 6 | 24 | 9·780467 | 12 34 | 10·219533 | 9·878691 | 12 52 | 10·121309 | 10·098224 | 12 19 | 9·901776 | 36 | 54 |
| 30 | 26 | 9·780551 | 13 36 | 10·219449 | 9·878822 | 13 57 | 10·121178 | 10·098271 | 13 21 | 9·901729 | 34 | 30 |
| 7 | 28 | 9·780634 | 14 39 | 10·219366 | 9·878953 | 14 61 | 10·121047 | 10·098319 | 14 22 | 9·901681 | 32 | 53 |
| 30 | 30 | 9·780718 | 15 42 | 10·219282 | 9·879085 | 15 66 | 10·120915 | 10·098367 | 15 24 | 9·901633 | 30 | 30 |
| 8 | 32 | 9·780801 | 16 45 | 10·219199 | 9·879216 | 16 70 | 10·120784 | 10·098415 | 16 25 | 9·901585 | 28 | 52 |
| 30 | 34 | 9·780884 | 17 47 | 10·219116 | 9·879347 | 17 74 | 10·120653 | 10·098463 | 17 27 | 9·901537 | 26 | 30 |
| 9 | 36 | 9·780968 | 18 50 | 10·219032 | 9·879478 | 18 79 | 10·120522 | 10·098510 | 18 29 | 9·901490 | 24 | 51 |
| 30 | 38 | 9·781051 | 19 53 | 10·218949 | 9·879609 | 19 83 | 10·120391 | 10·098558 | 19 30 | 9·901442 | 22 | 30 |
| 10 | 40 | 9·781134 | 20 56 | 10·218866 | 9·879741 | 20 87 | 10·120259 | 10·098606 | 20 32 | 9·901394 | 20 | 50 |
| 30 | 42 | 9·781218 | 21 58 | 10·218782 | 9·879872 | 21 92 | 10·120128 | 10·098654 | 21 33 | 9·901346 | 18 | 30 |
| 11 | 44 | 9·781301 | 22 61 | 10·218699 | 9·880003 | 22 96 | 10·119997 | 10·098702 | 22 35 | 9·901298 | 16 | 49 |
| 30 | 46 | 9·781384 | 23 64 | 10·218616 | 9·880134 | 23 101 | 10·119866 | 10·098750 | 23 37 | 9·901250 | 14 | 30 |
| 12 | 48 | 9·781468 | 24 67 | 10·218532 | 9·880265 | 24 105 | 10·119735 | 10·098798 | 24 38 | 9·901202 | 12 | 48 |
| 30 | 50 | 9·781551 | 25 70 | 10·218449 | 9·880397 | 25 109 | 10·119603 | 10·098846 | 25 40 | 9·901154 | 10 | 30 |
| 13 | 52 | 9·781634 | 26 73 | 10·218366 | 9·880528 | 26 114 | 10·119472 | 10·098894 | 26 41 | 9·901106 | 8 | 47 |
| 30 | 54 | 9·781717 | 27 75 | 10·218283 | 9·880659 | 27 118 | 10·119341 | 10·098942 | 27 43 | 9·901058 | 6 | 30 |
| 14 | 56 | 9·781800 | 28 78 | 10·218200 | 9·880790 | 28 122 | 10·119210 | 10·098990 | 28 45 | 9·901010 | 4 | 46 |
| 30 | 58 | 9·781883 | 29 81 | 10·218117 | 9·880921 | 29 127 | 10·119079 | 10·099038 | 29 46 | 9·900962 | 2 | 30 |
| 15 | 29 | 9·781966 | 30 83 | 10·218034 | 9·881052 | 30 131 | 10·118948 | 10·099086 | 30 48 | 9·900914 | 31 | 45 |
| 30 | 2 | 9·782049 | 1 3 | 10·217951 | 9·881183 | 1 4 | 10·118817 | 10·099134 | 1 2 | 9·900866 | 58 | 30 |
| 16 | 4 | 9·782132 | 2 6 | 10·217868 | 9·881314 | 2 9 | 10·118686 | 10·099182 | 2 3 | 9·900818 | 56 | 44 |
| 30 | 6 | 9·782215 | 3 8 | 10·217785 | 9·881445 | 3 13 | 10·118555 | 10·099230 | 3 5 | 9·900770 | 54 | 30 |
| 17 | 8 | 9·782298 | 4 11 | 10·217702 | 9·881577 | 4 17 | 10·118423 | 10·099278 | 4 6 | 9·900722 | 52 | 43 |
| 30 | 10 | 9·782381 | 5 14 | 10·217619 | 9·881708 | 5 22 | 10·118292 | 10·099326 | 5 8 | 9·900674 | 50 | 30 |
| 18 | 12 | 9·782464 | 6 17 | 10·217536 | 9·881839 | 6 26 | 10·118161 | 10·099374 | 6 10 | 9·900626 | 48 | 42 |
| 30 | 14 | 9·782547 | 7 19 | 10·217453 | 9·881970 | 7 31 | 10·118030 | 10·099422 | 7 11 | 9·900578 | 46 | 30 |
| 19 | 16 | 9·782630 | 8 22 | 10·217370 | 9·882101 | 8 35 | 10·117899 | 10·099471 | 8 13 | 9·900529 | 44 | 41 |
| 30 | 18 | 9·782713 | 9 25 | 10·217287 | 9·882232 | 9 39 | 10·117768 | 10·099519 | 9 14 | 9·900481 | 42 | 30 |
| 20 | 20 | 9·782796 | 10 28 | 10·217204 | 9·882363 | 10 44 | 10·117637 | 10·099567 | 10 16 | 9·900433 | 40 | 40 |
| 30 | 22 | 9·782879 | 11 30 | 10·217121 | 9·882494 | 11 48 | 10·117506 | 10·099615 | 11 18 | 9·900385 | 38 | 30 |
| 21 | 24 | 9·782961 | 12 33 | 10·217039 | 9·882625 | 12 52 | 10·117375 | 10·099663 | 12 19 | 9·900337 | 36 | 39 |
| 30 | 26 | 9·783044 | 13 36 | 10·216956 | 9·882756 | 13 57 | 10·117244 | 10·099711 | 13 21 | 9·900289 | 34 | 30 |
| 22 | 28 | 9·783127 | 14 39 | 10·216873 | 9·882887 | 14 61 | 10·117113 | 10·099760 | 14 23 | 9·900240 | 32 | 38 |
| 30 | 30 | 9·783210 | 15 41 | 10·216790 | 9·883018 | 15 65 | 10·116982 | 10·099808 | 15 24 | 9·900192 | 30 | 30 |
| 23 | 32 | 9·783292 | 16 44 | 10·216708 | 9·883148 | 16 70 | 10·116852 | 10·099856 | 16 26 | 9·900144 | 28 | 37 |
| 30 | 34 | 9·783375 | 17 47 | 10·216625 | 9·883279 | 17 74 | 10·116721 | 10·099904 | 17 27 | 9·900096 | 26 | 30 |
| 24 | 36 | 9·783458 | 18 50 | 10·216542 | 9·883410 | 18 78 | 10·116590 | 10·099953 | 18 29 | 9·900047 | 24 | 36 |
| 30 | 38 | 9·783540 | 19 52 | 10·216460 | 9·883541 | 19 83 | 10·116459 | 10·100001 | 19 31 | 9·899999 | 22 | 30 |
| 25 | 40 | 9·783623 | 20 55 | 10·216377 | 9·883672 | 20 87 | 10·116328 | 10·100049 | 20 32 | 9·899951 | 20 | 35 |
| 30 | 42 | 9·783705 | 21 58 | 10·216295 | 9·883803 | 21 92 | 10·116197 | 10·100098 | 21 34 | 9·899902 | 18 | 30 |
| 26 | 44 | 9·783788 | 22 61 | 10·216212 | 9·883934 | 22 96 | 10·116066 | 10·100146 | 22 35 | 9·899854 | 16 | 34 |
| 30 | 46 | 9·783870 | 23 63 | 10·216130 | 9·884065 | 23 100 | 10·115935 | 10·100194 | 23 37 | 9·899806 | 14 | 30 |
| 27 | 48 | 9·783953 | 24 66 | 10·216047 | 9·884196 | 24 105 | 10·115804 | 10·100243 | 24 39 | 9·899757 | 12 | 33 |
| 30 | 50 | 9·784035 | 25 69 | 10·215965 | 9·884326 | 25 109 | 10·115674 | 10·100291 | 25 40 | 9·899709 | 10 | 30 |
| 28 | 52 | 9·784118 | 26 72 | 10·215882 | 9·884457 | 26 113 | 10·115543 | 10·100340 | 26 42 | 9·899660 | 8 | 32 |
| 30 | 54 | 9·784200 | 27 74 | 10·215800 | 9·884588 | 27 118 | 10·115412 | 10·100388 | 27 43 | 9·899612 | 6 | 30 |
| 29 | 56 | 9·784282 | 28 77 | 10·215718 | 9·884719 | 28 122 | 10·115281 | 10·100436 | 28 45 | 9·899564 | 4 | 31 |
| 30 | 58 | 5·784365 | 29 80 | 10·215635 | 9·884850 | 29 126 | 10·115150 | 10·100485 | 29 47 | 9·899515 | 2 | 30 |
| 30 | 30 | 9·784447 | 30 83 | 10·215553 | 9·884980 | 30 131 | 10·115020 | 10·100533 | 30 48 | 9·899467 | 0 | 30 |
| ′ ″ | m. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. | ′ ″ |

52° — 3ᵗ 30ᵐ

## LOG. SINES, COSINES, &c.

2ʰ 30ᵐ — 37°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 9·784447 | | 10·215553 | 9·884980 | | 10·115020 | 10·100533 | | 9·899467 | 30 | 30 |
| 30 | 2 | 9·784529 | 1″ 3 | 10·215471 | 9·885111 | 1″ 4 | 10·114889 | 10·100582 | 1″ 2 | 9·899418 | 58 | 30 |
| 31 | 4 | 9·784612 | 2 5 | 10·215388 | 9·885242 | 2 9 | 10·114758 | 10·100630 | 2 3 | 9·899370 | 56 | 29 |
| 30 | 6 | 9·784694 | 3 8 | 10·215306 | 9·885373 | 3 13 | 10·114627 | 10·100679 | 3 5 | 9·899321 | 54 | 30 |
| 32 | 8 | 9·784776 | 4 11 | 10·215224 | 9·885504 | 4 17 | 10·114496 | 10·100727 | 4 6 | 9·899273 | 52 | 28 |
| 30 | 10 | 9·784858 | 5 14 | 10·215142 | 9·885634 | 5 22 | 10·114366 | 10·100776 | 5 8 | 9·899224 | 50 | 30 |
| 33 | 12 | 9·784941 | 6 16 | 10·215059 | 9·885765 | 6 26 | 10·114235 | 10·100824 | 6 10 | 9·899176 | 48 | 27 |
| 30 | 14 | 9·785023 | 7 19 | 10·214977 | 9·885896 | 7 30 | 10·114104 | 10·100873 | 7 11 | 9·899127 | 46 | 30 |
| 34 | 16 | 9·785105 | 8 22 | 10·214895 | 9·886026 | 8 35 | 10·113974 | 10·100922 | 8 13 | 9·899078 | 44 | 26 |
| 30 | 18 | 9·785187 | 9 25 | 10·214813 | 9·886157 | 9 39 | 10·113843 | 10·100970 | 9 15 | 9·899030 | 42 | 30 |
| 35 | 20 | 9·785269 | 10 27 | 10·214731 | 9·886288 | 10 43 | 10·113712 | 10·101019 | 10 16 | 9·898981 | 40 | 25 |
| 30 | 22 | 9·785351 | 11 30 | 10·214649 | 9·886419 | 11 48 | 10·113581 | 10·101067 | 11 18 | 9·898933 | 38 | 30 |
| 36 | 24 | 9·785433 | 12 33 | 10·214567 | 9·886549 | 12 52 | 10·113451 | 10·101116 | 12 19 | 9·898884 | 36 | 24 |
| 30 | 26 | 9·785515 | 13 36 | 10·214485 | 9·886680 | 13 57 | 10·113320 | 10·101165 | 13 21 | 9·898835 | 34 | 30 |
| 37 | 28 | 9·785597 | 14 39 | 10·214403 | 9·886811 | 14 61 | 10·113189 | 10·101213 | 14 23 | 9·898787 | 32 | 23 |
| 30 | 30 | 9·785679 | 15 41 | 10·214321 | 9·886941 | 15 65 | 10·113059 | 10·101262 | 15 24 | 9·898738 | 30 | 30 |
| 38 | 32 | 9·785761 | 16 44 | 10·214239 | 9·887072 | 16 70 | 10·112928 | 10·101311 | 16 26 | 9·898689 | 28 | 22 |
| 30 | 34 | 9·785843 | 17 47 | 10·214157 | 9·887202 | 17 74 | 10·112798 | 10·101359 | 17 28 | 9·898641 | 26 | 30 |
| 39 | 36 | 9·785925 | 18 49 | 10·214075 | 9·887333 | 18 78 | 10·112667 | 10·101408 | 18 29 | 9·898592 | 24 | 21 |
| 30 | 38 | 9·786007 | 19 52 | 10·213993 | 9·887464 | 19 83 | 10·112536 | 10·101457 | 19 31 | 9·898543 | 22 | 30 |
| 40 | 40 | 9·786089 | 20 55 | 10·213911 | 9·887594 | 20 87 | 10·112406 | 10·101506 | 20 32 | 9·898494 | 20 | 20 |
| 30 | 42 | 9·786170 | 21 57 | 10·213830 | 9·887725 | 21 91 | 10·112275 | 10·101554 | 21 34 | 9·898446 | 18 | 30 |
| 41 | 44 | 9·786252 | 22 60 | 10·213748 | 9·887855 | 22 96 | 10·112145 | 10·101603 | 22 36 | 9·898397 | 16 | 19 |
| 30 | 46 | 9·786334 | 23 63 | 10·213666 | 9·887986 | 23 100 | 10·112014 | 10·101652 | 23 37 | 9·898348 | 14 | 30 |
| 42 | 48 | 9·786416 | 24 66 | 10·213584 | 9·888116 | 24 104 | 10·111884 | 10·101701 | 24 39 | 9·898299 | 12 | 18 |
| 30 | 50 | 9·786497 | 25 68 | 10·213503 | 9·888247 | 25 109 | 10·111753 | 10·101750 | 25 41 | 9·898250 | 10 | 30 |
| 43 | 52 | 9·786579 | 26 71 | 10·213421 | 9·888378 | 26 113 | 10·111622 | 10·101798 | 26 42 | 9·898202 | 8 | 17 |
| 30 | 54 | 9·786661 | 27 74 | 10·213339 | 9·888508 | 27 117 | 10·111492 | 10·101847 | 27 44 | 9·898153 | 6 | 30 |
| 44 | 56 | 9·786742 | 28 77 | 10·213258 | 9·888639 | 28 122 | 10·111361 | 10·101896 | 28 46 | 9·898104 | 4 | 16 |
| 30 | 58 | 9·786824 | 29 80 | 10·213176 | 9·888769 | 29 126 | 10·111231 | 10·101945 | 29 47 | 9·898055 | 2 | 30 |
| 45 | 31 | 9·786906 | 30 82 | 10·213094 | 9·888900 | 30 130 | 10·111100 | 10·101994 | 30 48 | 9·898006 | 29 | 15 |
| 30 | 2 | 9·786987 | 1 3 | 10·213013 | 9·889030 | 1 4 | 10·110970 | 10·102043 | 1 2 | 9·897957 | 58 | 30 |
| 46 | 4 | 9·787069 | 2 5 | 10·212931 | 9·889161 | 2 9 | 10·110839 | 10·102092 | 2 3 | 9·897908 | 56 | 14 |
| 30 | 6 | 9·787150 | 3 8 | 10·212850 | 9·889291 | 3 13 | 10·110709 | 10·102141 | 3 5 | 9·897859 | 54 | 30 |
| 47 | 8 | 9·787232 | 4 11 | 10·212768 | 9·889421 | 4 17 | 10·110579 | 10·102190 | 4 7 | 9·897810 | 52 | 13 |
| 30 | 10 | 9·787313 | 5 14 | 10·212687 | 9·889552 | 5 22 | 10·110448 | 10·102239 | 5 8 | 9·897761 | 50 | 30 |
| 48 | 12 | 9·787395 | 6 16 | 10·212605 | 9·889682 | 6 26 | 10·110318 | 10·102288 | 6 10 | 9·897712 | 48 | 12 |
| 30 | 14 | 9·787476 | 7 19 | 10·212524 | 9·889813 | 7 30 | 10·110187 | 10·102337 | 7 11 | 9·897663 | 46 | 30 |
| 49 | 16 | 9·787557 | 8 22 | 10·212443 | 9·889943 | 8 35 | 10·110057 | 10·102386 | 8 13 | 9·897614 | 44 | 11 |
| 30 | 18 | 9·787639 | 9 24 | 10·212361 | 9·890074 | 9 39 | 10·109926 | 10·102435 | 9 15 | 9·897565 | 42 | 30 |
| 50 | 20 | 9·787720 | 10 27 | 10·212280 | 9·890204 | 10 43 | 10·109796 | 10·102484 | 10 16 | 9·897516 | 40 | 10 |
| 30 | 22 | 9·787801 | 11 30 | 10·212199 | 9·890334 | 11 48 | 10·109666 | 10·102533 | 11 18 | 9·897467 | 38 | 30 |
| 51 | 24 | 9·787883 | 12 33 | 10·212117 | 9·890465 | 12 52 | 10·109535 | 10·102582 | 12 20 | 9·897418 | 36 | 9 |
| 30 | 26 | 9·787964 | 13 35 | 10·212036 | 9·890595 | 13 56 | 10·109405 | 10·102631 | 13 21 | 9·897369 | 34 | 30 |
| 52 | 28 | 9·788045 | 14 38 | 10·211955 | 9·890725 | 14 61 | 10·109275 | 10·102680 | 14 23 | 9·897320 | 32 | 8 |
| 30 | 30 | 9·788127 | 15 41 | 10·211873 | 9·890856 | 15 65 | 10·109144 | 10·102729 | 15 25 | 9·897271 | 30 | 30 |
| 53 | 32 | 9·788208 | 16 43 | 10·211792 | 9·890986 | 16 69 | 10·109014 | 10·102778 | 16 26 | 9·897222 | 28 | 7 |
| 30 | 34 | 9·788289 | 17 46 | 10·211711 | 9·891116 | 17 74 | 10·108884 | 10·102828 | 17 28 | 9·897172 | 26 | 30 |
| 54 | 36 | 9·788370 | 18 49 | 10·211630 | 9·891247 | 18 78 | 10·108753 | 10·102877 | 18 29 | 9·897123 | 24 | 6 |
| 30 | 38 | 9·788451 | 19 51 | 10·211549 | 9·891377 | 19 82 | 10·108623 | 10·102926 | 19 31 | 9·897074 | 22 | 30 |
| 55 | 40 | 9·788532 | 20 54 | 10·211468 | 9·891507 | 20 87 | 10·108493 | 10·102975 | 20 33 | 9·897025 | 20 | 5 |
| 30 | 42 | 9·788613 | 21 57 | 10·211387 | 9·891638 | 21 91 | 10·108362 | 10·103024 | 21 34 | 9·896976 | 18 | 30 |
| 56 | 44 | 9·788694 | 22 60 | 10·211306 | 9·891768 | 22 95 | 10·108232 | 10·103074 | 22 36 | 9·896926 | 16 | 4 |
| 30 | 46 | 9·788775 | 23 62 | 10·211225 | 9·891898 | 23 100 | 10·108102 | 10·103123 | 23 38 | 9·896877 | 14 | 30 |
| 57 | 48 | 9·788856 | 24 65 | 10·211144 | 9·892028 | 24 104 | 10·107972 | 10·103172 | 24 39 | 9·896828 | 12 | 3 |
| 30 | 50 | 9·788937 | 25 68 | 10·211063 | 9·892159 | 25 108 | 10·107841 | 10·103221 | 25 41 | 9·896779 | 10 | 30 |
| 58 | 52 | 9·789018 | 26 71 | 10·210982 | 9·892289 | 26 113 | 10·107711 | 10·103271 | 26 42 | 9·896729 | 8 | 2 |
| 30 | 54 | 9·789099 | 27 73 | 10·210901 | 9·892419 | 27 117 | 10·107581 | 10·103320 | 27 44 | 9·896680 | 6 | 30 |
| 59 | 56 | 9·789180 | 28 76 | 10·210820 | 9·892549 | 28 122 | 10·107451 | 10·103369 | 28 46 | 9·896631 | 4 | 1 |
| 30 | 58 | 9·789261 | 29 79 | 10·210739 | 9·892680 | 29 126 | 10·107320 | 10·103419 | 29 48 | 9·896581 | 2 | 30 |
| 60 | 32 | 9·789342 | 30 81 | 10·210658 | 9·892810 | 30 130 | 10·107190 | 10·103468 | 30 49 | 9·896532 | 0 | 0 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

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## LOG. SINES, COSINES, &c.

2h 32m — 38°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 9·789342 | | 10·210658 | 9·892810 | | 10·107190 | 10·103468 | | 9·896532 | 28 | 60 |
| 30 | 2 | 9·789423 | 1″ 3 | 10·210577 | 9·892940 | 1″ 4 | 10·107060 | 10·103517 | 1″ 2 | 9·896483 | 58 | 30 |
| 1 | 4 | 9·789504 | 2 5 | 10·210496 | 9·893070 | 2 9 | 10·106930 | 10·103567 | 2 3 | 9·896433 | 56 | 59 |
| 30 | 6 | 9·789584 | 3 8 | 10·210416 | 9·893200 | 3 13 | 10·106800 | 10·103616 | 3 5 | 9·896384 | 54 | 30 |
| 2 | 8 | 9·789665 | 4 11 | 10·210335 | 9·893331 | 4 17 | 10·106669 | 10·103665 | 4 7 | 9·896335 | 52 | 58 |
| 30 | 10 | 9·789746 | 5 13 | 10·210254 | 9·893461 | 5 22 | 10·106539 | 10·103715 | 5 8 | 9·896285 | 50 | 30 |
| 3 | 12 | 9·789827 | 6 16 | 10·210173 | 9·893591 | 6 26 | 10·106409 | 10·103764 | 6 10 | 9·896236 | 48 | 57 |
| 30 | 14 | 9·789907 | 7 19 | 10·210093 | 9·893721 | 7 30 | 10·106279 | 10·103814 | 7 12 | 9·896186 | 46 | 30 |
| 4 | 16 | 9·789988 | 8 21 | 10·210012 | 9·893851 | 8 35 | 10·106149 | 10·103863 | 8 13 | 9·896137 | 44 | 56 |
| 30 | 18 | 9·790069 | 9 24 | 10·209931 | 9·893981 | 9 39 | 10·106019 | 10·103913 | 9 15 | 9·896087 | 42 | 30 |
| 5 | 20 | 9·790149 | 10 27 | 10·209851 | 9·894111 | 10 43 | 10·105889 | 10·103962 | 10 16 | 9·896038 | 40 | 55 |
| 30 | 22 | 9·790230 | 11 29 | 10·209770 | 9·894241 | 11 48 | 10·105759 | 10·104012 | 11 18 | 9·895988 | 38 | 30 |
| 6 | 24 | 9·790310 | 12 32 | 10·209690 | 9·894372 | 12 52 | 10·105628 | 10·104061 | 12 20 | 9·895939 | 36 | 54 |
| 30 | 26 | 9·790391 | 13 35 | 10·209609 | 9·894502 | 13 56 | 10·105498 | 10·104111 | 13 21 | 9·895889 | 34 | 30 |
| 7 | 28 | 9·790471 | 14 37 | 10·209529 | 9·894632 | 14 61 | 10·105368 | 10·104160 | 14 23 | 9·895840 | 32 | 53 |
| 30 | 30 | 9·790552 | 15 40 | 10·209448 | 9·894762 | 15 65 | 10·105238 | 10·104210 | 15 25 | 9·895790 | 30 | 30 |
| 8 | 32 | 9·790632 | 16 43 | 10·209368 | 9·894892 | 16 69 | 10·105108 | 10·104259 | 16 26 | 9·895741 | 28 | 52 |
| 30 | 34 | 9·790713 | 17 46 | 10·209287 | 9·895022 | 17 74 | 10·104978 | 10·104309 | 17 28 | 9·895691 | 26 | 30 |
| 9 | 36 | 9·790793 | 18 48 | 10·209207 | 9·895152 | 18 78 | 10·104848 | 10·104359 | 18 30 | 9·895641 | 24 | 51 |
| 30 | 38 | 9·790874 | 19 51 | 10·209126 | 9·895282 | 19 82 | 10·104718 | 10·104408 | 19 31 | 9·895592 | 22 | 30 |
| 10 | 40 | 9·790954 | 20 54 | 10·209046 | 9·895412 | 20 87 | 10·104588 | 10·104458 | 20 33 | 9·895542 | 20 | 50 |
| 30 | 42 | 9·791034 | 21 56 | 10·208966 | 9·895542 | 21 91 | 10·104458 | 10·104507 | 21 35 | 9·895493 | 18 | 30 |
| 11 | 44 | 9·791115 | 22 59 | 10·208885 | 9·895672 | 22 95 | 10·104328 | 10·104557 | 22 36 | 9·895443 | 16 | 49 |
| 30 | 46 | 9·791195 | 23 62 | 10·208805 | 9·895802 | 23 100 | 10·104198 | 10·104607 | 23 38 | 9·895393 | 14 | 30 |
| 12 | 48 | 9·791275 | 24 65 | 10·208725 | 9·895932 | 24 104 | 10·104068 | 10·104657 | 24 40 | 9·895343 | 12 | 48 |
| 30 | 50 | 9·791356 | 25 67 | 10·208644 | 9·896062 | 25 108 | 10·103938 | 10·104706 | 25 41 | 9·895294 | 10 | 30 |
| 13 | 52 | 9·791436 | 26 70 | 10·208564 | 9·896192 | 26 113 | 10·103808 | 10·104756 | 26 43 | 9·895244 | 8 | 47 |
| 30 | 54 | 9·791516 | 27 72 | 10·208484 | 9·896322 | 27 117 | 10·103678 | 10·104806 | 27 45 | 9·895194 | 6 | 30 |
| 14 | 56 | 9·791596 | 28 75 | 10·208404 | 9·896452 | 28 121 | 10·103548 | 10·104855 | 28 46 | 9·895145 | 4 | 46 |
| 30 | 58 | 9·791676 | 29 78 | 10·208324 | 9·896582 | 29 126 | 10·103418 | 10·104905 | 29 48 | 9·895095 | 2 | 30 |
| 15 | 33 | 9·791757 | 30 80 | 10·208243 | 9·896712 | 30 130 | 10·103288 | 10·104955 | 30 50 | 9·895045 | 27 | 45 |
| 30 | 2 | 9·791837 | 1 3 | 10·208163 | 9·896842 | 1 4 | 10·103158 | 10·105005 | 1 2 | 9·894995 | 58 | 30 |
| 16 | 4 | 9·791917 | 2 5 | 10·208083 | 9·896971 | 2 9 | 10·103029 | 10·105055 | 2 3 | 9·894945 | 56 | 44 |
| 30 | 6 | 9·791997 | 3 8 | 10·208003 | 9·897101 | 3 13 | 10·102899 | 10·105104 | 3 5 | 9·894896 | 54 | 30 |
| 17 | 8 | 9·792077 | 4 11 | 10·207923 | 9·897231 | 4 17 | 10·102769 | 10·105154 | 4 7 | 9·894846 | 52 | 43 |
| 30 | 10 | 9·792157 | 5 13 | 10·207843 | 9·897361 | 5 22 | 10·102639 | 10·105204 | 5 8 | 9·894796 | 50 | 30 |
| 18 | 12 | 9·792237 | 6 16 | 10·207763 | 9·897491 | 6 26 | 10·102509 | 10·105254 | 6 10 | 9·894746 | 48 | 42 |
| 30 | 14 | 9·792317 | 7 19 | 10·207683 | 9·897621 | 7 30 | 10·102379 | 10·105304 | 7 12 | 9·894696 | 46 | 30 |
| 19 | 16 | 9·792397 | 8 21 | 10·207603 | 9·897751 | 8 35 | 10·102249 | 10·105354 | 8 13 | 9·894646 | 44 | 41 |
| 30 | 18 | 9·792477 | 9 24 | 10·207523 | 9·897881 | 9 39 | 10·102119 | 10·105404 | 9 15 | 9·894596 | 42 | 30 |
| 20 | 20 | 9·792557 | 10 27 | 10·207443 | 9·898010 | 10 43 | 10·101990 | 10·105454 | 10 17 | 9·894546 | 40 | 40 |
| 30 | 22 | 9·792636 | 11 30 | 10·207364 | 9·898140 | 11 48 | 10·101860 | 10·105504 | 11 18 | 9·894496 | 38 | 30 |
| 21 | 24 | 9·792716 | 12 32 | 10·207284 | 9·898270 | 12 52 | 10·101730 | 10·105554 | 12 20 | 9·894446 | 36 | 39 |
| 30 | 26 | 9·792796 | 13 35 | 10·207204 | 9·898400 | 13 56 | 10·101600 | 10·105604 | 13 22 | 9·894396 | 34 | 30 |
| 22 | 28 | 9·792876 | 14 37 | 10·207124 | 9·898530 | 14 61 | 10·101470 | 10·105654 | 14 23 | 9·894346 | 32 | 38 |
| 30 | 30 | 9·792956 | 15 40 | 10·207044 | 9·898659 | 15 65 | 10·101341 | 10·105704 | 15 25 | 9·894296 | 30 | 30 |
| 23 | 32 | 9·793035 | 16 43 | 10·206965 | 9·898789 | 16 69 | 10·101211 | 10·105754 | 16 27 | 9·894246 | 28 | 37 |
| 30 | 34 | 9·793115 | 17 45 | 10·206885 | 9·898919 | 17 74 | 10·101081 | 10·105804 | 17 28 | 9·894196 | 26 | 30 |
| 24 | 36 | 9·793195 | 18 48 | 10·206805 | 9·899049 | 18 78 | 10·100951 | 10·105854 | 18 30 | 9·894146 | 24 | 36 |
| 30 | 38 | 9·793275 | 19 51 | 10·206725 | 9·899178 | 19 82 | 10·100822 | 10·105904 | 19 32 | 9·894096 | 22 | 30 |
| 25 | 40 | 9·793354 | 20 53 | 10·206646 | 9·899308 | 20 86 | 10·100692 | 10·105954 | 20 33 | 9·894046 | 20 | 35 |
| 30 | 42 | 9·793434 | 21 56 | 10·206566 | 9·899438 | 21 91 | 10·100502 | 10·106004 | 21 35 | 9·893996 | 18 | 30 |
| 26 | 44 | 9·793514 | 22 59 | 10·206486 | 9·899568 | 22 95 | 10·100432 | 10·106054 | 22 37 | 9·893946 | 16 | 34 |
| 30 | 46 | 9·793593 | 23 61 | 10·206407 | 9·899697 | 23 99 | 10·100303 | 10·106104 | 23 38 | 9·893896 | 14 | 30 |
| 27 | 48 | 9·793673 | 24 64 | 10·206327 | 9·899827 | 24 104 | 10·100173 | 10·106154 | 24 40 | 9·893846 | 12 | 33 |
| 30 | 50 | 9·793752 | 25 67 | 10·206248 | 9·899957 | 25 108 | 10·100043 | 10·106205 | 25 42 | 9·893795 | 10 | 30 |
| 28 | 52 | 9·793832 | 26 69 | 10·206168 | 9·900087 | 26 112 | 10·099913 | 10·106255 | 26 43 | 9·893745 | 8 | 32 |
| 30 | 54 | 9·793911 | 27 72 | 10·206089 | 9·900216 | 27 117 | 10·099784 | 10·106305 | 27 45 | 9·893695 | 6 | 30 |
| 29 | 56 | 9·793991 | 28 74 | 10·206009 | 9·900346 | 28 121 | 10·099654 | 10·106355 | 28 47 | 9·893645 | 4 | 31 |
| 30 | 58 | 9·794070 | 29 77 | 10·205930 | 9·900475 | 29 125 | 10·099524 | 10·106405 | 29 48 | 9·893595 | 2 | 30 |
| 30 | 34 | 9·794150 | 30 80 | 10·205850 | 9·900605 | 30 130 | 10·099395 | 10·106456 | 30 50 | 9·893544 | 0 | 30 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

51° — 3h 26m

## LOG. SINES, COSINES, &c.

$2^h\ 34^m$ 38°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 9·794150 | | 10·205850 | 9·900605 | | 10·099395 | 10·106456 | | 9·893544 | 26 | 30 |
| 30 | 2 | 9·794229 | 1″ 3 | 10·205771 | 9·900735 | 1″ 4 | 10·099265 | 10·106506 | 1″ 2 | 9·893494 | 58 | 30 |
| 31 | 4 | 9·794308 | 2 5 | 10·205692 | 9·900864 | 2 9 | 10·099136 | 10·106556 | 2 3 | 9·893444 | 56 | 29 |
| 30 | 6 | 9·794388 | 3 8 | 10·205612 | 9·900994 | 3 13 | 10·099006 | 10·106606 | 3 5 | 9·893394 | 54 | 30 |
| 32 | 8 | 9·794467 | 4 11 | 10·205533 | 9·901124 | 4 17 | 10·098876 | 10·106657 | 4 7 | 9·893343 | 52 | 28 |
| 30 | 10 | 9·794546 | 5 13 | 10·205454 | 9·901253 | 5 22 | 10·098747 | 10·106707 | 5 8 | 9·893293 | 50 | 30 |
| 33 | 12 | 9·794626 | 6 16 | 10·205374 | 9·901383 | 6 26 | 10·098617 | 10·106757 | 6 10 | 9·893243 | 48 | 27 |
| 30 | 14 | 9·794705 | 7 19 | 10·205295 | 9·901513 | 7 30 | 10·098487 | 10·106808 | 7 12 | 9·893192 | 46 | 30 |
| 34 | 16 | 9·794784 | 8 21 | 10·205216 | 9·901642 | 8 35 | 10·098358 | 10·106858 | 8 13 | 9·893142 | 44 | 26 |
| 30 | 18 | 9·794863 | 9 24 | 10·205137 | 9·901772 | 9 39 | 10·098228 | 10·106908 | 9 15 | 9·893092 | 42 | 30 |
| 35 | 20 | 9·794942 | 10 26 | 10·205058 | 9·901901 | 10 43 | 10·098099 | 10·106959 | 10 17 | 9·893041 | 40 | 25 |
| 30 | 22 | 9·795022 | 11 29 | 10·204978 | 9·902031 | 11 48 | 10·097969 | 10·107009 | 11 18 | 9·892991 | 38 | 30 |
| 36 | 24 | 9·795101 | 12 32 | 10·204899 | 9·902160 | 12 52 | 10·097840 | 10·107060 | 12 20 | 9·892940 | 36 | 24 |
| 30 | 26 | 9·795180 | 13 34 | 10·204820 | 9·902290 | 13 56 | 10·097710 | 10·107110 | 13 22 | 9·892890 | 34 | 30 |
| 37 | 28 | 9·795259 | 14 37 | 10·204741 | 9·902420 | 14 60 | 10·097580 | 10·107161 | 14 24 | 9·892839 | 32 | 23 |
| 30 | 30 | 9·795338 | 15 39 | 10·204662 | 9·902549 | 15 65 | 10·097451 | 10·107211 | 15 25 | 9·892789 | 30 | 30 |
| 38 | 32 | 9·795417 | 16 42 | 10·204583 | 9·902679 | 16 69 | 10·097321 | 10·107261 | 16 27 | 9·892739 | 28 | 22 |
| 30 | 34 | 9·795496 | 17 45 | 10·204504 | 9·902808 | 17 73 | 10·097192 | 10·107312 | 17 29 | 9·892688 | 26 | 30 |
| 39 | 36 | 9·795575 | 18 47 | 10·204425 | 9·902938 | 18 78 | 10·097062 | 10·107362 | 18 30 | 9·892638 | 24 | 21 |
| 30 | 38 | 9·795654 | 19 50 | 10·204346 | 9·903067 | 19 82 | 10·096933 | 10·107413 | 19 32 | 9·892587 | 22 | 30 |
| 40 | 40 | 9·795733 | 20 53 | 10·204267 | 9·903197 | 20 86 | 10·096803 | 10·107464 | 20 34 | 9·892536 | 20 | 20 |
| 30 | 42 | 9·795812 | 21 55 | 10·204188 | 9·903326 | 21 91 | 10·096674 | 10·107514 | 21 35 | 9·892486 | 18 | 30 |
| 41 | 44 | 9·795891 | 22 58 | 10·204109 | 9·903456 | 22 95 | 10·096544 | 10·107565 | 22 37 | 9·892435 | 16 | 19 |
| 30 | 46 | 9·795970 | 23 60 | 10·204030 | 9·903585 | 23 99 | 10·096415 | 10·107615 | 23 39 | 9·892385 | 14 | 30 |
| 42 | 48 | 9·796049 | 24 63 | 10·203951 | 9·903714 | 24 104 | 10·096286 | 10·107666 | 24 40 | 9·892334 | 12 | 18 |
| 30 | 50 | 9·796127 | 25 66 | 10·203873 | 9·903844 | 25 108 | 10·096156 | 10·107716 | 25 42 | 9·892284 | 10 | 30 |
| 43 | 52 | 9·796206 | 26 68 | 10·203794 | 9·903973 | 26 112 | 10·096027 | 10·107767 | 26 44 | 9·892233 | 8 | 17 |
| 30 | 54 | 9·796285 | 27 71 | 10·203715 | 9·904103 | 27 117 | 10·095897 | 10·107818 | 27 45 | 9·892182 | 6 | 30 |
| 44 | 56 | 9·796364 | 28 74 | 10·203636 | 9·904232 | 28 121 | 10·095768 | 10·107868 | 28 47 | 9·892132 | 4 | 16 |
| 30 | 58 | 9·796443 | 29 76 | 10·203557 | 9·904362 | 29 125 | 10·095638 | 10·107919 | 29 49 | 9·892081 | 2 | 30 |
| 45 | 35 | 9·796521 | 30 79 | 10·203479 | 9·904491 | 30 130 | 10·095509 | 10·107970 | 30 50 | 9·892030 | 25 | 15 |
| 30 | 2 | 9·796600 | 1 3 | 10·203400 | 9·904620 | 1 4 | 10·095380 | 10·108020 | 1 2 | 9·891980 | 58 | 30 |
| 46 | 4 | 9·796679 | 2 5 | 10·203321 | 9·904750 | 2 9 | 10·095250 | 10·108071 | 2 3 | 9·891929 | 56 | 14 |
| 30 | 6 | 9·796757 | 3 8 | 10·203243 | 9·904879 | 3 13 | 10·095121 | 10·108122 | 3 5 | 9·891878 | 54 | 30 |
| 47 | 8 | 9·796836 | 4 10 | 10·203164 | 9·905008 | 4 17 | 10·094992 | 10·108173 | 4 7 | 9·891827 | 52 | 13 |
| 30 | 10 | 9·796914 | 5 13 | 10·203086 | 9·905138 | 5 22 | 10·094862 | 10·108223 | 5 8 | 9·891777 | 50 | 30 |
| 48 | 12 | 9·796993 | 6 16 | 10·203007 | 9·905267 | 6 26 | 10·094733 | 10·108274 | 6 10 | 9·891726 | 48 | 12 |
| 30 | 14 | 9·797072 | 7 18 | 10·202928 | 9·905397 | 7 30 | 10·094603 | 10·108325 | 7 12 | 9·891675 | 46 | 30 |
| 49 | 16 | 9·797150 | 8 21 | 10·202850 | 9·905526 | 8 34 | 10·094474 | 10·108376 | 8 14 | 9·891624 | 44 | 11 |
| 30 | 18 | 9·797229 | 9 23 | 10·202771 | 9·905655 | 9 39 | 10·094345 | 10·108427 | 9 15 | 9·891573 | 42 | 30 |
| 50 | 20 | 9·797307 | 10 26 | 10·202693 | 9·905785 | 10 43 | 10·094215 | 10·108477 | 10 17 | 9·891523 | 40 | 10 |
| 30 | 22 | 9·797386 | 11 29 | 10·202614 | 9·905914 | 11 47 | 10·094086 | 10·108528 | 11 19 | 9·891472 | 38 | 30 |
| 51 | 24 | 9·797464 | 12 31 | 10·202536 | 9·906043 | 12 52 | 10·093957 | 10·108579 | 12 20 | 9·891421 | 36 | 9 |
| 30 | 26 | 9·797542 | 13 34 | 10·202458 | 9·906172 | 13 56 | 10·093828 | 10·108630 | 13 22 | 9·891370 | 34 | 30 |
| 52 | 28 | 9·797621 | 14 37 | 10·202379 | 9·906302 | 14 60 | 10·093698 | 10·108681 | 14 24 | 9·891319 | 32 | 8 |
| 30 | 30 | 9·797699 | 15 39 | 10·202301 | 9·906431 | 15 65 | 10·093569 | 10·108732 | 15 25 | 9·891268 | 30 | 30 |
| 53 | 32 | 9·797777 | 16 42 | 10·202223 | 9·906560 | 16 69 | 10·093440 | 10·108783 | 16 27 | 9·891217 | 28 | 7 |
| 30 | 34 | 9·797856 | 17 45 | 10·202144 | 9·906690 | 17 73 | 10·093310 | 10·108834 | 17 29 | 9·891166 | 26 | 30 |
| 54 | 36 | 9·797934 | 18 47 | 10·202066 | 9·906819 | 18 78 | 10·093181 | 10·108885 | 18 31 | 9·891115 | 24 | 6 |
| 30 | 38 | 9·798012 | 19 50 | 10·201988 | 9·906948 | 19 82 | 10·093052 | 10·108936 | 19 32 | 9·891064 | 22 | 30 |
| 55 | 40 | 9·798091 | 20 52 | 10·201909 | 9·907077 | 20 86 | 10·092923 | 10·108987 | 20 34 | 9·891013 | 20 | 5 |
| 30 | 42 | 9·798169 | 21 55 | 10·201831 | 9·907207 | 21 91 | 10·092793 | 10·109038 | 21 36 | 9·890962 | 18 | 30 |
| 56 | 44 | 9·798247 | 22 58 | 10·201753 | 9·907336 | 22 95 | 10·092664 | 10·109089 | 22 37 | 9·890911 | 16 | 4 |
| 30 | 46 | 9·798325 | 23 60 | 10·201675 | 9·907465 | 23 99 | 10·092535 | 10·109140 | 23 39 | 9·890860 | 14 | 30 |
| 57 | 48 | 9·798403 | 24 63 | 10·201597 | 9·907594 | 24 103 | 10·092406 | 10·109191 | 24 41 | 9·890809 | 12 | 3 |
| 30 | 50 | 9·798482 | 25 65 | 10·201518 | 9·907723 | 25 108 | 10·092277 | 10·109242 | 25 42 | 9·890758 | 10 | 30 |
| 58 | 52 | 9·798560 | 26 68 | 10·201440 | 9·907853 | 26 112 | 10·092147 | 10·109293 | 26 44 | 9·890707 | 8 | 2 |
| 30 | 54 | 9·798638 | 27 70 | 10·201362 | 9·907982 | 27 116 | 10·092018 | 10·109344 | 27 46 | 9·890656 | 6 | 30 |
| 59 | 56 | 9·798716 | 28 73 | 10·201284 | 9·908111 | 28 121 | 10·091889 | 10·109395 | 28 48 | 9·890605 | 4 | 1 |
| 30 | 58 | 9·798794 | 29 76 | 10·201206 | 9·908240 | 29 125 | 10·091760 | 10·109446 | 29 49 | 9·890554 | 2 | 30 |
| 60 | 36 | 9·798872 | 30 78 | 10·201128 | 9·908369 | 30 129 | 10·091631 | 10·109497 | 30 51 | 9·890503 | 0 | 0 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

51° $3^h\ 24^m$

## LOG. SINES, COSINES, &c.

$2^h$ $36^m$ — 39°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 9·798872 | | 10·201128 | 9·908369 | | 10·091631 | 10·109497 | | 9·890503 | 24 | 60 |
| 30 | 2 | 9·798950 | 1″ 3 | 10·201050 | 9·908498 | 1″ 4 | 10·091502 | 10·109549 | 1″ 2 | 9·890451 | 58 | 30 |
| 1 | 4 | 9·799028 | 2 5 | 10·200972 | 9·908628 | 2 9 | 10·091372 | 10·109600 | 2 3 | 9·890400 | 56 | 59 |
| 30 | 6 | 9·799106 | 3 8 | 10·200894 | 9·908757 | 3 13 | 10·091243 | 10·109651 | 3 5 | 9·890349 | 54 | 30 |
| 2 | 8 | 9·799184 | 4 10 | 10·200816 | 9·908886 | 4 17 | 10·091114 | 10·109702 | 4 7 | 9·890298 | 52 | 58 |
| 30 | 10 | 9·799262 | 5 13 | 10·200738 | 9·909015 | 5 21 | 10·090985 | 10·109753 | 5 9 | 9·890247 | 50 | 30 |
| 3 | 12 | 9·799339 | 6 16 | 10·200661 | 9·909144 | 6 26 | 10·090856 | 10·109805 | 6 10 | 9·890195 | 48 | 57 |
| 30 | 14 | 9·799417 | 7 18 | 10·200583 | 9·909273 | 7 30 | 10·090727 | 10·109856 | 7 12 | 9·890144 | 46 | 30 |
| 4 | 16 | 9·799495 | 8 21 | 10·200505 | 9·909402 | 8 34 | 10·090598 | 10·109907 | 8 14 | 9·890093 | 44 | 56 |
| 30 | 18 | 9·799573 | 9 23 | 10·200427 | 9·909531 | 9 38 | 10·090469 | 10·109958 | 9 15 | 9·890042 | 42 | 30 |
| 5 | 20 | 9·799651 | 10 26 | 10·200349 | 9·909660 | 10 43 | 10·090340 | 10·110010 | 10 17 | 9·889990 | 40 | 55 |
| 30 | 22 | 9·799728 | 11 28 | 10·200272 | 9·909789 | 11 47 | 10·090211 | 10·110061 | 11 19 | 9·889939 | 38 | 30 |
| 6 | 24 | 9·799806 | 12 31 | 10·200194 | 9·909918 | 12 52 | 10·090082 | 10·110112 | 12 21 | 9·889888 | 36 | 54 |
| 30 | 26 | 9·799884 | 13 33 | 10·200116 | 9·910048 | 13 56 | 10·089952 | 10·110164 | 13 22 | 9·889836 | 34 | 30 |
| 7 | 28 | 9·799962 | 14 36 | 10·200038 | 9·910177 | 14 60 | 10·089823 | 10·110215 | 14 24 | 9·889785 | 32 | 53 |
| 30 | 30 | 9·800039 | 15 38 | 10·199961 | 9·910306 | 15 64 | 10·089694 | 10·110266 | 15 26 | 9·889734 | 30 | 30 |
| 8 | 32 | 9·800117 | 16 41 | 10·199883 | 9·910435 | 16 69 | 10·089565 | 10·110318 | 16 27 | 9·889682 | 28 | 52 |
| 30 | 34 | 9·800195 | 17 44 | 10·199805 | 9·910564 | 17 73 | 10·089436 | 10·110369 | 17 29 | 9·889631 | 26 | 30 |
| 9 | 36 | 9·800272 | 18 47 | 10·199728 | 9·910693 | 18 77 | 10·089307 | 10·110421 | 18 31 | 9·889579 | 24 | 51 |
| 30 | 38 | 9·800350 | 19 50 | 10·199650 | 9·910822 | 19 82 | 10·089178 | 10·110472 | 19 32 | 9·889528 | 22 | 30 |
| 10 | 40 | 9·800427 | 20 52 | 10·195573 | 9·910951 | 20 86 | 10·089049 | 10·110523 | 20 34 | 9·889477 | 20 | 50 |
| 30 | 42 | 9·800505 | 21 55 | 10·199495 | 9·911080 | 21 90 | 10·088920 | 10·110575 | 21 36 | 9·889425 | 18 | 30 |
| 11 | 44 | 9·800582 | 22 57 | 10·199418 | 9·911209 | 22 95 | 10·088791 | 10·110626 | 22 38 | 9·889374 | 16 | 49 |
| 30 | 46 | 9·800660 | 23 00 | 10·199340 | 9·911338 | 23 99 | 10·088662 | 10·110678 | 23 39 | 9·889322 | 14 | 30 |
| 12 | 48 | 9·800737 | 24 62 | 10·199263 | 9·911467 | 24 103 | 10·088533 | 10·110729 | 24 41 | 9·889271 | 12 | 48 |
| 30 | 50 | 9·800815 | 25 65 | 10·199185 | 9·911596 | 25 107 | 10·088404 | 10·110781 | 25 43 | 9·889219 | 10 | 30 |
| 13 | 52 | 9·800892 | 26 67 | 10·199108 | 9·911725 | 26 112 | 10·088275 | 10·110832 | 26 44 | 9·889168 | 8 | 47 |
| 30 | 54 | 9·800969 | 27 70 | 10·199031 | 9·911853 | 27 116 | 10·088147 | 10·110884 | 27 46 | 9·889116 | 6 | 30 |
| 14 | 56 | 9·801047 | 28 73 | 10·198953 | 9·911982 | 28 120 | 10·088018 | 10·110936 | 28 48 | 9·889064 | 4 | 46 |
| 30 | 58 | 9·801124 | 29 75 | 10·198876 | 9·912111 | 29 125 | 10·087889 | 10·110987 | 29 50 | 9·889013 | 2 | 30 |
| 15 | 37 | 9·801201 | 30 78 | 10·198799 | 9·912240 | 30 129 | 10·087760 | 10·111039 | 30 51 | 9·888961 | 23 | 45 |
| 30 | 2 | 9·801279 | 1 3 | 10·198721 | 9·912369 | 1 4 | 10·087631 | 10·111090 | 1 2 | 9·888910 | 58 | 30 |
| 16 | 4 | 9·801356 | 2 5 | 10·198644 | 9·912498 | 2 9 | 10·087502 | 10·111142 | 2 3 | 9·888858 | 56 | 44 |
| 30 | 6 | 9·801433 | 3 8 | 10·198567 | 9·912627 | 3 13 | 10·087373 | 10·111194 | 3 5 | 9·888806 | 54 | 30 |
| 17 | 8 | 9·801511 | 4 10 | 10·198489 | 9·912756 | 4 17 | 10·087244 | 10·111245 | 4 7 | 9·888755 | 52 | 43 |
| 30 | 10 | 9·801588 | 5 13 | 10·198412 | 9·912885 | 5 21 | 10·087115 | 10·111297 | 5 9 | 9·888703 | 50 | 30 |
| 18 | 12 | 9·801665 | 6 15 | 10·198335 | 9·913014 | 6 26 | 10·086986 | 10·111349 | 6 10 | 9·888651 | 48 | 42 |
| 30 | 14 | 9·801742 | 7 18 | 10·198258 | 9·913143 | 7 30 | 10·086857 | 10·111400 | 7 12 | 9·888600 | 46 | 30 |
| 19 | 16 | 9·801819 | 8 21 | 10·198181 | 9·913271 | 8 34 | 10·086729 | 10·111452 | 8 14 | 9·888548 | 44 | 41 |
| 30 | 18 | 9·801896 | 9 23 | 10·198104 | 9·913400 | 9 39 | 10·086600 | 10·111504 | 9 16 | 9·888496 | 42 | 30 |
| 20 | 20 | 9·801973 | 10 26 | 10·198027 | 9·913529 | 10 43 | 10·086471 | 10·111556 | 10 17 | 9·888444 | 40 | 40 |
| 30 | 22 | 9·802051 | 11 28 | 10·197949 | 9·913658 | 11 47 | 10·086342 | 10·111607 | 11 19 | 9·888393 | 38 | 30 |
| 21 | 24 | 9·802128 | 12 31 | 10·197872 | 9·913787 | 12 51 | 10·086213 | 10·111659 | 12 21 | 9·888341 | 36 | 39 |
| 30 | 26 | 9·802205 | 13 33 | 10·197795 | 9·913916 | 13 56 | 10·086084 | 10·111711 | 13 22 | 9·888289 | 34 | 30 |
| 22 | 28 | 9·802282 | 14 36 | 10·197718 | 9·914044 | 14 60 | 10·085956 | 10·111763 | 14 24 | 9·888237 | 32 | 38 |
| 30 | 30 | 9·802359 | 15 38 | 10·197641 | 9·914173 | 15 64 | 10·085827 | 10·111815 | 15 26 | 9·888185 | 30 | 30 |
| 23 | 32 | 9·802436 | 16 41 | 10·197564 | 9·914302 | 16 69 | 10·085698 | 10·111866 | 16 28 | 9·888134 | 28 | 37 |
| 30 | 34 | 9·802512 | 17 43 | 10·197488 | 9·914431 | 17 73 | 10·085569 | 10·111918 | 17 29 | 9·888082 | 26 | 30 |
| 24 | 36 | 9·802589 | 18 46 | 10·197411 | 9·914560 | 18 77 | 10·085440 | 10·111970 | 18 31 | 9·888030 | 24 | 36 |
| 30 | 38 | 9·802666 | 19 48 | 10·197334 | 9·914688 | 19 82 | 10·085312 | 10·112022 | 19 33 | 9·887978 | 22 | 30 |
| 25 | 40 | 9·802743 | 20 51 | 10·197257 | 9·914817 | 20 86 | 10·085183 | 10·112074 | 20 35 | 9·887926 | 20 | 35 |
| 30 | 42 | 9·802820 | 21 54 | 10·197180 | 9·914946 | 21 90 | 10·085054 | 10·112126 | 21 36 | 9·887874 | 18 | 30 |
| 26 | 44 | 9·802897 | 22 57 | 10·197103 | 9·915075 | 22 94 | 10·084925 | 10·112178 | 22 38 | 9·887822 | 16 | 34 |
| 30 | 46 | 9·802974 | 23 59 | 10·197026 | 9·915203 | 23 99 | 10·084797 | 10·112230 | 23 40 | 9·887770 | 14 | 30 |
| 27 | 48 | 9·803050 | 24 62 | 10·196950 | 9·915332 | 24 103 | 10·084668 | 10·112282 | 24 42 | 9·887718 | 12 | 33 |
| 30 | 50 | 9·803127 | 25 64 | 10·196873 | 9·915461 | 25 107 | 10·084539 | 10·112334 | 25 43 | 9·887666 | 10 | 30 |
| 28 | 52 | 9·803204 | 26 67 | 10·196796 | 9·915590 | 26 112 | 10·084410 | 10·112386 | 26 45 | 9·887614 | 8 | 32 |
| 30 | 54 | 9·803281 | 27 69 | 10·196719 | 9·915718 | 27 116 | 10·084282 | 10·112438 | 27 47 | 9·887562 | 6 | 30 |
| 29 | 56 | 9·803357 | 28 72 | 10·196643 | 9·915847 | 28 120 | 10·084153 | 10·112490 | 28 48 | 9·887510 | 4 | 31 |
| 30 | 58 | 9·803434 | 29 74 | 10·196566 | 9·915976 | 29 124 | 10·084024 | 10·112542 | 29 50 | 9·887458 | 2 | 30 |
| 30 | 38 | 9·803511 | 30 77 | 10·196489 | 9·916104 | 30 129 | 10·083896 | 10·112594 | 30 52 | 9·887406 | 0 | 30 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

50° — $3^h$ $22^m$

## LOG. SINES, COSINES, &c.

$2^h\ 38^m$ 39°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 9·803511 | | 10·196489 | 9·916104 | | 10·083896 | 10·112594 | | 9·887406 | 22 | 30 |
| 30 | 2 | 9·803587 | 1″ 3 | 10·196413 | 9·916233 | 1″ 4 | 10·083767 | 10·112646 | 1″ 2 | 9·887354 | 58 | 30 |
| 31 | 4 | 9·803664 | 2 5 | 10·196336 | 9·916362 | 2 9 | 10·083638 | 10·112698 | 2 3 | 9·887302 | 56 | 29 |
| 30 | 6 | 9·803740 | 3 8 | 10·196260 | 9·916491 | 3 13 | 10·083510 | 10·112750 | 3 5 | 9·887250 | 54 | 30 |
| 32 | 8 | 9·803817 | 4 10 | 10·196183 | 9·916619 | 4 17 | 10·083381 | 10·112802 | 4 7 | 9·887198 | 52 | 28 |
| 30 | 10 | 9·803893 | 5 13 | 10·196107 | 9·916748 | 5 21 | 10·083252 | 10·112854 | 5 9 | 9·887146 | 50 | 30 |
| 33 | 12 | 9·803970 | 6 15 | 10·196030 | 9·916877 | 6 26 | 10·083123 | 10·112907 | 6 10 | 9·887093 | 48 | 27 |
| 30 | 14 | 9·804046 | 7 18 | 10·195954 | 9·917005 | 7 30 | 10·082995 | 10·112959 | 7 12 | 9·887041 | 46 | 30 |
| 34 | 16 | 9·804123 | 8 20 | 10·195877 | 9·917134 | 8 34 | 10·082866 | 10·113011 | 8 14 | 9·886989 | 44 | 26 |
| 30 | 18 | 9·804199 | 9 23 | 10·195801 | 9·917262 | 9 39 | 10·082738 | 10·113063 | 9 16 | 9·886937 | 42 | 30 |
| 35 | 20 | 9·804276 | 10 25 | 10·195724 | 9·917391 | 10 43 | 10·082609 | 10·113115 | 10 17 | 9·886885 | 40 | 25 |
| 30 | 22 | 9·804352 | 11 28 | 10·195648 | 9·917520 | 11 47 | 10·082480 | 10·113168 | 11 19 | 9·886832 | 38 | 30 |
| 36 | 24 | 9·804428 | 12 30 | 10·195572 | 9·917648 | 12 51 | 10·082352 | 10·113220 | 12 21 | 9·886780 | 36 | 24 |
| 30 | 26 | 9·804505 | 13 33 | 10·195495 | 9·917777 | 13 56 | 10·082223 | 10·113272 | 13 23 | 9·886728 | 34 | 30 |
| 37 | 28 | 9·804581 | 14 35 | 10·195419 | 9·917906 | 14 60 | 10·082094 | 10·113324 | 14 24 | 9·886676 | 32 | 23 |
| 30 | 30 | 9·804657 | 15 38 | 10·195343 | 9·918034 | 15 64 | 10·081966 | 10·113377 | 15 26 | 9·886623 | 30 | 30 |
| 38 | 32 | 9·804734 | 16 40 | 10·195266 | 9·918163 | 16 69 | 10·081837 | 10·113429 | 16 28 | 9·886571 | 28 | 22 |
| 30 | 34 | 9·804810 | 17 43 | 10·195190 | 9·918291 | 17 73 | 10·081709 | 10·113481 | 17 30 | 9·886519 | 26 | 30 |
| 39 | 36 | 9·804886 | 18 46 | 10·195114 | 9·918420 | 18 77 | 10·081580 | 10·113534 | 18 31 | 9·886466 | 24 | 21 |
| 30 | 38 | 9·804962 | 19 48 | 10·195038 | 9·918548 | 19 81 | 10·081452 | 10·113586 | 19 33 | 9·886414 | 22 | 30 |
| 40 | 40 | 9·805039 | 20 51 | 10·194961 | 9·918677 | 20 86 | 10·081323 | 10·113638 | 20 35 | 9·886362 | 20 | 20 |
| 30 | 42 | 9·805115 | 21 53 | 10·194885 | 9·918805 | 21 90 | 10·081195 | 10·113691 | 21 37 | 9·886309 | 18 | 30 |
| 41 | 44 | 9·805191 | 22 56 | 10·194809 | 9·918934 | 22 94 | 10·081066 | 10·113743 | 22 38 | 9·886257 | 16 | 19 |
| 30 | 46 | 9·805267 | 23 58 | 10·194733 | 9·919063 | 23 99 | 10·080937 | 10·113796 | 23 40 | 9·886204 | 14 | 30 |
| 42 | 48 | 9·805343 | 24 61 | 10·194657 | 9·919191 | 24 103 | 10·080809 | 10·113848 | 24 42 | 9·886152 | 12 | 18 |
| 30 | 50 | 9·805419 | 25 63 | 10·194581 | 9·919320 | 25 107 | 10·080680 | 10·113901 | 25 44 | 9·886099 | 10 | 30 |
| 43 | 52 | 9·805495 | 26 66 | 10·194505 | 9·919448 | 26 111 | 10·080552 | 10·113953 | 26 45 | 9·886047 | 8 | 17 |
| 30 | 54 | 9·805571 | 27 68 | 10·194429 | 9·919577 | 27 116 | 10·080423 | 10·114005 | 27 47 | 9·885995 | 6 | 30 |
| 44 | 56 | 9·805647 | 28 71 | 10·194353 | 9·919705 | 28 120 | 10·080295 | 10·114058 | 28 49 | 9·885942 | 4 | 16 |
| 30 | 58 | 9·805723 | 29 73 | 10·194277 | 9·919834 | 29 124 | 10·080166 | 10·114110 | 29 50 | 9·885890 | 2 | 30 |
| 45 | **39** | 9·805799 | 30 76 | 10·194201 | 9·919962 | 30 129 | 10·080038 | 10·114163 | 30 52 | 9·885837 | **21** | 15 |
| 30 | 2 | 9·805875 | 1 3 | 10·194125 | 9·920091 | 1 4 | 10·079909 | 10·114216 | 1 2 | 9·885784 | 58 | 30 |
| 46 | 4 | 9·805951 | 2 5 | 10·194049 | 9·920219 | 2 9 | 10·079781 | 10·114268 | 2 4 | 9·885732 | 56 | 14 |
| 30 | 6 | 9·806027 | 3 8 | 10·193973 | 9·920348 | 3 13 | 10·079652 | 10·114321 | 3 5 | 9·885679 | 54 | 30 |
| 47 | 8 | 9·806103 | 4 10 | 10·193897 | 9·920476 | 4 17 | 10·079524 | 10·114373 | 4 7 | 9·885627 | 52 | 13 |
| 30 | 10 | 9·806179 | 5 13 | 10·193821 | 9·920604 | 5 21 | 10·079396 | 10·114426 | 5 9 | 9·885574 | 50 | 30 |
| 48 | 12 | 9·806254 | 6 15 | 10·193746 | 9·920733 | 6 26 | 10·079267 | 10·114478 | 6 11 | 9·885522 | 48 | 12 |
| 30 | 14 | 9·806330 | 7 18 | 10·193670 | 9·920861 | 7 30 | 10·079139 | 10·114531 | 7 12 | 9·885469 | 46 | 30 |
| 49 | 16 | 9·806406 | 8 20 | 10·193594 | 9·920990 | 8 34 | 10·079010 | 10·114584 | 8 14 | 9·885416 | 44 | 11 |
| 30 | 18 | 9·806482 | 9 23 | 10·193518 | 9·921118 | 9 39 | 10·078882 | 10·114636 | 9 16 | 9·885364 | 42 | 30 |
| 50 | 20 | 9·806557 | 10 25 | 10·193443 | 9·921247 | 10 43 | 10·078753 | 10·114689 | 10 18 | 9·885311 | 40 | 10 |
| 30 | 22 | 9·806633 | 11 28 | 10·193367 | 9·921375 | 11 47 | 10·078625 | 10·114742 | 11 20 | 9·885258 | 38 | 30 |
| 51 | 24 | 9·806709 | 12 30 | 10·193291 | 9·921503 | 12 51 | 10·078497 | 10·114795 | 12 21 | 9·885205 | 36 | 9 |
| 30 | 26 | 9·806785 | 13 33 | 10·193215 | 9·921632 | 13 56 | 10·078368 | 10·114847 | 13 23 | 9·885153 | 34 | 30 |
| 52 | 28 | 9·806860 | 14 35 | 10·193140 | 9·921760 | 14 60 | 10·078240 | 10·114900 | 14 25 | 9·885100 | 32 | 8 |
| 30 | 30 | 9·806936 | 15 38 | 10·193064 | 9·921889 | 15 64 | 10·078111 | 10·114953 | 15 26 | 9·885047 | 30 | 30 |
| 53 | 32 | 9·807011 | 16 40 | 10·192989 | 9·922017 | 16 68 | 10·077983 | 10·115006 | 16 28 | 9·884994 | 28 | 7 |
| 30 | 34 | 9·807087 | 17 43 | 10·192913 | 9·922145 | 17 73 | 10·077855 | 10·115058 | 17 30 | 9·884942 | 26 | 30 |
| 54 | 36 | 9·807163 | 18 45 | 10·192837 | 9·922274 | 18 77 | 10·077726 | 10·115111 | 18 32 | 9·884889 | 24 | 6 |
| 30 | 38 | 9·807238 | 19 48 | 10·192762 | 9·922402 | 19 81 | 10·077598 | 10·115164 | 19 33 | 9·884836 | 22 | 30 |
| 55 | 40 | 9·807314 | 20 50 | 10·192686 | 9·922530 | 20 86 | 10·077470 | 10·115217 | 20 35 | 9·884783 | 20 | 5 |
| 30 | 42 | 9·807389 | 21 53 | 10·192611 | 9·922659 | 21 90 | 10·077341 | 10·115270 | 21 37 | 9·884730 | 18 | 30 |
| 56 | 44 | 9·807465 | 22 55 | 10·192535 | 9·922787 | 22 94 | 10·077213 | 10·115323 | 22 39 | 9·884677 | 16 | 4 |
| 30 | 46 | 9·807540 | 23 58 | 10·192460 | 9·922915 | 23 98 | 10·077085 | 10·115375 | 23 40 | 9·884625 | 14 | 30 |
| 57 | 48 | 9·807615 | 24 60 | 10·192385 | 9·923044 | 24 103 | 10·076956 | 10·115428 | 24 42 | 9·884572 | 12 | 3 |
| 30 | 50 | 9·807691 | 25 63 | 10·192309 | 9·923172 | 25 107 | 10·076828 | 10·115481 | 25 44 | 9·884519 | 10 | 30 |
| 58 | 52 | 9·807766 | 26 65 | 10·192234 | 9·923300 | 26 111 | 10·076700 | 10·115534 | 26 46 | 9·884466 | 8 | 2 |
| 30 | 54 | 9·807842 | 27 68 | 10·192158 | 9·923429 | 27 116 | 10·076571 | 10·115587 | 27 48 | 9·884413 | 6 | 30 |
| 59 | 56 | 9·807917 | 28 70 | 10·192083 | 9·923557 | 28 120 | 10·076443 | 10·115640 | 28 49 | 9·884360 | 4 | 1 |
| 30 | 58 | 9·807992 | 29 73 | 10·192008 | 9·923685 | 29 124 | 10·076315 | 10·115693 | 29 51 | 9·884307 | 2 | 30 |
| 60 | **40** | 9·808067 | 30 76 | 10·191933 | 9·923814 | 30 128 | 10·076186 | 10·115746 | 30 53 | 9·884254 | 0 | 0 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

50° $3^h\ 20^m$

## LOG. SINES, COSINES, &c.

$2^h\ 40^m$ — 40°

| ′ ″ | m. s. | Sine | Parts | Cosec | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 9·808067 | | 10·191933 | 9·923814 | | 10·076186 | 10·115746 | | 9·884254 | 20 | 60 |
| 30 | 2 | 9·808143 | 1″ 3 | 10·191857 | 9·923942 | 1″ 4 | 10·076058 | 10·115799 | 1″ 2 | 9·884201 | 58 | 30 |
| 1 | 4 | 9·808218 | 2 5 | 10·191782 | 9·924070 | 2 9 | 10·075930 | 10·115852 | 2 4 | 9·884148 | 56 | 59 |
| 30 | 6 | 9·808293 | 3 8 | 10·191707 | 9·924198 | 3 13 | 10·075802 | 10·115905 | 3 5 | 9·884095 | 54 | 30 |
| 2 | 8 | 9·808368 | 4 10 | 10·191632 | 9·924327 | 4 17 | 10·075673 | 10·115958 | 4 7 | 9·884042 | 52 | 58 |
| 30 | 10 | 9·808444 | 5 13 | 10·191556 | 9·924455 | 5 21 | 10·075545 | 10·116011 | 5 9 | 9·883989 | 50 | 30 |
| 3 | 12 | 9·808519 | 6 15 | 10·191481 | 9·924583 | 6 26 | 10·075417 | 10·116064 | 6 11 | 9·883936 | 48 | 57 |
| 30 | 14 | 9·808594 | 7 18 | 10·191406 | 9·924711 | 7 30 | 10·075289 | 10·116117 | 7 12 | 9·883883 | 46 | 30 |
| 4 | 16 | 9·808669 | 8 20 | 10·191331 | 9·924840 | 8 34 | 10·075160 | 10·116171 | 8 14 | 9·883829 | 44 | 56 |
| 30 | 18 | 9·808744 | 9 23 | 10·191256 | 9·924968 | 9 38 | 10·075032 | 10·116224 | 9 16 | 9·883776 | 42 | 30 |
| 5 | 20 | 9·808819 | 10 25 | 10·191181 | 9·925096 | 10 43 | 10·074904 | 10·116277 | 10 18 | 9·883723 | 40 | 55 |
| 30 | 22 | 9·808894 | 11 28 | 10·191106 | 9·925224 | 11 47 | 10·074776 | 10·116330 | 11 19 | 9·883670 | 38 | 30 |
| 6 | 24 | 9·808969 | 12 30 | 10·191031 | 9·925352 | 12 51 | 10·074648 | 10·116383 | 12 21 | 9·883617 | 36 | 54 |
| 30 | 26 | 9·809044 | 13 33 | 10·190956 | 9·925481 | 13 56 | 10·074519 | 10·116436 | 13 23 | 9·883564 | 34 | 30 |
| 7 | 28 | 9·809119 | 14 35 | 10·190881 | 9·925609 | 14 60 | 10·074391 | 10·116490 | 14 25 | 9·883510 | 32 | 53 |
| 30 | 30 | 9·809194 | 15 38 | 10·190806 | 9·925737 | 15 64 | 10·074263 | 10·116543 | 15 27 | 9·883457 | 30 | 30 |
| 8 | 32 | 9·809269 | 16 40 | 10·190731 | 9·925865 | 16 68 | 10·074135 | 10·116596 | 16 28 | 9·883404 | 28 | 52 |
| 30 | 34 | 9·809344 | 17 43 | 10·190656 | 9·925993 | 17 73 | 10·074007 | 10·116649 | 17 30 | 9·883351 | 26 | 30 |
| 9 | 36 | 9·809419 | 18 45 | 10·190581 | 9·926122 | 18 77 | 10·073878 | 10·116703 | 18 32 | 9·883297 | 24 | 51 |
| 30 | 38 | 9·809494 | 19 48 | 10·190506 | 9·926250 | 19 81 | 10·073750 | 10·116756 | 19 34 | 9·883244 | 22 | 30 |
| 10 | 40 | 9·809569 | 20 50 | 10·190431 | 9·926378 | 20 85 | 10·073622 | 10·116809 | 20 35 | 9·883191 | 20 | 50 |
| 30 | 42 | 9·809643 | 21 53 | 10·190357 | 9·926506 | 21 90 | 10·073494 | 10·116863 | 21 37 | 9·883137 | 18 | 30 |
| 11 | 44 | 9·809718 | 22 55 | 10·190282 | 9·926634 | 22 94 | 10·073366 | 10·116916 | 22 39 | 9·883084 | 16 | 49 |
| 30 | 46 | 9·809793 | 23 58 | 10·190207 | 9·926762 | 23 98 | 10·073238 | 10·116969 | 23 41 | 9·883031 | 14 | 30 |
| 12 | 48 | 9·809868 | 24 60 | 10·190132 | 9·926890 | 24 102 | 10·073110 | 10·117023 | 24 42 | 9·882977 | 12 | 48 |
| 30 | 50 | 9·809943 | 25 63 | 10·190057 | 9·927019 | 25 107 | 10·072981 | 10·117076 | 25 44 | 9·882924 | 10 | 30 |
| 13 | 52 | 9·810017 | 26 65 | 10·189983 | 9·927147 | 26 111 | 10·072853 | 10·117129 | 26 46 | 9·882871 | 8 | 47 |
| 30 | 54 | 9·810092 | 27 68 | 10·189908 | 9·927275 | 27 115 | 10·072725 | 10·117183 | 27 48 | 9·882817 | 6 | 30 |
| 14 | 56 | 9·810167 | 28 70 | 10·189833 | 9·927403 | 28 120 | 10·072597 | 10·117236 | 28 50 | 9·882764 | 4 | 46 |
| 30 | 58 | 9·810241 | 29 73 | 10·189759 | 9·927531 | 29 124 | 10·072469 | 10·117290 | 29 51 | 9·882710 | 2 | 30 |
| 15 | 41 | 9·810316 | 30 75 | 10·189684 | 9·927659 | 30 128 | 10·072341 | 10·117343 | 30 53 | 9·882657 | 19 | 45 |
| 30 | 2 | 9·810390 | 1 2 | 10·189610 | 9·927787 | 1 4 | 10·072213 | 10·117397 | 1 2 | 9·882603 | 58 | 30 |
| 16 | 4 | 9·810465 | 2 5 | 10·189535 | 9·927915 | 2 9 | 10·072085 | 10·117450 | 2 4 | 9·882550 | 56 | 44 |
| 30 | 6 | 9·810540 | 3 7 | 10·189460 | 9·928043 | 3 13 | 10·071957 | 10·117504 | 3 5 | 9·882496 | 54 | 30 |
| 17 | 8 | 9·810614 | 4 10 | 10·189386 | 9·928171 | 4 17 | 10·071829 | 10·117557 | 4 7 | 9·882443 | 52 | 43 |
| 30 | 10 | 9·810689 | 5 12 | 10·189311 | 9·928299 | 5 21 | 10·071701 | 10·117611 | 5 9 | 9·882389 | 50 | 30 |
| 18 | 12 | 9·810763 | 6 15 | 10·189237 | 9·928427 | 6 26 | 10·071573 | 10·117664 | 6 11 | 9·882336 | 48 | 42 |
| 30 | 14 | 9·810838 | 7 17 | 10·189162 | 9·928555 | 7 30 | 10·071445 | 10·117718 | 7 13 | 9·882282 | 46 | 30 |
| 19 | 16 | 9·810912 | 8 20 | 10·189088 | 9·928684 | 8 34 | 10·071316 | 10·117771 | 8 14 | 9·882229 | 44 | 41 |
| 30 | 18 | 9·810986 | 9 22 | 10·189014 | 9·928812 | 9 38 | 10·071188 | 10·117825 | 9 16 | 9·882175 | 42 | 30 |
| 20 | 20 | 9·811061 | 10 25 | 10·188939 | 9·928940 | 10 43 | 10·071060 | 10·117879 | 10 18 | 9·882121 | 40 | 40 |
| 30 | 22 | 9·811135 | 11 27 | 10·188865 | 9·929068 | 11 47 | 10·070932 | 10·117932 | 11 20 | 9·882068 | 38 | 30 |
| 21 | 24 | 9·811210 | 12 30 | 10·188790 | 9·929196 | 12 51 | 10·070804 | 10·117986 | 12 21 | 9·882014 | 36 | 39 |
| 30 | 26 | 9·811284 | 13 32 | 10·188716 | 9·929324 | 13 55 | 10·070676 | 10·118040 | 13 23 | 9·881960 | 34 | 30 |
| 22 | 28 | 9·811358 | 14 35 | 10·188642 | 9·929452 | 14 60 | 10·070548 | 10·118093 | 14 25 | 9·881907 | 32 | 38 |
| 30 | 30 | 9·811433 | 15 37 | 10·188567 | 9·929580 | 15 64 | 10·070420 | 10·118147 | 15 27 | 9·881853 | 30 | 30 |
| 23 | 32 | 9·811507 | 16 40 | 10·188493 | 9·929708 | 16 68 | 10·070292 | 10·118201 | 16 29 | 9·881799 | 28 | 37 |
| 30 | 34 | 9·811581 | 17 42 | 10·188419 | 9·929836 | 17 73 | 10·070164 | 10·118254 | 17 30 | 9·881746 | 26 | 30 |
| 24 | 36 | 9·811655 | 18 45 | 10·188345 | 9·929964 | 18 77 | 10·070036 | 10·118308 | 18 32 | 9·881692 | 24 | 36 |
| 30 | 38 | 9·811730 | 19 47 | 10·188270 | 9·930092 | 19 81 | 10·069908 | 10·118362 | 19 34 | 9·881638 | 22 | 30 |
| 25 | 40 | 9·811804 | 20 50 | 10·188196 | 9·930220 | 20 85 | 10·069780 | 10·118416 | 20 36 | 9·881584 | 20 | 35 |
| 30 | 42 | 9·811878 | 21 52 | 10·188122 | 9·930348 | 21 90 | 10·069652 | 10·118470 | 21 38 | 9·881530 | 18 | 30 |
| 26 | 44 | 9·811952 | 22 55 | 10·188048 | 9·930475 | 22 94 | 10·069525 | 10·118523 | 22 39 | 9·881477 | 16 | 34 |
| 30 | 46 | 9·812026 | 23 57 | 10·187974 | 9·930603 | 23 98 | 10·069397 | 10·118577 | 23 41 | 9·881423 | 14 | 30 |
| 27 | 48 | 9·812100 | 24 60 | 10·187900 | 9·930731 | 24 102 | 10·069269 | 10·118631 | 24 43 | 9·881369 | 12 | 33 |
| 30 | 50 | 9·812174 | 25 62 | 10·187826 | 9·930859 | 25 107 | 10·069141 | 10·118685 | 25 45 | 9·881315 | 10 | 30 |
| 28 | 52 | 9·812248 | 26 65 | 10·187752 | 9·930987 | 26 111 | 10·069013 | 10·118739 | 26 47 | 9·881261 | 8 | 32 |
| 30 | 54 | 9·812322 | 27 67 | 10·187678 | 9·931115 | 27 115 | 10·068885 | 10·118793 | 27 48 | 9·881207 | 6 | 30 |
| 29 | 56 | 9·812396 | 28 70 | 10·187604 | 9·931243 | 28 119 | 10·068757 | 10·118847 | 28 50 | 9·881153 | 4 | 31 |
| 30 | 58 | 9·812470 | 29 72 | 10·187530 | 9·931371 | 29 124 | 10·068629 | 10·118901 | 29 52 | 9·881099 | 2 | 30 |
| 30 | 42 | 9·812544 | 30 74 | 10·187456 | 9·931499 | 30 128 | 10·068501 | 10·118954 | 30 54 | 9·881046 | 0 | 30 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

49° — $3^h\ 18^m$

## LOG. SINES, COSINES, &c.

$2^h\ 42^m$ 40°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 9·812544 | | 10·187456 | 9·931499 | | 10·068501 | 10·118954 | | 9·881046 | 18 | 30 |
| 30 | 2 | 9·812618 | 1″ 2 | 10·187382 | 9·931627 | 1″ 4 | 10·068373 | 10·119008 | 1″ 2 | 9·880992 | 58 | 30 |
| 31 | 4 | 9·812692 | 2 5 | 10·187308 | 9·931755 | 2 9 | 10·068245 | 10·119062 | 2 4 | 9·880938 | 56 | 29 |
| 30 | 6 | 9·812766 | 3 7 | 10·187234 | 9·931883 | 3 13 | 10·068117 | 10·119116 | 3 5 | 9·880884 | 54 | 30 |
| 32 | 8 | 9·812840 | 4 10 | 10·187160 | 9·932010 | 4 17 | 10·067990 | 10·119170 | 4 7 | 9·880830 | 52 | 28 |
| 30 | 10 | 9·812914 | 5 12 | 10·187086 | 9·932138 | 5 21 | 10·067862 | 10·119224 | 5 9 | 9·880776 | 50 | 30 |
| 33 | 12 | 9·812988 | 6 15 | 10·187012 | 9·932266 | 6 26 | 10·067734 | 10·119278 | 6 11 | 9·880722 | 48 | 27 |
| 30 | 14 | 9·813062 | 7 17 | 10·186938 | 9·932394 | 7 30 | 10·067606 | 10·119333 | 7 13 | 9·880667 | 46 | 30 |
| 34 | 16 | 9·813135 | 8 20 | 10·186865 | 9·932522 | 8 34 | 10·067478 | 10·119387 | 8 14 | 9·880613 | 44 | 26 |
| 30 | 18 | 9·813209 | 9 22 | 10·186791 | 9·932650 | 9 38 | 10·067350 | 10·119441 | 9 16 | 9·880559 | 42 | 30 |
| 35 | 20 | 9·813283 | 10 24 | 10·186717 | 9·932778 | 10 43 | 10·067222 | 10·119495 | 10 18 | 9·880505 | 40 | 25 |
| 30 | 22 | 9·813357 | 11 27 | 10·186643 | 9·932906 | 11 47 | 10·067094 | 10·119549 | 11 20 | 9·880451 | 38 | 30 |
| 36 | 24 | 9·813430 | 12 29 | 10·186570 | 9·933033 | 12 51 | 10·066967 | 10·119603 | 12 22 | 9·880397 | 36 | 24 |
| 30 | 26 | 9·813504 | 13 32 | 10·186496 | 9·933161 | 13 55 | 10·066839 | 10·119657 | 13 24 | 9·880343 | 34 | 30 |
| 37 | 28 | 9·813578 | 14 34 | 10·186422 | 9·933289 | 14 60 | 10·066711 | 10·119711 | 14 25 | 9·880289 | 32 | 23 |
| 30 | 30 | 9·813651 | 15 37 | 10·186349 | 9·933417 | 15 64 | 10·066583 | 10·119766 | 15 27 | 9·880234 | 30 | 30 |
| 38 | 32 | 9·813725 | 16 39 | 10·186275 | 9·933545 | 16 68 | 10·066455 | 10·119820 | 16 29 | 9·880180 | 28 | 22 |
| 30 | 34 | 9·813799 | 17 42 | 10·186201 | 9·933672 | 17 72 | 10·066328 | 10·119874 | 17 31 | 9·880126 | 26 | 30 |
| 39 | 36 | 9·813872 | 18 44 | 10·186128 | 9·933800 | 18 77 | 10·066200 | 10·119928 | 18 32 | 9·880072 | 24 | 21 |
| 30 | 38 | 9·813946 | 19 47 | 10·186054 | 9·933928 | 19 81 | 10·066072 | 10·119982 | 19 34 | 9·880018 | 22 | 30 |
| 40 | 40 | 9·814019 | 20 49 | 10·185981 | 9·934056 | 20 85 | 10·065944 | 10·120037 | 20 36 | 9·879963 | 20 | 20 |
| 30 | 42 | 9·814093 | 21 51 | 10·185907 | 9·934184 | 21 89 | 10·065816 | 10·120091 | 21 38 | 9·879909 | 18 | 30 |
| 41 | 44 | 9·814166 | 22 54 | 10·185834 | 9·934311 | 22 94 | 10·065689 | 10·120145 | 22 40 | 9·879855 | 16 | 19 |
| 30 | 46 | 9·814240 | 23 56 | 10·185760 | 9·934439 | 23 98 | 10·065561 | 10·120200 | 23 42 | 9·879800 | 14 | 30 |
| 42 | 48 | 9·814313 | 24 59 | 10·185687 | 9·934567 | 24 102 | 10·065433 | 10·120254 | 24 43 | 9·879746 | 12 | 18 |
| 30 | 50 | 9·814387 | 25 61 | 10·185613 | 9·934695 | 25 106 | 10·065305 | 10·120308 | 25 45 | 9·879692 | 10 | 30 |
| 43 | 52 | 9·814460 | 26 64 | 10·185540 | 9·934822 | 26 111 | 10·065178 | 10·120363 | 26 47 | 9·879637 | 8 | 17 |
| 30 | 54 | 9·814533 | 27 66 | 10·185467 | 9·934950 | 27 115 | 10·065050 | 10·120417 | 27 49 | 9·879583 | 6 | 30 |
| 44 | 56 | 9·814607 | 28 69 | 10·185393 | 9·935078 | 28 119 | 10·064922 | 10·120471 | 28 51 | 9·879529 | 4 | 16 |
| 30 | 58 | 9·814680 | 29 71 | 10·185320 | 9·935206 | 29 124 | 10·064794 | 10·120526 | 29 52 | 9·879474 | 2 | 30 |
| 45 | 43 | 9·814753 | 30 74 | 10·185247 | 9·935333 | 30 128 | 10·064667 | 10·120580 | 30 54 | 9·879420 | 17 | 15 |
| 30 | 2 | 9·814827 | 1 2 | 10·185173 | 9·935461 | 1 4 | 10·064539 | 10·120635 | 1 2 | 9·879365 | 58 | 30 |
| 46 | 4 | 9·814900 | 2 5 | 10·185100 | 9·935589 | 2 9 | 10·064411 | 10·120689 | 2 4 | 9·879311 | 56 | 14 |
| 30 | 6 | 9·814973 | 3 7 | 10·185027 | 9·935717 | 3 13 | 10·064283 | 10·120743 | 3 5 | 9·879257 | 54 | 30 |
| 47 | 8 | 9·815046 | 4 10 | 10·184954 | 9·935844 | 4 17 | 10·064156 | 10·120798 | 4 7 | 9·879202 | 52 | 13 |
| 30 | 10 | 9·815120 | 5 12 | 10·184880 | 9·935972 | 5 21 | 10·064028 | 10·120852 | 5 9 | 9·879148 | 50 | 30 |
| 48 | 12 | 9·815193 | 6 15 | 10·184807 | 9·936100 | 6 26 | 10·063900 | 10·120907 | 6 11 | 9·879093 | 48 | 12 |
| 30 | 14 | 9·815266 | 7 17 | 10·184734 | 9·936227 | 7 30 | 10·063773 | 10·120961 | 7 13 | 9·879039 | 46 | 30 |
| 49 | 16 | 9·815339 | 8 20 | 10·184661 | 9·936355 | 8 34 | 10·063645 | 10·121016 | 8 15 | 9·878984 | 44 | 11 |
| 30 | 18 | 9·815412 | 9 22 | 10·184588 | 9·936483 | 9 38 | 10·063517 | 10·121071 | 9 16 | 9·878929 | 42 | 30 |
| 50 | 20 | 9·815485 | 10 24 | 10·184515 | 9·936611 | 10 43 | 10·063389 | 10·121125 | 10 18 | 9·878875 | 40 | 10 |
| 30 | 22 | 9·815558 | 11 27 | 10·184442 | 9·936738 | 11 47 | 10·063262 | 10·121180 | 11 20 | 9·878820 | 38 | 30 |
| 51 | 24 | 9·815632 | 12 29 | 10·184368 | 9·936866 | 12 51 | 10·063134 | 10·121234 | 12 22 | 9·878766 | 36 | 9 |
| 30 | 26 | 9·815705 | 13 32 | 10·184295 | 9·936994 | 13 55 | 10·063006 | 10·121289 | 13 24 | 9·878711 | 34 | 30 |
| 52 | 28 | 9·815778 | 14 34 | 10·184222 | 9·937121 | 14 60 | 10·062879 | 10·121344 | 14 25 | 9·878656 | 32 | 8 |
| 30 | 30 | 9·815851 | 15 36 | 10·184149 | 9·937249 | 15 64 | 10·062751 | 10·121398 | 15 27 | 9·878602 | 30 | 30 |
| 53 | 32 | 9·815924 | 16 39 | 10·184076 | 9·937377 | 16 68 | 10·062623 | 10·121453 | 16 29 | 9·878547 | 28 | 7 |
| 30 | 34 | 9·815996 | 17 41 | 10·184004 | 9·937504 | 17 72 | 10·062496 | 10·121508 | 17 31 | 9·878492 | 26 | 30 |
| 54 | 36 | 9·816069 | 18 44 | 10·183931 | 9·937632 | 18 77 | 10·062368 | 10·121562 | 18 33 | 9·878438 | 24 | 6 |
| 30 | 38 | 9·816142 | 19 46 | 10·183858 | 9·937759 | 19 81 | 10·062241 | 10·121617 | 19 35 | 9·878383 | 22 | 30 |
| 55 | 40 | 9·816215 | 20 49 | 10·183785 | 9·937887 | 20 85 | 10·062113 | 10·121672 | 20 36 | 9·878328 | 20 | 5 |
| 30 | 42 | 9·816288 | 21 51 | 10·183712 | 9·938015 | 21 89 | 10·061985 | 10·121727 | 21 38 | 9·878273 | 18 | 30 |
| 56 | 44 | 9·816361 | 22 54 | 10·183639 | 9·938142 | 22 94 | 10·061858 | 10·121781 | 22 40 | 9·878219 | 16 | 4 |
| 30 | 46 | 9·816434 | 23 56 | 10·183566 | 9·938270 | 23 98 | 10·061730 | 10·121836 | 23 42 | 9·878164 | 14 | 30 |
| 57 | 48 | 9·816507 | 24 58 | 10·183493 | 9·938398 | 24 102 | 10·061602 | 10·121891 | 24 44 | 9·878109 | 12 | 3 |
| 30 | 50 | 9·816579 | 25 61 | 10·183421 | 9·938525 | 25 106 | 10·061475 | 10·121946 | 25 46 | 9·878054 | 10 | 30 |
| 58 | 52 | 9·816652 | 26 63 | 10·183348 | 9·938653 | 26 111 | 10·061347 | 10·122001 | 26 47 | 9·877999 | 8 | 2 |
| 30 | 54 | 9·816725 | 27 66 | 10·183275 | 9·938780 | 27 115 | 10·061220 | 10·122055 | 27 49 | 9·877945 | 6 | 30 |
| 59 | 56 | 9·816798 | 28 68 | 10·183202 | 9·938908 | 28 119 | 10·061092 | 10·122110 | 28 51 | 9·877890 | 4 | 1 |
| 30 | 58 | 9·816870 | 29 70 | 10·183130 | 9·939035 | 29 123 | 10·060965 | 10·122165 | 29 53 | 9·877835 | 2 | 30 |
| 60 | 44 | 9·816943 | 30 73 | 10·183057 | 9·939163 | 30 128 | 10·060837 | 10·122220 | 30 55 | 9·877780 | 0 | 0 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

49° $3^h\ 16^m$

## LOG. SINES, COSINES, &c.

2ʰ 44ᵐ — 41°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 9·816943 | | 10·183057 | 9·939163 | | 10·060837 | 10·122220 | | 9·877780 | 16 | 60 |
| 30 | 2 | 9·817016 | 1″ 2 | 10·182984 | 9·939291 | 1″ 4 | 10·060709 | 10·122275 | 1″ 2 | 9·877725 | 54 | 30 |
| 1 | 4 | 9·817088 | 2 5 | 10·182912 | 9·939418 | 2 8 | 10·060582 | 10·122330 | 2 4 | 9·877670 | 56 | 59 |
| 30 | 6 | 9·817161 | 3 7 | 10·182839 | 9·939546 | 3 13 | 10·060454 | 10·122385 | 3 5 | 9·877615 | 54 | 30 |
| 2 | 8 | 9·817233 | 4 10 | 10·182767 | 9·939673 | 4 17 | 10·060327 | 10·122440 | 4 7 | 9·877560 | 52 | 58 |
| 30 | 10 | 9·817306 | 5 12 | 10·182694 | 9·939801 | 5 21 | 10·060199 | 10·122495 | 5 9 | 9·877505 | 50 | 30 |
| 3 | 12 | 9·817379 | 6 14 | 10·182621 | 9·939928 | 6 25 | 10·060072 | 10·122550 | 6 11 | 9·877450 | 48 | 57 |
| 30 | 14 | 9·817451 | 7 17 | 10·182549 | 9·940056 | 7 30 | 10·059944 | 10·122605 | 7 13 | 9·877395 | 46 | 30 |
| 4 | 16 | 9·817524 | 8 19 | 10·182476 | 9·940183 | 8 34 | 10·059817 | 10·122660 | 8 15 | 9·877340 | 44 | 56 |
| 30 | 18 | 9·817596 | 9 22 | 10·182404 | 9·940311 | 9 38 | 10·059689 | 10·122715 | 9 16 | 9·877285 | 42 | 30 |
| 5 | 20 | 9·817668 | 10 24 | 10·182332 | 9·940439 | 10 42 | 10·059561 | 10·122770 | 10 18 | 9·877230 | 40 | 55 |
| 30 | 22 | 9·817741 | 11 27 | 10·182259 | 9·940566 | 11 47 | 10·059434 | 10·122825 | 11 20 | 9·877175 | 38 | 30 |
| 6 | 24 | 9·817813 | 12 29 | 10·182187 | 9·940694 | 12 51 | 10·059306 | 10·122880 | 12 22 | 9·877120 | 36 | 54 |
| 30 | 26 | 9·817886 | 13 32 | 10·182114 | 9·940821 | 13 55 | 10·059179 | 10·122935 | 13 24 | 9·877065 | 34 | 30 |
| 7 | 28 | 9·817958 | 14 34 | 10·182042 | 9·940949 | 14 59 | 10·059051 | 10·122990 | 14 26 | 9·877010 | 32 | 53 |
| 30 | 30 | 9·818030 | 15 36 | 10·181970 | 9·941076 | 15 64 | 10·058924 | 10·123046 | 15 27 | 9·876954 | 30 | 30 |
| 8 | 32 | 9·818103 | 16 39 | 10·181897 | 9·941204 | 16 68 | 10·058796 | 10·123101 | 16 29 | 9·876899 | 28 | 52 |
| 30 | 34 | 9·818175 | 17 41 | 10·181825 | 9·941331 | 17 72 | 10·058669 | 10·123156 | 17 31 | 9·876844 | 26 | 30 |
| 9 | 36 | 9·818247 | 18 43 | 10·181753 | 9·941459 | 18 76 | 10·058541 | 10·123211 | 18 33 | 9·876789 | 24 | 51 |
| 30 | 38 | 9·818320 | 19 46 | 10·181680 | 9·941586 | 19 81 | 10·058414 | 10·123266 | 19 35 | 9·876734 | 22 | 30 |
| 10 | 40 | 9·818392 | 20 48 | 10·181608 | 9·941713 | 20 85 | 10·058287 | 10·123322 | 20 37 | 9·876678 | 20 | 50 |
| 30 | 42 | 9·818464 | 21 51 | 10·181536 | 9·941841 | 21 89 | 10·058159 | 10·123377 | 21 38 | 9·876623 | 18 | 30 |
| 11 | 44 | 9·818536 | 22 53 | 10·181464 | 9·941968 | 22 93 | 10·058032 | 10·123432 | 22 40 | 9·876568 | 16 | 49 |
| 30 | 46 | 9·818609 | 23 56 | 10·181391 | 9·942096 | 23 98 | 10·057904 | 10·123487 | 23 42 | 9·876513 | 14 | 30 |
| 12 | 48 | 9·818681 | 24 58 | 10·181319 | 9·942223 | 24 102 | 10·057777 | 10·123543 | 24 44 | 9·876457 | 12 | 48 |
| 30 | 50 | 9·818753 | 25 61 | 10·181247 | 9·942351 | 25 106 | 10·057649 | 10·123598 | 25 46 | 9·876402 | 10 | 30 |
| 13 | 52 | 9·818825 | 26 63 | 10·181175 | 9·942478 | 26 110 | 10·057522 | 10·123653 | 26 48 | 9·876347 | 8 | 47 |
| 30 | 54 | 9·818897 | 27 65 | 10·181103 | 9·942606 | 27 115 | 10·057394 | 10·123709 | 27 49 | 9·876291 | 6 | 30 |
| 14 | 56 | 9·818969 | 28 68 | 10·181031 | 9·942733 | 28 119 | 10·057267 | 10·123764 | 28 51 | 9·876236 | 4 | 46 |
| 30 | 58 | 9·819041 | 29 70 | 10·180959 | 9·942861 | 29 123 | 10·057139 | 10·123819 | 29 53 | 9·876181 | 2 | 30 |
| 15 | 45 | 9·819113 | 30 72 | 10·180887 | 9·942988 | 30 127 | 10·057012 | 10·123875 | 30 55 | 9·876125 | 15 | 45 |
| 30 | 2 | 9·819185 | 1 2 | 10·180815 | 9·943115 | 1 4 | 10·056885 | 10·123930 | 1 2 | 9·876070 | 58 | 30 |
| 16 | 4 | 9·819257 | 2 5 | 10·180743 | 9·943243 | 2 8 | 10·056757 | 10·123986 | 2 4 | 9·876014 | 56 | 44 |
| 30 | 6 | 9·819329 | 3 7 | 10·180671 | 9·943370 | 3 13 | 10·056630 | 10·124041 | 3 6 | 9·875959 | 54 | 30 |
| 17 | 8 | 9·819401 | 4 10 | 10·180599 | 9·943498 | 4 17 | 10·056502 | 10·124096 | 4 7 | 9·875904 | 52 | 43 |
| 30 | 10 | 9·819473 | 5 12 | 10·180527 | 9·943625 | 5 21 | 10·056375 | 10·124152 | 5 9 | 9·875848 | 50 | 30 |
| 18 | 12 | 9·819545 | 6 14 | 10·180455 | 9·943752 | 6 25 | 10·056248 | 10·124207 | 6 11 | 9·875793 | 48 | 42 |
| 30 | 14 | 9·819617 | 7 17 | 10·180383 | 9·943880 | 7 30 | 10·056120 | 10·124263 | 7 13 | 9·875737 | 46 | 30 |
| 19 | 16 | 9·819689 | 8 19 | 10·180311 | 9·944007 | 8 34 | 10·055993 | 10·124318 | 8 15 | 9·875682 | 44 | 41 |
| 30 | 18 | 9·819761 | 9 22 | 10·180239 | 9·944135 | 9 38 | 10·055865 | 10·124374 | 9 17 | 9·875626 | 42 | 30 |
| 20 | 20 | 9·819832 | 10 24 | 10·180168 | 9·944262 | 10 42 | 10·055738 | 10·124429 | 10 19 | 9·875571 | 40 | 40 |
| 30 | 22 | 9·819904 | 11 26 | 10·180096 | 9·944389 | 11 47 | 10·055611 | 10·124485 | 11 20 | 9·875515 | 38 | 30 |
| 21 | 24 | 9·819976 | 12 29 | 10·180024 | 9·944517 | 12 51 | 10·055483 | 10·124541 | 12 22 | 9·875459 | 36 | 39 |
| 30 | 26 | 9·820048 | 13 31 | 10·179952 | 9·944644 | 13 55 | 10·055356 | 10·124596 | 13 24 | 9·875404 | 34 | 30 |
| 22 | 28 | 9·820120 | 14 34 | 10·179880 | 9·944771 | 14 59 | 10·055229 | 10·124652 | 14 26 | 9·875348 | 32 | 38 |
| 30 | 30 | 9·820191 | 15 36 | 10·179809 | 9·944899 | 15 64 | 10·055101 | 10·124707 | 15 28 | 9·875293 | 30 | 30 |
| 23 | 32 | 9·820263 | 16 38 | 10·179737 | 9·945026 | 16 68 | 10·054974 | 10·124763 | 16 30 | 9·875237 | 28 | 37 |
| 30 | 34 | 9·820335 | 17 41 | 10·179665 | 9·945153 | 17 72 | 10·054847 | 10·124819 | 17 31 | 9·875181 | 26 | 30 |
| 24 | 36 | 9·820406 | 18 43 | 10·179594 | 9·945281 | 18 76 | 10·054719 | 10·124874 | 18 33 | 9·875126 | 24 | 36 |
| 30 | 38 | 9·820478 | 19 46 | 10·179522 | 9·945408 | 19 81 | 10·054592 | 10·124930 | 19 35 | 9·875070 | 22 | 30 |
| 25 | 40 | 9·820550 | 20 48 | 10·179450 | 9·945535 | 20 85 | 10·054465 | 10·124986 | 20 37 | 9·875014 | 20 | 35 |
| 30 | 42 | 9·820621 | 21 50 | 10·179379 | 9·945663 | 21 89 | 10·054337 | 10·125042 | 21 39 | 9·874958 | 18 | 30 |
| 26 | 44 | 9·820693 | 22 53 | 10·179307 | 9·945790 | 22 93 | 10·054210 | 10·125097 | 22 41 | 9·874903 | 16 | 34 |
| 30 | 46 | 9·820764 | 23 55 | 10·179236 | 9·945917 | 23 98 | 10·054083 | 10·125153 | 23 43 | 9·874847 | 14 | 30 |
| 27 | 48 | 9·820836 | 24 57 | 10·179164 | 9·946045 | 24 102 | 10·053955 | 10·125209 | 24 45 | 9·874791 | 12 | 33 |
| 30 | 50 | 9·820907 | 25 60 | 10·179093 | 9·946172 | 25 106 | 10·053828 | 10·125265 | 25 46 | 9·874735 | 10 | 30 |
| 28 | 52 | 9·820979 | 26 62 | 10·179021 | 9·946299 | 26 110 | 10·053701 | 10·125320 | 26 48 | 9·874680 | 8 | 32 |
| 30 | 54 | 9·821050 | 27 65 | 10·178950 | 9·946427 | 27 115 | 10·053573 | 10·125376 | 27 50 | 9·874624 | 6 | 30 |
| 29 | 56 | 9·821122 | 28 67 | 10·178878 | 9·946554 | 28 119 | 10·053446 | 10·125432 | 28 52 | 9·874568 | 4 | 31 |
| 30 | 58 | 9·821193 | 29 69 | 10·178807 | 9·946681 | 29 123 | 10·053319 | 10·125488 | 29 54 | 9·874512 | 2 | 30 |
| 30 | 46 | 9·821265 | 30 72 | 10·178735 | 9·946808 | 30 127 | 10·053192 | 10·125544 | 30 56 | 9·874456 | 0 | 30 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

48° — 3ʰ 14ᵐ

LOG. SINES, COSINES, &c.

2h 46m 41°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 9·821265 | | 10·178735 | 9·946808 | | 10·053192 | 10·125544 | | 9·874456 | 14 | 30 |
| 30 | 2 | 9·821336 | 1″ 2 | 10·178664 | 9·946936 | 1″ 4 | 10·053064 | 10·125600 | 1″ 2 | 9·874400 | 58 | 30 |
| 31 | 4 | 9·821407 | 2 5 | 10·178593 | 9·947063 | 2 8 | 10·052937 | 10·125656 | 2 4 | 9·874344 | 56 | 29 |
| 30 | 6 | 9·821479 | 3 7 | 10·178521 | 9·947190 | 3 13 | 10·052810 | 10·125712 | 3 6 | 9·874288 | 54 | 30 |
| 32 | 8 | 9·821550 | 4 10 | 10·178450 | 9·947318 | 4 17 | 10·052682 | 10·125768 | 4 7 | 9·874232 | 52 | 28 |
| 30 | 10 | 9·821621 | 5 12 | 10·178379 | 9·947445 | 5 21 | 10·052555 | 10·125823 | 5 9 | 9·874177 | 50 | 30 |
| 33 | 12 | 9·821693 | 6 14 | 10·178307 | 9·947572 | 6 25 | 10·052428 | 10·125879 | 6 11 | 9·874121 | 48 | 27 |
| 30 | 14 | 9·821764 | 7 17 | 10·178236 | 9·947699 | 7 30 | 10·052301 | 10·125935 | 7 13 | 9·874065 | 46 | 30 |
| 34 | 16 | 9·821835 | 8 19 | 10·178165 | 9·947827 | 8 34 | 10·052173 | 10·125991 | 8 15 | 9·874009 | 44 | 26 |
| 30 | 18 | 9·821906 | 9 21 | 10·178094 | 9·947954 | 9 38 | 10·052046 | 10·126047 | 9 17 | 9·873953 | 42 | 30 |
| 35 | 20 | 9·821977 | 10 24 | 10·178023 | 9·948081 | 10 42 | 10·051919 | 10·126104 | 10 19 | 9·873896 | 40 | 25 |
| 30 | 22 | 9·822049 | 11 26 | 10·177951 | 9·948208 | 11 47 | 10·051792 | 10·126160 | 11 21 | 9·873840 | 38 | 30 |
| 36 | 24 | 9·822120 | 12 28 | 10·177880 | 9·948335 | 12 51 | 10·051665 | 10·126216 | 12 22 | 9·873784 | 36 | 24 |
| 30 | 26 | 9·822191 | 13 31 | 10·177809 | 9·948463 | 13 55 | 10·051537 | 10·126272 | 13 24 | 9·873728 | 34 | 30 |
| 37 | 28 | 9·822262 | 14 33 | 10·177738 | 9·948590 | 14 59 | 10·051410 | 10·126328 | 14 26 | 9·873672 | 32 | 23 |
| 30 | 30 | 9·822333 | 15 36 | 10·177667 | 9·948717 | 15 64 | 10·051283 | 10·126384 | 15 28 | 9·873616 | 30 | 30 |
| 38 | 32 | 9·822404 | 16 38 | 10·177596 | 9·948844 | 16 68 | 10·051156 | 10·126440 | 16 30 | 9·873560 | 28 | 22 |
| 30 | 34 | 9·822475 | 17 40 | 10·177525 | 9·948972 | 17 72 | 10·051028 | 10·126496 | 17 32 | 9·873504 | 26 | 30 |
| 39 | 36 | 9·822546 | 18 43 | 10·177454 | 9·949099 | 18 76 | 10·050901 | 10·126552 | 18 34 | 9·873448 | 24 | 21 |
| 30 | 38 | 9·822617 | 19 45 | 10·177383 | 9·949226 | 19 81 | 10·050774 | 10·126609 | 19 36 | 9·873391 | 22 | 30 |
| 40 | 40 | 9·822688 | 20 47 | 10·177312 | 9·949353 | 20 85 | 10·050647 | 10·126665 | 20 37 | 9·873335 | 20 | 20 |
| 30 | 42 | 9·822759 | 21 50 | 10·177241 | 9·949480 | 21 89 | 10·050520 | 10·126721 | 21 39 | 9·873279 | 18 | 30 |
| 41 | 44 | 9·822830 | 22 52 | 10·177170 | 9·949608 | 22 93 | 10·050392 | 10·126777 | 22 41 | 9·873223 | 16 | 19 |
| 30 | 46 | 9·822901 | 23 55 | 10·177099 | 9·949735 | 23 98 | 10·050265 | 10·126834 | 23 43 | 9·873166 | 14 | 30 |
| 42 | 48 | 9·822972 | 24 57 | 10·177028 | 9·949862 | 24 102 | 10·050138 | 10·126890 | 24 45 | 9·873110 | 12 | 18 |
| 30 | 50 | 9·823043 | 25 59 | 10·176957 | 9·949989 | 25 106 | 10·050011 | 10·126946 | 25 47 | 9·873054 | 10 | 30 |
| 43 | 52 | 9·823114 | 26 62 | 10·176886 | 9·950116 | 26 110 | 10·049884 | 10·127002 | 26 49 | 9·872998 | 8 | 17 |
| 30 | 54 | 9·823185 | 27 64 | 10·176815 | 9·950243 | 27 114 | 10·049757 | 10·127059 | 27 50 | 9·872941 | 6 | 30 |
| 44 | 56 | 9·823255 | 28 66 | 10·176745 | 9·950371 | 28 119 | 10·049629 | 10·127115 | 28 52 | 9·872885 | 4 | 16 |
| 30 | 58 | 9·823326 | 29 69 | 10·176674 | 9·950498 | 29 123 | 10·049502 | 10·127171 | 29 54 | 9·872829 | 2 | 30 |
| 45 | 47 | 9·823397 | 30 71 | 10·176603 | 9·950625 | 30 127 | 10·049375 | 10·127228 | 30 56 | 9·872772 | 13 | 15 |
| 30 | 2 | 9·823468 | 1 2 | 10·176532 | 9·950752 | 1 4 | 10·049248 | 10·127284 | 1 2 | 9·872716 | 58 | 30 |
| 46 | 4 | 9·823539 | 2 5 | 10·176461 | 9·950879 | 2 8 | 10·049121 | 10·127341 | 2 4 | 9·872659 | 56 | 14 |
| 30 | 6 | 9·823609 | 3 7 | 10·176391 | 9·951006 | 3 13 | 10·048994 | 10·127397 | 3 6 | 9·872603 | 54 | 30 |
| 47 | 8 | 9·823680 | 4 9 | 10·176320 | 9·951133 | 4 17 | 10·048867 | 10·127453 | 4 8 | 9·872547 | 52 | 13 |
| 30 | 10 | 9·823751 | 5 12 | 10·176249 | 9·951261 | 5 21 | 10·048739 | 10·127510 | 5 9 | 9·872490 | 50 | 30 |
| 48 | 12 | 9·823821 | 6 14 | 10·176179 | 9·951388 | 6 25 | 10·048612 | 10·127566 | 6 11 | 9·872434 | 48 | 12 |
| 30 | 14 | 9·823892 | 7 16 | 10·176108 | 9·951515 | 7 30 | 10·048485 | 10·127623 | 7 13 | 9·872377 | 46 | 30 |
| 49 | 16 | 9·823963 | 8 19 | 10·176037 | 9·951642 | 8 34 | 10·048358 | 10·127679 | 8 15 | 9·872321 | 44 | 11 |
| 30 | 18 | 9·824033 | 9 21 | 10·175967 | 9·951769 | 9 38 | 10·048231 | 10·127736 | 9 17 | 9·872264 | 42 | 30 |
| 50 | 20 | 9·824104 | 10 23 | 10·175896 | 9·951896 | 10 42 | 10·048104 | 10·127792 | 10 19 | 9·872208 | 40 | 10 |
| 30 | 22 | 9·824174 | 11 26 | 10·175826 | 9·952023 | 11 47 | 10·047977 | 10·127849 | 11 21 | 9·872151 | 38 | 30 |
| 51 | 24 | 9·824245 | 12 28 | 10·175755 | 9·952150 | 12 51 | 10·047850 | 10·127905 | 12 23 | 9·872095 | 36 | 9 |
| 30 | 26 | 9·824315 | 13 30 | 10·175685 | 9·952277 | 13 55 | 10·047723 | 10·127962 | 13 25 | 9·872038 | 34 | 30 |
| 52 | 28 | 9·824386 | 14 33 | 10·175614 | 9·952405 | 14 59 | 10·047595 | 10·128019 | 14 26 | 9·871981 | 32 | 8 |
| 30 | 30 | 9·824456 | 15 35 | 10·175544 | 9·952532 | 15 64 | 10·047468 | 10·128075 | 15 28 | 9·871925 | 30 | 30 |
| 53 | 32 | 9·824527 | 16 37 | 10·175473 | 9·952659 | 16 68 | 10·047341 | 10·128132 | 16 30 | 9·871868 | 28 | 7 |
| 30 | 34 | 9·824597 | 17 40 | 10·175403 | 9·952786 | 17 72 | 10·047214 | 10·128189 | 17 32 | 9·871811 | 26 | 30 |
| 54 | 36 | 9·824668 | 18 42 | 10·175332 | 9·952913 | 18 76 | 10·047087 | 10·128245 | 18 34 | 9·871755 | 24 | 6 |
| 30 | 38 | 9·824738 | 19 44 | 10·175262 | 9·953040 | 19 80 | 10·046960 | 10·128302 | 19 36 | 9·871698 | 22 | 30 |
| 55 | 40 | 9·824808 | 20 47 | 10·175192 | 9·953167 | 20 85 | 10·046833 | 10·128359 | 20 38 | 9·871641 | 20 | 5 |
| 30 | 42 | 9·824879 | 21 49 | 10·175121 | 9·953294 | 21 89 | 10·046706 | 10·128415 | 21 40 | 9·871585 | 18 | 30 |
| 56 | 44 | 9·824949 | 22 51 | 10·175051 | 9·953421 | 22 93 | 10·046579 | 10·128472 | 22 42 | 9·871528 | 16 | 4 |
| 30 | 46 | 9·825019 | 23 54 | 10·174981 | 9·953548 | 23 97 | 10·046452 | 10·128529 | 23 43 | 9·871471 | 14 | 30 |
| 57 | 48 | 9·825090 | 24 56 | 10·174910 | 9·953675 | 24 102 | 10·046325 | 10·128586 | 24 45 | 9·871414 | 12 | 3 |
| 30 | 50 | 9·825160 | 25 58 | 10·174840 | 9·953802 | 25 106 | 10·046198 | 10·128642 | 25 47 | 9·871358 | 10 | 30 |
| 58 | 52 | 9·825230 | 26 61 | 10·174770 | 9·953929 | 26 110 | 10·046071 | 10·128699 | 26 49 | 9·871301 | 8 | 2 |
| 30 | 54 | 9·825300 | 27 63 | 10·174700 | 9·954056 | 27 114 | 10·045944 | 10·128756 | 27 51 | 9·871244 | 6 | 30 |
| 59 | 56 | 9·825371 | 28 66 | 10·174629 | 9·954183 | 28 118 | 10·045817 | 10·128813 | 28 53 | 9·871187 | 4 | 1 |
| 30 | 58 | 9·825441 | 29 68 | 10·174559 | 9·954310 | 29 123 | 10·045690 | 10·128870 | 29 55 | 9·871130 | 2 | 30 |
| 60 | 48 | 9·825511 | 30 71 | 10·174489 | 9·954437 | 30 127 | 10·045563 | 10·128927 | 30 57 | 9·871073 | 0 | 0 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

48° 3h 12m

## LOG. SINES, COSINES, &c.

2ʰ 48ᵐ — 42°

| ′ ″ | m. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 9·825511 | | 10·174489 | 9·954437 | | 10·045563 | 10·128927 | | 9·871073 | 12 | 60 |
| 30 | 2 | 9·825581 | 1″ 2 | 10·174419 | 9·954564 | 1″ 4 | 10·045436 | 10·128983 | 1″ 2 | 9·871017 | 58 | 30 |
| 1 | 4 | 9·825651 | 2 5 | 10·174349 | 9·954691 | 2 8 | 10·045309 | 10·129040 | 2 4 | 9·870960 | 56 | 59 |
| 30 | 6 | 9·825721 | 3 7 | 10·174279 | 9·954819 | 3 13 | 10·045181 | 10·129097 | 3 6 | 9·870903 | 54 | 30 |
| 2 | 8 | 9·825791 | 4 9 | 10·174209 | 9·954946 | 4 17 | 10·045054 | 10·129154 | 4 8 | 9·870846 | 52 | 58 |
| 30 | 10 | 9·825861 | 5 12 | 10·174139 | 9·955073 | 5 21 | 10·044927 | 10·129211 | 5 10 | 9·870789 | 50 | 30 |
| 3 | 12 | 9·825931 | 6 14 | 10·174069 | 9·955200 | 6 25 | 10·044800 | 10·129268 | 6 11 | 9·870732 | 48 | 57 |
| 30 | 14 | 9·826001 | 7 16 | 10·173999 | 9·955327 | 7 30 | 10·044673 | 10·129325 | 7 13 | 9·870675 | 46 | 30 |
| 4 | 16 | 9·826071 | 8 19 | 10·173929 | 9·955454 | 8 34 | 10·044546 | 10·129382 | 8 15 | 9·870618 | 44 | 56 |
| 30 | 18 | 9·826141 | 9 21 | 10·173859 | 9·955581 | 9 38 | 10·044419 | 10·129439 | 9 17 | 9·870561 | 42 | 30 |
| 5 | 20 | 9·826211 | 10 23 | 10·173789 | 9·955708 | 10 42 | 10·044292 | 10·129496 | 10 19 | 9·870504 | 40 | 55 |
| 30 | 22 | 9·826281 | 11 26 | 10·173719 | 9·955835 | 11 47 | 10·044165 | 10·129553 | 11 21 | 9·870447 | 38 | 30 |
| 6 | 24 | 9·826351 | 12 28 | 10·173649 | 9·955961 | 12 51 | 10·044039 | 10·129610 | 12 23 | 9·870390 | 36 | 54 |
| 30 | 26 | 9·826421 | 13 30 | 10·173579 | 9·956088 | 13 55 | 10·043912 | 10·129667 | 13 25 | 9·870333 | 34 | 30 |
| 7 | 28 | 9·826491 | 14 33 | 10·173509 | 9·956215 | 14 59 | 10·043785 | 10·129724 | 14 27 | 9·870276 | 32 | 53 |
| 30 | 30 | 9·826561 | 15 35 | 10·173439 | 9·956342 | 15 63 | 10·043658 | 10·129782 | 15 29 | 9·870218 | 30 | 30 |
| 8 | 32 | 9·826631 | 16 37 | 10·173369 | 9·956469 | 16 68 | 10·043531 | 10·129839 | 16 30 | 9·870161 | 28 | 52 |
| 30 | 34 | 9·826701 | 17 40 | 10·173299 | 9·956596 | 17 72 | 10·043404 | 10·129896 | 17 32 | 9·870104 | 26 | 30 |
| 9 | 36 | 9·826770 | 18 42 | 10·173230 | 9·956723 | 18 76 | 10·043277 | 10·129953 | 18 34 | 9·870047 | 24 | 51 |
| 30 | 38 | 9·826840 | 19 44 | 10·173160 | 9·956850 | 19 80 | 10·043150 | 10·130010 | 19 36 | 9·869990 | 22 | 30 |
| 10 | 40 | 9·826910 | 20 47 | 10·173090 | 9·956977 | 20 85 | 10·043023 | 10·130067 | 20 38 | 9·869933 | 20 | 50 |
| 30 | 42 | 9·826980 | 21 49 | 10·173020 | 9·957104 | 21 89 | 10·042896 | 10·130125 | 21 40 | 9·869875 | 18 | 30 |
| 11 | 44 | 9·827049 | 22 51 | 10·172951 | 9·957231 | 22 93 | 10·042769 | 10·130182 | 22 42 | 9·869818 | 16 | 49 |
| 30 | 46 | 9·827119 | 23 54 | 10·172881 | 9·957358 | 23 97 | 10·042642 | 10·130239 | 23 44 | 9·869761 | 14 | 30 |
| 12 | 48 | 9·827189 | 24 56 | 10·172811 | 9·957485 | 24 102 | 10·042515 | 10·130296 | 24 46 | 9·869704 | 12 | 48 |
| 30 | 50 | 9·827258 | 25 58 | 10·172742 | 9·957612 | 25 106 | 10·042388 | 10·130354 | 25 48 | 9·869646 | 10 | 30 |
| 13 | 52 | 9·827328 | 26 61 | 10·172672 | 9·957739 | 26 110 | 10·042261 | 10·130411 | 26 49 | 9·869589 | 8 | 47 |
| 30 | 54 | 9·827398 | 27 63 | 10·172602 | 9·957866 | 27 114 | 10·042134 | 10·130468 | 27 51 | 9·869532 | 6 | 30 |
| 14 | 56 | 9·827467 | 28 65 | 10·172533 | 9·957993 | 28 118 | 10·042007 | 10·130526 | 28 53 | 9·869474 | 4 | 46 |
| 30 | 58 | 9·827537 | 29 68 | 10·172463 | 9·958120 | 29 123 | 10·041880 | 10·130583 | 29 55 | 9·869417 | 2 | 30 |
| 15 | 49 | 9·827606 | 30 70 | 10·172394 | 9·958247 | 30 127 | 10·041753 | 10·130640 | 30 57 | 9·869360 | 11 | 45 |
| 30 | 2 | 9·827676 | 1 2 | 10·172324 | 9·958373 | 1 4 | 10·041627 | 10·130698 | 1 2 | 9·869302 | 58 | 30 |
| 16 | 4 | 9·827745 | 2 5 | 10·172255 | 9·958500 | 2 8 | 10·041500 | 10·130755 | 2 4 | 9·869245 | 56 | 44 |
| 30 | 6 | 9·827815 | 3 7 | 10·172185 | 9·958627 | 3 13 | 10·041373 | 10·130812 | 3 6 | 9·869188 | 54 | 30 |
| 17 | 8 | 9·827884 | 4 9 | 10·172116 | 9·958754 | 4 17 | 10·041246 | 10·130870 | 4 8 | 9·869130 | 52 | 43 |
| 30 | 10 | 9·827954 | 5 12 | 10·172046 | 9·958881 | 5 21 | 10·041119 | 10·130927 | 5 10 | 9·869073 | 50 | 30 |
| 18 | 12 | 9·828023 | 6 14 | 10·171977 | 9·959008 | 6 25 | 10·040992 | 10·130985 | 6 12 | 9·869015 | 48 | 42 |
| 30 | 14 | 9·828093 | 7 16 | 10·171907 | 9·959135 | 7 30 | 10·040865 | 10·131042 | 7 13 | 9·868958 | 46 | 30 |
| 19 | 16 | 9·828162 | 8 19 | 10·171838 | 9·959262 | 8 34 | 10·040738 | 10·131100 | 8 15 | 9·868900 | 44 | 41 |
| 30 | 18 | 9·828231 | 9 21 | 10·171769 | 9·959389 | 9 38 | 10·040611 | 10·131157 | 9 17 | 9·868843 | 42 | 30 |
| 20 | 20 | 9·828301 | 10 23 | 10·171699 | 9·959516 | 10 42 | 10·040484 | 10·131215 | 10 19 | 9·868785 | 40 | 40 |
| 30 | 22 | 9·828370 | 11 26 | 10·171630 | 9·959642 | 11 47 | 10·040358 | 10·131272 | 11 21 | 9·868728 | 38 | 30 |
| 21 | 24 | 9·828439 | 12 28 | 10·171561 | 9·959769 | 12 51 | 10·040231 | 10·131330 | 12 23 | 9·868670 | 36 | 39 |
| 30 | 26 | 9·828509 | 13 30 | 10·171491 | 9·959896 | 13 55 | 10·040104 | 10·131388 | 13 25 | 9·868612 | 34 | 30 |
| 22 | 28 | 9·828578 | 14 33 | 10·171422 | 9·960023 | 14 59 | 10·039977 | 10·131445 | 14 27 | 9·868555 | 32 | 38 |
| 30 | 30 | 9·828647 | 15 35 | 10·171353 | 9·960150 | 15 63 | 10·039850 | 10·131503 | 15 29 | 9·868497 | 30 | 30 |
| 23 | 32 | 9·828716 | 16 37 | 10·171284 | 9·960277 | 16 68 | 10·039723 | 10·131560 | 16 31 | 9·868440 | 28 | 37 |
| 30 | 34 | 9·828786 | 17 40 | 10·171214 | 9·960404 | 17 72 | 10·039596 | 10·131618 | 17 33 | 9·868382 | 26 | 30 |
| 24 | 36 | 9·828855 | 18 42 | 10·171145 | 9·960530 | 18 76 | 10·039470 | 10·131676 | 18 35 | 9·868324 | 24 | 36 |
| 30 | 38 | 9·828924 | 19 44 | 10·171076 | 9·960657 | 19 80 | 10·039343 | 10·131733 | 19 36 | 9·868267 | 22 | 30 |
| 25 | 40 | 9·828993 | 20 46 | 10·171007 | 9·960784 | 20 85 | 10·039216 | 10·131791 | 20 38 | 9·868209 | 20 | 35 |
| 30 | 42 | 9·829062 | 21 49 | 10·170938 | 9·960911 | 21 89 | 10·039089 | 10·131849 | 21 40 | 9·868151 | 18 | 30 |
| 26 | 44 | 9·829131 | 22 51 | 10·170869 | 9·961038 | 22 93 | 10·038962 | 10·131907 | 22 42 | 9·868093 | 16 | 34 |
| 30 | 46 | 9·829200 | 23 53 | 10·170800 | 9·961165 | 23 97 | 10·038835 | 10·131964 | 23 44 | 9·868036 | 14 | 30 |
| 27 | 48 | 9·829269 | 24 55 | 10·170731 | 9·961292 | 24 102 | 10·038708 | 10·132022 | 24 46 | 9·867978 | 12 | 33 |
| 30 | 50 | 9·829338 | 25 58 | 10·170662 | 9·961418 | 25 106 | 10·038582 | 10·132080 | 25 48 | 9·867920 | 10 | 30 |
| 28 | 52 | 9·829407 | 26 60 | 10·170593 | 9·961545 | 26 110 | 10·038455 | 10·132138 | 26 50 | 9·867862 | 8 | 32 |
| 30 | 54 | 9·829476 | 27 62 | 10·170524 | 9·961672 | 27 114 | 10·038328 | 10·132196 | 27 52 | 9·867804 | 6 | 30 |
| 29 | 56 | 9·829545 | 28 65 | 10·170455 | 9·961799 | 28 118 | 10·038201 | 10·132253 | 28 54 | 9·867747 | 4 | 31 |
| 30 | 58 | 9·829614 | 29 67 | 10·170386 | 9·961926 | 29 123 | 10·038074 | 10·132311 | 29 56 | 9·867689 | 2 | 30 |
| 30 | 50 | 9·829683 | 30 69 | 10·170317 | 9·962052 | 30 127 | 10·037948 | 10·132369 | 30 58 | 9·867631 | 0 | 30 |
| ′ ″ | m. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. | ′ ″ |

47° — 3ʰ 10ᵐ

## LOG. SINES, COSINES, &c.

2h 50m — 42°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 9·829683 | | 10·170317 | 9·962052 | | 10·037948 | 10·132369 | | 9·867631 | 10 | 30 |
| 30 | 2 | 9·829752 | 1″ 2 | 10·170248 | 9·962179 | 1″ 4 | 10·037821 | 10·132427 | 1″ 2 | 9·867573 | 58 | 30 |
| 31 | 4 | 9·829821 | 2 5 | 10·170179 | 9·962306 | 2 8 | 10·037694 | 10·132485 | 2 4 | 9·867515 | 56 | 29 |
| 30 | 6 | 9·829890 | 3 7 | 10·170110 | 9·962433 | 3 13 | 10·037567 | 10·132543 | 3 6 | 9·867457 | 54 | 30 |
| 32 | 8 | 9·829959 | 4 9 | 10·170041 | 9·962560 | 4 17 | 10·037440 | 10·132601 | 4 8 | 9·867399 | 52 | 28 |
| 30 | 10 | 9·830028 | 5 12 | 10·169972 | 9·962686 | 5 21 | 10·037314 | 10·132659 | 5 10 | 9·867341 | 50 | 30 |
| 33 | 12 | 9·830097 | 6 14 | 10·169903 | 9·962813 | 6 25 | 10·037187 | 10·132717 | 6 12 | 9·867283 | 48 | 27 |
| 30 | 14 | 9·830165 | 7 16 | 10·169835 | 9·962940 | 7 30 | 10·037060 | 10·132775 | 7 14 | 9·867225 | 46 | 30 |
| 34 | 16 | 9·830234 | 8 19 | 10·169766 | 9·963067 | 8 34 | 10·036933 | 10·132833 | 8 15 | 9·867167 | 44 | 26 |
| 30 | 18 | 9·830303 | 9 21 | 10·169697 | 9·963194 | 9 38 | 10·036806 | 10·132891 | 9 17 | 9·867109 | 42 | 30 |
| 35 | 20 | 9·830372 | 10 23 | 10·169628 | 9·963320 | 10 42 | 10·036680 | 10·132949 | 10 19 | 9·867051 | 40 | 25 |
| 30 | 22 | 9·830440 | 11 25 | 10·169560 | 9·963447 | 11 46 | 10·036553 | 10·133007 | 11 21 | 9·866993 | 38 | 30 |
| 36 | 24 | 9·830509 | 12 27 | 10·169491 | 9·963574 | 12 51 | 10·036426 | 10·133065 | 12 23 | 9·866935 | 36 | 24 |
| 30 | 26 | 9·830578 | 13 30 | 10·169422 | 9·963701 | 13 55 | 10·036299 | 10·133123 | 13 25 | 9·866877 | 34 | 30 |
| 37 | 28 | 9·830646 | 14 32 | 10·169354 | 9·963828 | 14 59 | 10·036172 | 10·133181 | 14 27 | 9·866819 | 32 | 23 |
| 30 | 30 | 9·830715 | 15 34 | 10·169285 | 9·963954 | 15 63 | 10·036046 | 10·133239 | 15 29 | 9·866761 | 30 | 30 |
| 38 | 32 | 9·830784 | 16 36 | 10·169216 | 9·964081 | 16 68 | 10·035919 | 10·133297 | 16 31 | 9·866703 | 28 | 22 |
| 30 | 34 | 9·830852 | 17 39 | 10·169148 | 9·964208 | 17 72 | 10·035792 | 10·133356 | 17 33 | 9·866644 | 26 | 30 |
| 39 | 36 | 9·830921 | 18 41 | 10·169079 | 9·964335 | 18 76 | 10·035665 | 10·133414 | 18 35 | 9·866586 | 24 | 21 |
| 30 | 38 | 9·830989 | 19 43 | 10·169011 | 9·964461 | 19 80 | 10·035539 | 10·133472 | 19 37 | 9·866528 | 22 | 30 |
| 40 | 40 | 9·831058 | 20 46 | 10·168942 | 9·964588 | 20 84 | 10·035412 | 10·133530 | 20 39 | 9·866470 | 20 | 20 |
| 30 | 42 | 9·831127 | 21 48 | 10·168873 | 9·964715 | 21 89 | 10·035285 | 10·133588 | 21 41 | 9·866412 | 18 | 30 |
| 41 | 44 | 9·831195 | 22 50 | 10·168805 | 9·964842 | 22 93 | 10·035158 | 10·133647 | 22 43 | 9·866353 | 16 | 19 |
| 30 | 46 | 9·831263 | 23 52 | 10·168736 | 9·964968 | 23 97 | 10·035032 | 10·133705 | 23 44 | 9·866295 | 14 | 30 |
| 42 | 48 | 9·831332 | 24 55 | 10·168668 | 9·965095 | 24 101 | 10·034905 | 10·133763 | 24 46 | 9·866237 | 12 | 18 |
| 30 | 50 | 9·831400 | 25 57 | 10·168600 | 9·965222 | 25 105 | 10·034778 | 10·133821 | 25 48 | 9·866179 | 10 | 30 |
| 43 | 52 | 9·831469 | 26 59 | 10·168531 | 9·965349 | 26 110 | 10·034651 | 10·133880 | 26 50 | 9·866120 | 8 | 17 |
| 30 | 54 | 9·831537 | 27 62 | 10·168463 | 9·965475 | 27 114 | 10·034525 | 10·133938 | 27 52 | 9·866062 | 6 | 30 |
| 44 | 56 | 9·831606 | 28 64 | 10·168394 | 9·965602 | 28 118 | 10·034398 | 10·133996 | 28 54 | 9·866004 | 4 | 16 |
| 30 | 58 | 9·831674 | 29 66 | 10·168326 | 9·965729 | 29 122 | 10·034271 | 10·134055 | 29 56 | 9·865945 | 2 | 30 |
| 45 | 51 | 9·831742 | 30 69 | 10·168258 | 9·965855 | 30 127 | 10·034145 | 10·134113 | 30 58 | 9·865887 | 9 | 15 |
| 30 | 2 | 9·831811 | 1 2 | 10·168189 | 9·965982 | 1 4 | 10·034018 | 10·134172 | 1 2 | 9·865828 | 58 | 30 |
| 46 | 4 | 9·831879 | 2 5 | 10·168121 | 9·966109 | 2 8 | 10·033891 | 10·134230 | 2 4 | 9·865770 | 56 | 14 |
| 30 | 6 | 9·831947 | 3 7 | 10·168053 | 9·966236 | 3 13 | 10·033764 | 10·134288 | 3 6 | 9·865712 | 54 | 30 |
| 47 | 8 | 9·832015 | 4 9 | 10·167985 | 9·966362 | 4 17 | 10·033638 | 10·134347 | 4 8 | 9·865653 | 52 | 13 |
| 30 | 10 | 9·832084 | 5 12 | 10·167916 | 9·966489 | 5 21 | 10·033511 | 10·134405 | 5 10 | 9·865595 | 50 | 30 |
| 48 | 12 | 9·832152 | 6 14 | 10·167848 | 9·966616 | 6 25 | 10·033384 | 10·134464 | 6 12 | 9·865536 | 48 | 12 |
| 30 | 14 | 9·832220 | 7 16 | 10·167780 | 9·966742 | 7 30 | 10·033258 | 10·134522 | 7 14 | 9·865478 | 46 | 30 |
| 49 | 16 | 9·832288 | 8 19 | 10·167712 | 9·966869 | 8 34 | 10·033131 | 10·134581 | 8 16 | 9·865419 | 44 | 11 |
| 30 | 18 | 9·832356 | 9 21 | 10·167643 | 9·966996 | 9 38 | 10·033004 | 10·134639 | 9 18 | 9·865361 | 42 | 30 |
| 50 | 20 | 9·832425 | 10 23 | 10·167575 | 9·967123 | 10 42 | 10·032877 | 10·134698 | 10 20 | 9·865302 | 40 | 10 |
| 30 | 22 | 9·832493 | 11 25 | 10·167507 | 9·967249 | 11 46 | 10·032751 | 10·134756 | 11 21 | 9·865244 | 38 | 30 |
| 51 | 24 | 9·832561 | 12 27 | 10·167439 | 9·967376 | 12 51 | 10·032624 | 10·134815 | 12 23 | 9·865185 | 36 | 9 |
| 30 | 26 | 9·832629 | 13 30 | 10·167371 | 9·967503 | 13 55 | 10·032497 | 10·134874 | 13 25 | 9·865126 | 34 | 30 |
| 52 | 28 | 9·832697 | 14 32 | 10·167303 | 9·967629 | 14 59 | 10·032371 | 10·134932 | 14 27 | 9·865068 | 32 | 8 |
| 30 | 30 | 9·832765 | 15 34 | 10·167235 | 9·967756 | 15 63 | 10·032244 | 10·134991 | 15 29 | 9·865009 | 30 | 30 |
| 53 | 32 | 9·832833 | 16 36 | 10·167167 | 9·967883 | 16 68 | 10·032117 | 10·135050 | 16 31 | 9·864950 | 28 | 7 |
| 30 | 34 | 9·832901 | 17 39 | 10·167099 | 9·968009 | 17 72 | 10·031991 | 10·135108 | 17 33 | 9·864892 | 26 | 30 |
| 54 | 36 | 9·832969 | 18 41 | 10·167031 | 9·968136 | 18 76 | 10·031864 | 10·135167 | 18 35 | 9·864833 | 24 | 6 |
| 30 | 38 | 9·833037 | 19 43 | 10·166963 | 9·968263 | 19 80 | 10·031737 | 10·135226 | 19 37 | 9·864774 | 22 | 30 |
| 55 | 40 | 9·833105 | 20 45 | 10·166895 | 9·968389 | 20 84 | 10·031611 | 10·135284 | 20 39 | 9·864716 | 20 | 5 |
| 30 | 42 | 9·833173 | 21 48 | 10·166827 | 9·968516 | 21 89 | 10·031484 | 10·135343 | 21 41 | 9·864657 | 18 | 30 |
| 56 | 44 | 9·833241 | 22 50 | 10·166759 | 9·968643 | 22 93 | 10·031357 | 10·135402 | 22 43 | 9·864598 | 16 | 4 |
| 30 | 46 | 9·833309 | 23 52 | 10·166691 | 9·968769 | 23 97 | 10·031231 | 10·135461 | 23 45 | 9·864539 | 14 | 30 |
| 57 | 48 | 9·833377 | 24 55 | 10·166623 | 9·968896 | 24 101 | 10·031104 | 10·135519 | 24 47 | 9·864481 | 12 | 3 |
| 30 | 50 | 9·833444 | 25 57 | 10·166556 | 9·969023 | 25 106 | 10·030977 | 10·135578 | 25 49 | 9·864422 | 10 | 30 |
| 58 | 52 | 9·833512 | 26 59 | 10·166488 | 9·969149 | 26 110 | 10·030851 | 10·135637 | 26 51 | 9·864363 | 8 | 2 |
| 30 | 54 | 9·833580 | 27 61 | 10·166420 | 9·969276 | 27 114 | 10·030724 | 10·135696 | 27 53 | 9·864304 | 6 | 30 |
| 59 | 56 | 9·833648 | 28 64 | 10·166352 | 9·969403 | 28 118 | 10·030597 | 10·135755 | 28 55 | 9·864245 | 4 | 1 |
| 30 | 58 | 9·833716 | 29 66 | 10·166284 | 9·969529 | 29 122 | 10·030471 | 10·135814 | 29 57 | 9·864186 | 2 | 30 |
| 60 | 52 | 9·833783 | 30 68 | 10·166217 | 9·969656 | 30 127 | 10·030344 | 10·135873 | 30 59 | 9·864127 | 0 | 0 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

47° — 3h 8m

## LOG. SINES, COSINES, &c.

$2^h\ 52^m$ — 43°

| ″ ′ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ″ ′ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 9·833783 | | 10·166217 | 9·969656 | | 10·030344 | 10·135873 | | 9·864127 | 8 | 60 |
| 30 | 2 | 9·833851 | 1″ 2 | 10·166149 | 9·969783 | 1″ 4 | 10·030217 | 10·135931 | 1″ 2 | 9·864069 | 58 | 30 |
| 1 | 4 | 9·833919 | 2 4 | 10·166081 | 9·969909 | 2 8 | 10·030091 | 10·135990 | 2 4 | 9·864010 | 56 | 59 |
| 30 | 6 | 9·833986 | 3 7 | 10·166014 | 9·970036 | 3 13 | 10·029964 | 10·136049 | 3 6 | 9·863951 | 54 | 30 |
| 2 | 8 | 9·834054 | 4 9 | 10·165946 | 9·970162 | 4 17 | 10·029838 | 10·136108 | 4 8 | 9·863892 | 52 | 58 |
| 30 | 10 | 9·834122 | 5 11 | 10·165878 | 9·970289 | 5 21 | 10·029711 | 10·136167 | 5 10 | 9·863833 | 50 | 30 |
| 3 | 12 | 9·834189 | 6 13 | 10·165811 | 9·970416 | 6 25 | 10·029584 | 10·136226 | 6 12 | 9·863774 | 48 | 57 |
| 30 | 14 | 9·834257 | 7 16 | 10·165743 | 9·970542 | 7 30 | 10·029458 | 10·136285 | 7 14 | 9·863715 | 46 | 30 |
| 4 | 16 | 9·834325 | 8 18 | 10·165675 | 9·970669 | 8 34 | 10·029331 | 10·136344 | 8 16 | 9·863656 | 44 | 56 |
| 30 | 18 | 9·834392 | 9 20 | 10·165608 | 9·970796 | 9 38 | 10·029204 | 10·136403 | 9 18 | 9·863597 | 42 | 30 |
| 5 | 20 | 9·834460 | 10 22 | 10·165540 | 9·970922 | 10 42 | 10·029078 | 10·136462 | 10 20 | 9·863538 | 40 | 55 |
| 30 | 22 | 9·834527 | 11 25 | 10·165473 | 9·971049 | 11 46 | 10·028951 | 10·136522 | 11 22 | 9·863478 | 38 | 30 |
| 6 | 24 | 9·834595 | 12 27 | 10·165405 | 9·971175 | 12 51 | 10·028825 | 10·136581 | 12 24 | 9·863419 | 36 | 54 |
| 30 | 26 | 9·834662 | 13 29 | 10·165338 | 9·971302 | 13 55 | 10·028698 | 10·136640 | 13 26 | 9·863360 | 34 | 30 |
| 7 | 28 | 9·834730 | 14 31 | 10·165270 | 9·971429 | 14 59 | 10·028571 | 10·136699 | 14 28 | 9·863301 | 32 | 53 |
| 30 | 30 | 9·834797 | 15 34 | 10·165203 | 9·971555 | 15 63 | 10·028445 | 10·136758 | 15 30 | 9·863242 | 30 | 30 |
| 8 | 32 | 9·834865 | 16 36 | 10·165135 | 9·971682 | 16 68 | 10·028318 | 10·136817 | 16 32 | 9·863183 | 28 | 52 |
| 30 | 34 | 9·834932 | 17 38 | 10·165068 | 9·971808 | 17 72 | 10·028192 | 10·136876 | 17 33 | 9·863124 | 26 | 30 |
| 9 | 36 | 9·834999 | 18 41 | 10·165001 | 9·971935 | 18 76 | 10·028065 | 10·136936 | 18 35 | 9·863064 | 24 | 51 |
| 30 | 38 | 9·835067 | 19 43 | 10·164933 | 9·972062 | 19 80 | 10·027938 | 10·136995 | 19 37 | 9·863005 | 22 | 30 |
| 10 | 40 | 9·835134 | 20 45 | 10·164866 | 9·972188 | 20 84 | 10·027812 | 10·137054 | 20 39 | 9·862946 | 20 | 50 |
| 30 | 42 | 9·835201 | 21 47 | 10·164799 | 9·972315 | 21 89 | 10·027685 | 10·137113 | 21 41 | 9·862887 | 18 | 30 |
| 11 | 44 | 9·835269 | 22 49 | 10·164731 | 9·972441 | 22 93 | 10·027559 | 10·137173 | 22 43 | 9·862827 | 16 | 49 |
| 30 | 46 | 9·835336 | 23 52 | 10·164664 | 9·972568 | 23 97 | 10·027432 | 10·137232 | 23 45 | 9·862768 | 14 | 30 |
| 12 | 48 | 9·835403 | 24 54 | 10·164597 | 9·972695 | 24 101 | 10·027305 | 10·137291 | 24 47 | 9·862709 | 12 | 48 |
| 30 | 50 | 9·835471 | 25 56 | 10·164529 | 9·972821 | 25 105 | 10·027179 | 10·137350 | 25 49 | 9·862650 | 10 | 30 |
| 13 | 52 | 9·835538 | 26 58 | 10·164462 | 9·972948 | 26 110 | 10·027052 | 10·137410 | 26 51 | 9·862590 | 8 | 47 |
| 30 | 54 | 9·835605 | 27 61 | 10·164395 | 9·973074 | 27 114 | 10·026926 | 10·137469 | 27 53 | 9·862531 | 6 | 30 |
| 14 | 56 | 9·835672 | 28 63 | 10·164328 | 9·973201 | 28 118 | 10·026799 | 10·137529 | 28 55 | 9·862471 | 4 | 46 |
| 30 | 58 | 9·835739 | 29 65 | 10·164261 | 9·973327 | 29 122 | 10·026673 | 10·137588 | 29 57 | 9·862412 | 2 | 30 |
| 15 | **53** | 9·835807 | 30 68 | 10·164193 | 9·973454 | 30 126 | 10·026546 | 10·137647 | 30 59 | 9·862353 | **7** | 45 |
| 30 | 2 | 9·835874 | 1 2 | 10·164126 | 9·973581 | 1 4 | 10·026419 | 10·137707 | 1 2 | 9·862293 | 58 | 30 |
| 16 | 4 | 9·835941 | 2 4 | 10·164059 | 9·973707 | 2 8 | 10·026293 | 10·137766 | 2 4 | 9·862234 | 56 | 44 |
| 30 | 6 | 9·836008 | 3 7 | 10·163992 | 9·973834 | 3 13 | 10·026166 | 10·137826 | 3 6 | 9·862174 | 54 | 30 |
| 17 | 8 | 9·836075 | 4 9 | 10·163925 | 9·973960 | 4 17 | 10·026040 | 10·137885 | 4 8 | 9·862115 | 52 | 43 |
| 30 | 10 | 9·836142 | 5 11 | 10·163858 | 9·974087 | 5 21 | 10·025913 | 10·137945 | 5 10 | 9·862055 | 50 | 30 |
| 18 | 12 | 9·836209 | 6 13 | 10·163791 | 9·974213 | 6 25 | 10·025787 | 10·138004 | 6 12 | 9·861996 | 48 | 42 |
| 30 | 14 | 9·836276 | 7 16 | 10·163724 | 9·974340 | 7 30 | 10·025660 | 10·138064 | 7 14 | 9·861936 | 46 | 30 |
| 19 | 16 | 9·836343 | 8 18 | 10·163657 | 9·974466 | 8 34 | 10·025534 | 10·138123 | 8 16 | 9·861877 | 44 | 41 |
| 30 | 18 | 9·836410 | 9 20 | 10·163590 | 9·974593 | 9 38 | 10·025407 | 10·138183 | 9 18 | 9·861817 | 42 | 30 |
| 20 | 20 | 9·836477 | 10 22 | 10·163523 | 9·974720 | 10 42 | 10·025280 | 10·138242 | 10 20 | 9·861758 | 40 | 40 |
| 30 | 22 | 9·836544 | 11 25 | 10·163456 | 9·974846 | 11 46 | 10·025154 | 10·138302 | 11 22 | 9·861698 | 38 | 30 |
| 21 | 24 | 9·836611 | 12 27 | 10·163389 | 9·974973 | 12 51 | 10·025027 | 10·138362 | 12 24 | 9·861638 | 36 | 39 |
| 30 | 26 | 9·836678 | 13 29 | 10·163322 | 9·975099 | 13 55 | 10·024901 | 10·138421 | 13 26 | 9·861579 | 34 | 30 |
| 22 | 28 | 9·836745 | 14 31 | 10·163255 | 9·975226 | 14 59 | 10·024774 | 10·138481 | 14 28 | 9·861519 | 32 | 38 |
| 30 | 30 | 9·836812 | 15 33 | 10·163188 | 9·975352 | 15 63 | 10·024648 | 10·138541 | 15 30 | 9·861459 | 30 | 30 |
| 23 | 32 | 9·836878 | 16 36 | 10·163122 | 9·975479 | 16 68 | 10·024521 | 10·138600 | 16 32 | 9·861400 | 28 | 37 |
| 30 | 34 | 9·836945 | 17 38 | 10·163055 | 9·975605 | 17 72 | 10·024395 | 10·138660 | 17 34 | 9·861340 | 26 | 30 |
| 24 | 36 | 9·837012 | 18 40 | 10·162988 | 9·975732 | 18 76 | 10·024268 | 10·138720 | 18 36 | 9·861280 | 24 | 36 |
| 30 | 38 | 9·837079 | 19 42 | 10·162921 | 9·975858 | 19 80 | 10·024142 | 10·138779 | 19 38 | 9·861221 | 22 | 30 |
| 25 | 40 | 9·837146 | 20 45 | 10·162854 | 9·975985 | 20 84 | 10·024015 | 10·138839 | 20 40 | 9·861161 | 20 | 35 |
| 30 | 42 | 9·837212 | 21 47 | 10·162788 | 9·976111 | 21 89 | 10·023889 | 10·138899 | 21 42 | 9·861101 | 18 | 30 |
| 26 | 44 | 9·837279 | 22 49 | 10·162721 | 9·976238 | 22 93 | 10·023762 | 10·138959 | 22 44 | 9·861041 | 16 | 34 |
| 30 | 46 | 9·837346 | 23 52 | 10·162654 | 9·976364 | 23 97 | 10·023636 | 10·139019 | 23 46 | 9·860981 | 14 | 30 |
| 27 | 48 | 9·837412 | 24 54 | 10·162588 | 9·976491 | 24 101 | 10·023509 | 10·139078 | 24 48 | 9·860922 | 12 | 33 |
| 30 | 50 | 9·837479 | 25 56 | 10·162521 | 9·976617 | 25 105 | 10·023383 | 10·139138 | 25 50 | 9·860862 | 10 | 30 |
| 28 | 52 | 9·837546 | 26 58 | 10·162454 | 9·976744 | 26 110 | 10·023256 | 10·139198 | 26 52 | 9·860802 | 8 | 32 |
| 30 | 54 | 9·837612 | 27 60 | 10·162388 | 9·976870 | 27 114 | 10·023130 | 10·139258 | 27 54 | 9·860742 | 6 | 30 |
| 29 | 56 | 9·837679 | 28 63 | 10·162321 | 9·976997 | 28 118 | 10·023003 | 10·139318 | 28 56 | 9·860682 | 4 | 31 |
| 30 | 58 | 9·837746 | 29 65 | 10·162254 | 9·977123 | 29 122 | 10·022877 | 10·139378 | 29 58 | 9·860622 | 2 | 30 |
| 30 | **54** | 9·837812 | 30 67 | 10·162188 | 9·977250 | 30 126 | 10·022750 | 10·139438 | 30 60 | 9·860562 | 0 | 30 |
| ″ ′ | m. s. | Cosine | Parts | Secant | Parts | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ″ ′ |

46° — $3^h\ 6^m$

## LOG. SINES, COSINES, &c.

2h 54m  43°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 9·837812 | | 10·162188 | 9·977250 | | 10·022750 | 10·139438 | | 9·860562 | 6 | 30 |
| 30 | 2 | 9·837879 | 1″ 2 | 10·162121 | 9·977377 | 1″ 4 | 10·022623 | 10·139498 | 1″ 2 | 9·860502 | 58 | 30 |
| 31 | 4 | 9·837945 | 2 4 | 10·162055 | 9·977503 | 2 8 | 10·022497 | 10·139558 | 2 4 | 9·860442 | 56 | 29 |
| 30 | 0 | 9·838012 | 3 7 | 10·161988 | 9·977630 | 3 13 | 10·022370 | 10·139618 | 3 6 | 9·860382 | 54 | 30 |
| 32 | 8 | 9·838078 | 4 9 | 10·161922 | 9·977756 | 4 17 | 10·022244 | 10·139678 | 4 8 | 9·860322 | 52 | 28 |
| 30 | 10 | 9·838145 | 5 11 | 10·161855 | 9·977882 | 5 21 | 10·022118 | 10·139738 | 5 10 | 9·860262 | 50 | 30 |
| 33 | 12 | 9·838211 | 6 13 | 10·161789 | 9·978009 | 6 25 | 10·021991 | 10·139798 | 6 12 | 9·860202 | 48 | 27 |
| 30 | 14 | 9·838278 | 7 15 | 10·161722 | 9·978135 | 7 30 | 10·021865 | 10·139858 | 7 14 | 9·860142 | 46 | 30 |
| 34 | 16 | 9·838344 | 8 17 | 10·161656 | 9·978262 | 8 34 | 10·021738 | 10·139918 | 8 16 | 9·860082 | 44 | 26 |
| 30 | 18 | 9·838410 | 9 20 | 10·161590 | 9·978388 | 9 38 | 10·021612 | 10·139978 | 9 18 | 9·860022 | 42 | 30 |
| 35 | 20 | 9·838477 | 10 22 | 10·161523 | 9·978515 | 10 42 | 10·021485 | 10·140038 | 10 20 | 9·859962 | 40 | 25 |
| 30 | 22 | 9·838543 | 11 24 | 10·161457 | 9·978641 | 11 46 | 10·021359 | 10·140098 | 11 22 | 9·859902 | 38 | 30 |
| 36 | 24 | 9·838610 | 12 27 | 10·161390 | 9·978768 | 12 51 | 10·021232 | 10·140158 | 12 24 | 9·859842 | 36 | 24 |
| 30 | 26 | 9·838676 | 13 29 | 10·161324 | 9·978894 | 13 55 | 10·021106 | 10·140219 | 13 26 | 9·859781 | 34 | 30 |
| 37 | 28 | 9·838742 | 14 31 | 10·161258 | 9·979021 | 14 59 | 10·020979 | 10·140279 | 14 28 | 9·859721 | 32 | 23 |
| 30 | 30 | 9·838808 | 15 33 | 10·161192 | 9·979147 | 15 63 | 10·020853 | 10·140339 | 15 30 | 9·859661 | 30 | 30 |
| 38 | 32 | 9·838875 | 16 35 | 10·161125 | 9·979274 | 16 67 | 10·020726 | 10·140399 | 16 32 | 9·859601 | 28 | 22 |
| 30 | 34 | 9·838941 | 17 37 | 10·161059 | 9·979400 | 17 72 | 10·020600 | 10·140459 | 17 34 | 9·859541 | 26 | 30 |
| 39 | 36 | 9·839007 | 18 40 | 10·160993 | 9·979527 | 18 76 | 10·020473 | 10·140520 | 18 36 | 9·859480 | 24 | 21 |
| 30 | 38 | 9·839073 | 19 42 | 10·160927 | 9·979653 | 19 80 | 10·020347 | 10·140580 | 19 38 | 9·859420 | 22 | 30 |
| 40 | 40 | 9·839140 | 20 44 | 10·160860 | 9·979780 | 20 84 | 10·020220 | 10·140640 | 20 40 | 9·859360 | 20 | 20 |
| 30 | 42 | 9·839206 | 21 46 | 10·160794 | 9·979906 | 21 89 | 10·020094 | 10·140700 | 21 42 | 9·859300 | 18 | 30 |
| 41 | 44 | 9·839272 | 22 48 | 10·160728 | 9·980033 | 22 93 | 10·019967 | 10·140761 | 22 44 | 9·859239 | 16 | 19 |
| 30 | 46 | 9·839338 | 23 51 | 10·160662 | 9·980159 | 23 97 | 10·019841 | 10·140821 | 23 46 | 9·859179 | 14 | 30 |
| 42 | 48 | 9·839404 | 24 53 | 10·160596 | 9·980286 | 24 101 | 10·019714 | 10·140881 | 24 48 | 9·859119 | 12 | 18 |
| 30 | 50 | 9·839470 | 25 55 | 10·160530 | 9·980412 | 25 105 | 10·019588 | 10·140942 | 25 50 | 9·859058 | 10 | 30 |
| 43 | 52 | 9·839536 | 26 57 | 10·160464 | 9·980538 | 26 110 | 10·019462 | 10·141002 | 26 52 | 9·858998 | 8 | 17 |
| 30 | 54 | 9·839602 | 27 60 | 10·160398 | 9·980665 | 27 114 | 10·019335 | 10·141063 | 27 54 | 9·858937 | 6 | 30 |
| 44 | 56 | 9·839668 | 28 62 | 10·160332 | 9·980791 | 28 118 | 10·019209 | 10·141123 | 28 56 | 9·858877 | 4 | 16 |
| 30 | 58 | 9·839734 | 29 64 | 10·160266 | 9·980918 | 29 122 | 10·019082 | 10·141183 | 29 58 | 9·858817 | 2 | 30 |
| 45 | 55 | 9·839800 | 30 66 | 10·160200 | 9·981044 | 30 126 | 10·018956 | 10·141244 | 30 60 | 9·858756 | 5 | 15 |
| 30 | 2 | 9·839866 | 1 2 | 10·160134 | 9·981171 | 1 4 | 10·018829 | 10·141304 | 1 2 | 9·858696 | 58 | 30 |
| 46 | 4 | 9·839932 | 2 4 | 10·160068 | 9·981297 | 2 8 | 10·018703 | 10·141365 | 2 4 | 9·858635 | 56 | 14 |
| 30 | 6 | 9·839998 | 3 7 | 10·160002 | 9·981424 | 3 13 | 10·018576 | 10·141425 | 3 6 | 9·858575 | 54 | 30 |
| 47 | 8 | 9·840064 | 4 9 | 10·159936 | 9·981550 | 4 17 | 10·018450 | 10·141486 | 4 8 | 9·858514 | 52 | 13 |
| 30 | 10 | 9·840130 | 5 11 | 10·159870 | 9·981677 | 5 21 | 10·018323 | 10·141546 | 5 10 | 9·858454 | 50 | 30 |
| 48 | 12 | 9·840196 | 6 13 | 10·159804 | 9·981803 | 6 25 | 10·018197 | 10·141607 | 6 12 | 9·858393 | 48 | 12 |
| 30 | 14 | 9·840262 | 7 15 | 10·159738 | 9·981929 | 7 29 | 10·018071 | 10·141668 | 7 14 | 9·858332 | 46 | 30 |
| 49 | 16 | 9·840328 | 8 17 | 10·159672 | 9·982056 | 8 34 | 10·017944 | 10·141728 | 8 16 | 9·858272 | 44 | 11 |
| 30 | 18 | 9·840393 | 9 20 | 10·159607 | 9·982182 | 9 38 | 10·017818 | 10·141789 | 9 18 | 9·858211 | 42 | 30 |
| 50 | 20 | 9·840459 | 10 22 | 10·159541 | 9·982309 | 10 42 | 10·017691 | 10·141849 | 10 20 | 9·858151 | 40 | 10 |
| 30 | 22 | 9·840525 | 11 24 | 10·159475 | 9·982435 | 11 46 | 10·017565 | 10·141910 | 11 22 | 9·858090 | 38 | 30 |
| 51 | 24 | 9·840591 | 12 26 | 10·159409 | 9·982562 | 12 51 | 10·017438 | 10·141971 | 12 24 | 9·858029 | 36 | 9 |
| 30 | 26 | 9·840657 | 13 29 | 10·159343 | 9·982688 | 13 55 | 10·017312 | 10·142032 | 13 26 | 9·857968 | 34 | 30 |
| 52 | 28 | 9·840722 | 14 31 | 10·159278 | 9·982814 | 14 59 | 10·017186 | 10·142092 | 14 28 | 9·857908 | 32 | 8 |
| 30 | 30 | 9·840788 | 15 33 | 10·159212 | 9·982941 | 15 63 | 10·017059 | 10·142153 | 15 30 | 9·857847 | 30 | 30 |
| 53 | 32 | 9·840854 | 16 35 | 10·159146 | 9·983067 | 16 67 | 10·016933 | 10·142214 | 16 32 | 9·857786 | 28 | 7 |
| 30 | 34 | 9·840919 | 17 37 | 10·159081 | 9·983194 | 17 72 | 10·016806 | 10·142274 | 17 34 | 9·857726 | 26 | 30 |
| 54 | 36 | 9·840985 | 18 39 | 10·159015 | 9·983320 | 18 76 | 10·016680 | 10·142335 | 18 36 | 9·857665 | 24 | 6 |
| 30 | 38 | 9·841051 | 19 42 | 10·158949 | 9·983447 | 19 80 | 10·016553 | 10·142396 | 19 38 | 9·857604 | 22 | 30 |
| 55 | 40 | 9·841116 | 20 44 | 10·158884 | 9·983573 | 20 84 | 10·016427 | 10·142457 | 20 40 | 9·857543 | 20 | 5 |
| 30 | 42 | 9·841182 | 21 46 | 10·158818 | 9·983699 | 21 88 | 10·016301 | 10·142518 | 21 42 | 9·857482 | 18 | 30 |
| 56 | 44 | 9·841247 | 22 48 | 10·158753 | 9·983826 | 22 93 | 10·016174 | 10·142578 | 22 45 | 9·857422 | 16 | 4 |
| 30 | 46 | 9·841313 | 23 51 | 10·158687 | 9·983952 | 23 97 | 10·016048 | 10·142639 | 23 46 | 9·857361 | 14 | 30 |
| 57 | 48 | 9·841378 | 24 53 | 10·158622 | 9·984079 | 24 101 | 10·015921 | 10·142700 | 24 48 | 9·857300 | 12 | 3 |
| 30 | 50 | 9·841444 | 25 55 | 10·158556 | 9·984205 | 25 105 | 10·015795 | 10·142761 | 25 51 | 9·857239 | 10 | 30 |
| 58 | 52 | 9·841509 | 26 57 | 10·158491 | 9·984331 | 26 109 | 10·015668 | 10·142822 | 26 53 | 9·857178 | 8 | 2 |
| 30 | 54 | 9·841575 | 27 59 | 10·158425 | 9·984458 | 27 114 | 10·015542 | 10·142883 | 27 55 | 9·857117 | 6 | 30 |
| 59 | 56 | 9·841640 | 28 61 | 10·158360 | 9·984584 | 28 118 | 10·015416 | 10·142944 | 28 57 | 9·857056 | 4 | 1 |
| 30 | 58 | 9·841706 | 29 64 | 10·158294 | 9·984711 | 29 122 | 10·015289 | 10·143005 | 29 59 | 9·856995 | 2 | 30 |
| 60 | 56 | 9·841771 | 30 66 | 10·158229 | 9·984837 | 30 126 | 10·015163 | 10·143066 | 30 61 | 9·856934 | 0 | 0 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

46°  3h 4m

## LOG. SINES, COSINES, &c.

2h 56m — 44°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 9·841771 | | 10·158229 | 9·984837 | | 10·015163 | 10·143066 | | 9·856934 | [illegible] | 60 |
| 30 | 2 | 9·841837 | 1″ 2 | 10·158163 | 9·984964 | 1″ 4 | 10·015036 | 10·143127 | 1″ 2 | 9·856873 | 58 | 30 |
| 1 | 4 | 9·841902 | 2 4 | 10·158098 | 9·985090 | 2 8 | 10·014910 | 10·143188 | 2 4 | 9·856812 | 56 | 59 |
| 30 | 6 | 9·841967 | 3 7 | 10·158033 | 9·985216 | 3 13 | 10·014784 | 10·143249 | 3 6 | 9·856751 | 54 | 30 |
| 2 | 8 | 9·842033 | 4 9 | 10·157967 | 9·985343 | 4 17 | 10·014657 | 10·143310 | 4 8 | 9·856690 | 52 | 58 |
| 30 | 10 | 9·842098 | 5 11 | 10·157902 | 9·985469 | 5 21 | 10·014531 | 10·143371 | 5 10 | 9·856629 | 50 | 30 |
| 3 | 12 | 9·842163 | 6 13 | 10·157837 | 9·985596 | 6 25 | 10·014404 | 10·143432 | 6 12 | 9·856568 | 48 | 57 |
| 30 | 14 | 9·842229 | 7 15 | 10·157771 | 9·985722 | 7 29 | 10·014278 | 10·143493 | 7 14 | 9·856507 | 46 | 30 |
| 4 | 16 | 9·842294 | 8 17 | 10·157706 | 9·985848 | 8 34 | 10·014152 | 10·143554 | 8 16 | 9·856446 | 44 | 56 |
| 30 | 18 | 9·842359 | 9 20 | 10·157641 | 9·985975 | 9 38 | 10·014025 | 10·143616 | 9 18 | 9·856384 | 42 | 30 |
| 5 | 20 | 9·842424 | 10 22 | 10·157576 | 9·986101 | 10 42 | 10·013899 | 10·143677 | 10 20 | 9·856323 | 40 | 55 |
| 30 | 22 | 9·842490 | 11 24 | 10·157510 | 9·986228 | 11 46 | 10·013772 | 10·143738 | 11 22 | 9·856262 | 38 | 30 |
| 6 | 24 | 9·842555 | 12 26 | 10·157445 | 9·986354 | 12 51 | 10·013646 | 10·143799 | 12 24 | 9·856201 | 36 | 54 |
| 30 | 26 | 9·842620 | 13 28 | 10·157380 | 9·986480 | 13 55 | 10·013520 | 10·143860 | 13 27 | 9·856140 | 34 | 30 |
| 7 | 28 | 9·842685 | 14 30 | 10·157315 | 9·986607 | 14 59 | 10·013393 | 10·143922 | 14 29 | 9·856078 | 32 | 53 |
| 30 | 30 | 9·842750 | 15 33 | 10·157250 | 9·986733 | 15 63 | 10·013267 | 10·143983 | 15 31 | 9·856017 | 30 | 30 |
| 8 | 32 | 9·842815 | 16 35 | 10·157185 | 9·986860 | 16 67 | 10·013140 | 10·144044 | 16 33 | 9·855956 | 28 | 52 |
| 30 | 34 | 9·842880 | 17 37 | 10·157120 | 9·986986 | 17 72 | 10·013014 | 10·144106 | 17 35 | 9·855895 | 26 | 30 |
| 9 | 36 | 9·842946 | 18 39 | 10·157054 | 9·987112 | 18 76 | 10·012888 | 10·144167 | 18 37 | 9·855833 | 24 | 51 |
| 30 | 38 | 9·843011 | 19 41 | 10·156989 | 9·987239 | 19 80 | 10·012761 | 10·144228 | 19 39 | 9·855772 | 22 | 30 |
| 10 | 40 | 9·843076 | 20 43 | 10·156924 | 9·987365 | 20 84 | 10·012635 | 10·144289 | 20 41 | 9·855711 | 20 | 50 |
| 30 | 42 | 9·843141 | 21 46 | 10·156859 | 9·987491 | 21 88 | 10·012509 | 10·144351 | 21 43 | 9·855649 | 18 | 30 |
| 11 | 44 | 9·843206 | 22 48 | 10·156794 | 9·987618 | 22 93 | 10·012382 | 10·144412 | 22 45 | 9·855588 | 16 | 49 |
| 30 | 46 | 9·843271 | 23 50 | 10·156729 | 9·987744 | 23 97 | 10·012256 | 10·144474 | 23 47 | 9·855526 | 14 | 30 |
| 12 | 48 | 9·843336 | 24 52 | 10·156664 | 9·987871 | 24 101 | 10·012129 | 10·144535 | 24 49 | 9·855465 | 12 | 48 |
| 30 | 50 | 9·843401 | 25 54 | 10·156599 | 9·987997 | 25 105 | 10·012003 | 10·144596 | 25 51 | 9·855404 | 10 | 30 |
| 13 | 52 | 9·843466 | 26 56 | 10·156534 | 9·988123 | 26 109 | 10·011877 | 10·144658 | 26 53 | 9·855342 | 8 | 47 |
| 30 | 54 | 9·843530 | 27 59 | 10·156470 | 9·988250 | 27 114 | 10·011750 | 10·144719 | 27 55 | 9·855281 | 6 | 30 |
| 14 | 56 | 9·843595 | 28 61 | 10·156405 | 9·988376 | 28 118 | 10·011624 | 10·144781 | 28 57 | 9·855219 | 4 | 46 |
| 30 | 58 | 9·843660 | 29 63 | 10·156340 | 9·988503 | 29 122 | 10·011497 | 10·144842 | 29 59 | 9·855158 | 2 | 30 |
| 15 | 57 | 9·843725 | 30 65 | 10·156275 | 9·988629 | 30 126 | 10·011371 | 10·144904 | 30 61 | 9·855096 | 3 | 45 |
| 30 | 2 | 9·843790 | 1 2 | 10·156210 | 9·988755 | 1 4 | 10·011245 | 10·144965 | 1 2 | 9·855035 | 58 | 30 |
| 16 | 4 | 9·843855 | 2 4 | 10·156145 | 9·988882 | 2 8 | 10·011118 | 10·145027 | 2 4 | 9·854973 | 56 | 44 |
| 30 | 6 | 9·843919 | 3 6 | 10·156081 | 9·989008 | 3 13 | 10·010992 | 10·145089 | 3 6 | 9·854911 | 54 | 30 |
| 17 | 8 | 9·843984 | 4 9 | 10·156016 | 9·989134 | 4 17 | 10·010866 | 10·145150 | 4 8 | 9·854850 | 52 | 43 |
| 30 | 10 | 9·844049 | 5 11 | 10·155951 | 9·989261 | 5 21 | 10·010739 | 10·145212 | 5 10 | 9·854788 | 50 | 30 |
| 18 | 12 | 9·844114 | 6 13 | 10·155886 | 9·989387 | 6 25 | 10·010613 | 10·145273 | 6 12 | 9·854727 | 48 | 42 |
| 30 | 14 | 9·844178 | 7 15 | 10·155822 | 9·989513 | 7 29 | 10·010487 | 10·145335 | 7 14 | 9·854665 | 46 | 30 |
| 19 | 16 | 9·844243 | 8 17 | 10·155757 | 9·989640 | 8 34 | 10·010360 | 10·145397 | 8 16 | 9·854603 | 44 | 41 |
| 30 | 18 | 9·844308 | 9 19 | 10·155692 | 9·989766 | 9 38 | 10·010234 | 10·145458 | 9 19 | 9·854542 | 42 | 30 |
| 20 | 20 | 9·844372 | 10 21 | 10·155628 | 9·989893 | 10 42 | 10·010107 | 10·145520 | 10 21 | 9·854480 | 40 | 40 |
| 30 | 22 | 9·844437 | 11 24 | 10·155563 | 9·990019 | 11 46 | 10·009981 | 10·145582 | 11 23 | 9·854418 | 38 | 30 |
| 21 | 24 | 9·844502 | 12 26 | 10·155498 | 9·990145 | 12 51 | 10·009855 | 10·145644 | 12 25 | 9·854356 | 36 | 39 |
| 30 | 26 | 9·844566 | 13 28 | 10·155434 | 9·990272 | 13 55 | 10·009728 | 10·145705 | 13 27 | 9·854295 | 34 | 30 |
| 22 | 28 | 9·844631 | 14 30 | 10·155369 | 9·990398 | 14 59 | 10·009602 | 10·145767 | 14 29 | 9·854233 | 32 | 38 |
| 30 | 30 | 9·844696 | 15 32 | 10·155304 | 9·990524 | 15 63 | 10·009476 | 10·145829 | 15 31 | 9·854171 | 30 | 30 |
| 23 | 32 | 9·844760 | 16 34 | 10·155240 | 9·990651 | 16 67 | 10·009349 | 10·145891 | 16 33 | 9·854109 | 28 | 37 |
| 30 | 34 | 9·844825 | 17 37 | 10·155175 | 9·990777 | 17 72 | 10·009223 | 10·145953 | 17 35 | 9·854047 | 26 | 30 |
| 24 | 36 | 9·844889 | 18 39 | 10·155111 | 9·990903 | 18 76 | 10·009097 | 10·146014 | 18 37 | 9·853986 | 24 | 36 |
| 30 | 38 | 9·844954 | 19 41 | 10·155046 | 9·991030 | 19 80 | 10·008970 | 10·146076 | 19 39 | 9·853924 | 22 | 30 |
| 25 | 40 | 9·845018 | 20 43 | 10·154982 | 9·991156 | 20 84 | 10·008844 | 10·146138 | 20 41 | 9·853862 | 20 | 35 |
| 30 | 42 | 9·845083 | 21 45 | 10·154917 | 9·991283 | 21 88 | 10·008717 | 10·146200 | 21 43 | 9·853800 | 18 | 30 |
| 26 | 44 | 9·845147 | 22 47 | 10·154853 | 9·991409 | 22 93 | 10·008591 | 10·146262 | 22 45 | 9·853738 | 16 | 34 |
| 30 | 46 | 9·845211 | 23 49 | 10·154789 | 9·991535 | 23 97 | 10·008465 | 10·146324 | 23 47 | 9·853676 | 14 | 30 |
| 27 | 48 | 9·845276 | 24 52 | 10·154724 | 9·991662 | 24 101 | 10·008338 | 10·146386 | 24 49 | 9·853614 | 12 | 33 |
| 30 | 50 | 9·845340 | 25 54 | 10·154660 | 9·991788 | 25 105 | 10·008212 | 10·146448 | 25 51 | 9·853552 | 10 | 30 |
| 28 | 52 | 9·845405 | 26 56 | 10·154595 | 9·991914 | 26 109 | 10·008086 | 10·146510 | 26 54 | 9·853490 | 8 | 32 |
| 30 | 54 | 9·845469 | 27 58 | 10·154531 | 9·992041 | 27 114 | 10·007959 | 10·146572 | 27 56 | 9·853428 | 6 | 30 |
| 29 | 56 | 9·845533 | 28 60 | 10·154467 | 9·992167 | 28 118 | 10·007833 | 10·146634 | 28 58 | 9·853366 | 4 | 31 |
| 30 | 58 | 9·845598 | 29 62 | 10·154402 | 9·992293 | 29 122 | 10·007707 | 10·146696 | 29 60 | 9·853304 | 2 | 30 |
| 30 | 58 | 9·845662 | 30 64 | 10·154338 | 9·992420 | 30 126 | 10·007580 | 10·146758 | 30 62 | 9·853242 | 0 | 30 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

45° — 3h 2m

## LOG. SINES, COSINES, &c.

2ʰ 58ᵐ — 44°

| ′ ″ | m. s. | Sine | Parts | Cosec. | Tangent | Parts | Cotang. | Secant | Parts | Cosine | m. s. | ′ ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | 9·845662 | | 10·154338 | 9·992420 | | 10·007580 | 10·146758 | | 9·853242 | 2 | 30 |
| 30 | 2 | 9·845726 | 1″ 2 | 10·154274 | 9·992546 | 1″ 4 | 10·007454 | 10·146820 | 1″ 2 | 9·853180 | 58 | 30 |
| 31 | 4 | 9·845790 | 2 4 | 10·154210 | 9·992672 | 2 8 | 10·007328 | 10·146882 | 2 4 | 9·853118 | 56 | 29 |
| 30 | 6 | 9·845855 | 3 6 | 10·154145 | 9·992799 | 3 13 | 10·007201 | 10·146944 | 3 6 | 9·853056 | 54 | 30 |
| 32 | 8 | 9·845919 | 4 8 | 10·154081 | 9·992925 | 4 17 | 10·007075 | 10·147006 | 4 8 | 9·852994 | 52 | 28 |
| 30 | 10 | 9·845983 | 5 10 | 10·154017 | 9·993051 | 5 21 | 10·006949 | 10·147069 | 5 10 | 9·852931 | 50 | 30 |
| 33 | 12 | 9·846047 | 6 13 | 10·153953 | 9·993178 | 6 25 | 10·006822 | 10·147131 | 6 12 | 9·852869 | 48 | 27 |
| 30 | 14 | 9·846111 | 7 15 | 10·153889 | 9·993304 | 7 29 | 10·006696 | 10·147193 | 7 15 | 9·852807 | 46 | 30 |
| 34 | 16 | 9·846175 | 8 17 | 10·153825 | 9·993430 | 8 34 | 10·006570 | 10·147255 | 8 17 | 9·852745 | 44 | 26 |
| 30 | 18 | 9·846240 | 9 19 | 10·153760 | 9·993557 | 9 38 | 10·006443 | 10·147317 | 9 19 | 9·852683 | 42 | 30 |
| 35 | 20 | 9·846304 | 10 21 | 10·153696 | 9·993683 | 10 42 | 10·006317 | 10·147380 | 10 21 | 9·852620 | 40 | 25 |
| 30 | 22 | 9·846368 | 11 23 | 10·153632 | 9·993810 | 11 46 | 10·006190 | 10·147442 | 11 23 | 9·852558 | 38 | 30 |
| 36 | 24 | 9·846432 | 12 26 | 10·153568 | 9·993936 | 12 51 | 10·006064 | 10·147504 | 12 25 | 9·852496 | 36 | 24 |
| 30 | 26 | 9·846496 | 13 28 | 10·153504 | 9·994062 | 13 55 | 10·005938 | 10·147566 | 13 27 | 9·852434 | 34 | 30 |
| 37 | 28 | 9·846560 | 14 30 | 10·153440 | 9·994189 | 14 59 | 10·005811 | 10·147629 | 14 29 | 9·852371 | 32 | 23 |
| 30 | 30 | 9·846624 | 15 32 | 10·153376 | 9·994315 | 15 63 | 10·005685 | 10·147691 | 15 31 | 9·852309 | 30 | 30 |
| 38 | 32 | 9·846688 | 16 34 | 10·153312 | 9·994441 | 16 67 | 10·005559 | 10·147753 | 16 33 | 9·852247 | 28 | 22 |
| 30 | 34 | 9·846752 | 17 36 | 10·153248 | 9·994568 | 17 72 | 10·005432 | 10·147816 | 17 35 | 9·852184 | 26 | 30 |
| 39 | 36 | 9·846816 | 18 38 | 10·153184 | 9·994694 | 18 76 | 10·005306 | 10·147878 | 18 37 | 9·852122 | 24 | 21 |
| 30 | 38 | 9·846880 | 19 40 | 10·153120 | 9·994820 | 19 80 | 10·005180 | 10·147941 | 19 40 | 9·852059 | 22 | 30 |
| 40 | 40 | 9·846944 | 20 42 | 10·153056 | 9·994947 | 20 84 | 10·005053 | 10·148003 | 20 42 | 9·851997 | 20 | 20 |
| 30 | 42 | 9·847008 | 21 45 | 10·152992 | 9·995073 | 21 88 | 10·004927 | 10·148066 | 21 44 | 9·851934 | 18 | 30 |
| 41 | 44 | 9·847071 | 22 47 | 10·152929 | 9·995199 | 22 93 | 10·004801 | 10·148128 | 22 46 | 9·851872 | 16 | 19 |
| 30 | 46 | 9·847135 | 23 49 | 10·152865 | 9·995326 | 23 97 | 10·004674 | 10·148190 | 23 48 | 9·851810 | 14 | 30 |
| 42 | 48 | 9·847199 | 24 51 | 10·152801 | 9·995452 | 24 101 | 10·004548 | 10·148253 | 24 50 | 9·851747 | 12 | 18 |
| 30 | 50 | 9·847263 | 25 53 | 10·152737 | 9·995578 | 25 105 | 10·004422 | 10·148315 | 25 52 | 9·851685 | 10 | 30 |
| 43 | 52 | 9·847327 | 26 55 | 10·152673 | 9·995705 | 26 109 | 10·004295 | 10·148378 | 26 54 | 9·851622 | 8 | 17 |
| 30 | 54 | 9·847391 | 27 58 | 10·152609 | 9·995831 | 27 114 | 10·004169 | 10·148441 | 27 56 | 9·851559 | 6 | 30 |
| 44 | 56 | 9·847454 | 28 60 | 10·152546 | 9·995957 | 28 118 | 10·004043 | 10·148503 | 28 58 | 9·851497 | 4 | 16 |
| 30 | 58 | 9·847518 | 29 62 | 10·152482 | 9·996084 | 29 122 | 10·003916 | 10·148566 | 29 60 | 9·851434 | 2 | 30 |
| 45 | 59 | 9·847582 | 30 64 | 10·152418 | 9·996210 | 30 126 | 10·003790 | 10·148628 | 30 62 | 9·851372 | 1 | 15 |
| 30 | 2 | 9·847646 | 1 2 | 10·152354 | 9·996336 | 1 4 | 10·003664 | 10·148691 | 1 2 | 9·851309 | 58 | 30 |
| 46 | 4 | 9·847709 | 2 4 | 10·152291 | 9·996463 | 2 8 | 10·003537 | 10·148754 | 2 4 | 9·851246 | 56 | 14 |
| 30 | 6 | 9·847773 | 3 6 | 10·152227 | 9·996589 | 3 13 | 10·003411 | 10·148816 | 3 6 | 9·851184 | 54 | 30 |
| 47 | 8 | 9·847836 | 4 8 | 10·152164 | 9·996715 | 4 17 | 10·003285 | 10·148879 | 4 8 | 9·851121 | 52 | 13 |
| 30 | 10 | 9·847900 | 5 11 | 10·152100 | 9·996842 | 5 21 | 10·003158 | 10·148942 | 5 10 | 9·851058 | 50 | 30 |
| 48 | 12 | 9·847964 | 6 13 | 10·152036 | 9·996968 | 6 25 | 10·003032 | 10·149004 | 6 13 | 9·850996 | 48 | 12 |
| 30 | 14 | 9·848027 | 7 15 | 10·151973 | 9·997094 | 7 29 | 10·002906 | 10·149067 | 7 15 | 9·850933 | 46 | 30 |
| 49 | 16 | 9·848091 | 8 17 | 10·151909 | 9·997221 | 8 34 | 10·002779 | 10·149130 | 8 17 | 9·850870 | 44 | 11 |
| 30 | 18 | 9·848155 | 9 19 | 10·151845 | 9·997347 | 9 38 | 10·002653 | 10·149193 | 9 19 | 9·850807 | 42 | 30 |
| 50 | 20 | 9·848218 | 10 21 | 10·151782 | 9·997473 | 10 42 | 10·002527 | 10·149255 | 10 21 | 9·850745 | 40 | 10 |
| 30 | 22 | 9·848282 | 11 23 | 10·151718 | 9·997600 | 11 46 | 10·002400 | 10·149318 | 11 23 | 9·850682 | 38 | 30 |
| 51 | 24 | 9·848345 | 12 25 | 10·151655 | 9·997726 | 12 51 | 10·002274 | 10·149381 | 12 25 | 9·850619 | 36 | 9 |
| 30 | 26 | 9·848409 | 13 28 | 10·151591 | 9·997852 | 13 55 | 10·002148 | 10·149444 | 13 27 | 9·850556 | 34 | 30 |
| 52 | 28 | 9·848472 | 14 30 | 10·151528 | 9·997979 | 14 59 | 10·002021 | 10·149507 | 14 29 | 9·850493 | 32 | 8 |
| 30 | 30 | 9·848535 | 15 32 | 10·151465 | 9·998105 | 15 63 | 10·001895 | 10·149570 | 15 31 | 9·850430 | 30 | 30 |
| 53 | 32 | 9·848599 | 16 34 | 10·151401 | 9·998231 | 16 67 | 10·001769 | 10·149632 | 16 34 | 9·850368 | 28 | 7 |
| 30 | 34 | 9·848662 | 17 36 | 10·151338 | 9·998358 | 17 72 | 10·001642 | 10·149695 | 17 36 | 9·850305 | 26 | 30 |
| 54 | 36 | 9·848726 | 18 38 | 10·151274 | 9·998484 | 18 76 | 10·001516 | 10·149758 | 18 38 | 9·850242 | 24 | 6 |
| 30 | 38 | 9·848789 | 19 40 | 10·151211 | 9·998610 | 19 80 | 10·001390 | 10·149821 | 19 40 | 9·850179 | 22 | 30 |
| 55 | 40 | 9·848852 | 20 43 | 10·151148 | 9·998737 | 20 84 | 10·001263 | 10·149884 | 20 42 | 9·850116 | 20 | 5 |
| 30 | 42 | 9·848916 | 21 45 | 10·151084 | 9·998863 | 21 88 | 10·001137 | 10·149947 | 21 44 | 9·850053 | 18 | 30 |
| 56 | 44 | 9·848979 | 22 47 | 10·151021 | 9·998989 | 22 93 | 10·001011 | 10·150010 | 22 46 | 9·849990 | 16 | 4 |
| 30 | 46 | 9·849042 | 23 49 | 10·150958 | 9·999116 | 23 97 | 10·000884 | 10·150073 | 23 48 | 9·849927 | 14 | 30 |
| 57 | 48 | 9·849106 | 24 51 | 10·150894 | 9·999242 | 24 101 | 10·000758 | 10·150136 | 24 50 | 9·849864 | 12 | 3 |
| 30 | 50 | 9·849169 | 25 53 | 10·150831 | 9·999368 | 25 105 | 10·000632 | 10·150199 | 25 52 | 9·849801 | 10 | 30 |
| 58 | 52 | 9·849232 | 26 55 | 10·150768 | 9·999495 | 26 109 | 10·000505 | 10·150262 | 26 54 | 9·849738 | 8 | 2 |
| 30 | 54 | 9·849295 | 27 57 | 10·150705 | 9·999621 | 27 114 | 10·000379 | 10·150326 | 27 56 | 9·849674 | 6 | 30 |
| 59 | 56 | 9·849359 | 28 60 | 10·150641 | 9·999747 | 28 118 | 10·000253 | 10·150389 | 28 59 | 9·849611 | 4 | 1 |
| 30 | 58 | 9·849422 | 29 62 | 10·150578 | 9·999874 | 29 122 | 10·000126 | 10·150452 | 29 61 | 9·849548 | 2 | 30 |
| 60 | 60 | 9·849485 | 30 64 | 10·150515 | 10·000000 | 30 126 | 10·000000 | 10·150515 | 30 63 | 9·849485 | 0 | 0 |
| ′ ″ | m. s. | Cosine | Parts | Secant | Cotang. | Parts | Tangent | Cosec. | Parts | Sine | m. s. | ′ ″ |

45° — 3ʰ 0ᵐ

## LOG. OF THE SQUARE OF THE SINE*
### OF HALF THE ARC.

| | 0° | | | | 1° | | | | 2° | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | |
| ′ ″ | 0h 0m | 0h 1m | 0h 2m | 0h 3m | 0h 4m | 0h 5m | 0h 6m | 0h 7m | 0h 8m | 0h 9m | 0h 10m | s. |
| | | | 5· | 5· | | 6· | 6 | 6· | 6· | 6· | 6· | |
| 0 0 | | 4·67757 | 27963 | 63181 | 5·88168 | 07550 | 23385 | 36774 | 48371 | 58600 | 67751 | 0 |
| 15 | 1·12127 | 4·69193 | 28684 | 63662 | 5·88530 | 07839 | 23626 | 36980 | 48552 | 58761 | 67895 | 1 |
| 30 | 1·72333 | 4·70605 | 29379 | 64141 | 5·88889 | 08127 | 23866 | 37186 | 48732 | 58921 | 68040 | 2 |
| 45 | 2·07558 | 4·71995 | 30108 | 64617 | 5·89247 | 08414 | 24106 | 37392 | 48912 | 59081 | 68184 | 3 |
| 1 0 | 2·32539 | 4·73363 | 30811 | 65090 | 5·89604 | 08700 | 24345 | 37597 | 49092 | 59241 | 68328 | 4 |
| 15 | 2·51921 | 4·74710 | 31509 | 65561 | 5·89959 | 08985 | 24583 | 37802 | 49271 | 59401 | 68471 | 5 |
| 30 | 2·67757 | 4·76036 | 32201 | 66029 | 5·90313 | 09270 | 24821 | 38006 | 49450 | 59560 | 68615 | 6 |
| 45 | 2·81147 | 4·77342 | 32888 | 66495 | 5·90665 | 09553 | 25058 | 38209 | 49628 | 59719 | 68758 | 7 |
| 2 0 | 2·92745 | 4·78629 | 33569 | 66958 | 5·91016 | 09836 | 25294 | 38412 | 49807 | 59878 | 68901 | 8 |
| 15 | 3·02976 | 4·79897 | 34245 | 67419 | 5·91366 | 10117 | 25530 | 38615 | 49984 | 60036 | 69044 | 9 |
| 30 | 3·12127 | 4·81147 | 34916 | 67877 | 5·91714 | 10398 | 25765 | 38817 | 50162 | 60194 | 69186 | 10 |
| 45 | 3·20406 | 4·82379 | 35581 | 68333 | 5·92061 | 10677 | 25999 | 39019 | 50339 | 60352 | 69328 | 11 |
| 3 0 | 3·27963 | 4·83594 | 36242 | 68787 | 5·92406 | 10956 | 26233 | 39220 | 50516 | 60509 | 69470 | 12 |
| 15 | 3·34916 | 4·84792 | 36897 | 69238 | 5·92750 | 11234 | 26466 | 39421 | 50692 | 60666 | 69612 | 13 |
| 30 | 3·41353 | 4·85973 | 37548 | 69687 | 5·93093 | 11511 | 26699 | 39622 | 50868 | 60823 | 69754 | 14 |
| 45 | 3·47345 | 4·87139 | 38194 | 70133 | 5·93434 | 11787 | 26931 | 39821 | 51044 | 60980 | 69895 | 15 |
| 4 0 | 3·52951 | 4·88290 | 38835 | 70578 | 5·93774 | 12063 | 27162 | 40021 | 51219 | 61136 | 70036 | 16 |
| 15 | 3·58217 | 4·89425 | 39471 | 71020 | 5·94113 | 12337 | 27393 | 40220 | 51394 | 61292 | 70177 | 17 |
| 30 | 3·63182 | 4·90546 | 40103 | 71460 | 5·94450 | 12611 | 27623 | 40418 | 51568 | 61448 | 70318 | 18 |
| 45 | 3·67878 | 4·91653 | 40730 | 71897 | 5·94786 | 12883 | 27852 | 40616 | 51743 | 61604 | 70458 | 19 |
| 5 0 | 3·72333 | 4·92745 | 41352 | 72332 | 5·95121 | 13155 | 28081 | 40814 | 51916 | 61759 | 70598 | 20 |
| 15 | 3·76571 | 4·93824 | 41971 | 72766 | 5·95454 | 13426 | 28309 | 41011 | 52090 | 61914 | 70738 | 21 |
| 30 | 3·80612 | 4·94890 | 42584 | 73197 | 5·95786 | 13696 | 28537 | 41208 | 52263 | 62068 | 70878 | 22 |
| 45 | 3·84473 | 4·95943 | 43194 | 73626 | 5·96117 | 13966 | 28764 | 41404 | 52436 | 62223 | 71017 | 23 |
| 6 0 | 3·88169 | 4·96983 | 43799 | 74052 | 5·96447 | 14234 | 28991 | 41600 | 52608 | 62377 | 71157 | 24 |
| 15 | 3·91715 | 4·98011 | 44400 | 74477 | 5·96775 | 14502 | 29217 | 41795 | 52780 | 62531 | 71296 | 25 |
| 30 | 3·95122 | 4·99027 | 44997 | 74900 | 5·97102 | 14769 | 29442 | 41990 | 52952 | 62684 | 71435 | 26 |
| 45 | 3·98400 | 5·00031 | 45590 | 75320 | 5·97428 | 15035 | 29667 | 42185 | 53124 | 62838 | 71573 | 27 |
| 7 0 | 4·01559 | 5·01024 | 46179 | 75739 | 5·97753 | 15300 | 29891 | 42379 | 53295 | 62991 | 71712 | 28 |
| 15 | 4·04607 | 5·02005 | 46764 | 76156 | 5·98076 | 15564 | 30114 | 42573 | 53466 | 63143 | 71850 | 29 |
| 30 | 4·07551 | 5·02976 | 47345 | 76570 | 5·98399 | 15828 | 30337 | 42766 | 53636 | 63296 | 71988 | 30 |
| 45 | 4·10400 | 5·03935 | 47922 | 76983 | 5·98720 | 16091 | 30560 | 42959 | 53806 | 63448 | 72125 | 31 |
| 8 0 | 4·13157 | 5·04885 | 48495 | 77394 | 5·99040 | 16353 | 30781 | 43151 | 53976 | 63600 | 72263 | 32 |
| 15 | 4·15830 | 5·05824 | 49065 | 77802 | 5·99358 | 16614 | 31003 | 43343 | 54146 | 63752 | 72400 | 33 |
| 30 | 4·18423 | 5·06753 | 49631 | 78209 | 5·99676 | 16874 | 31223 | 43534 | 54315 | 63903 | 72537 | 34 |
| 45 | 4·20941 | 5·07672 | 50193 | 78614 | 5·99992 | 17134 | 31444 | 43726 | 54484 | 64054 | 72674 | 35 |
| 9 0 | 4·23388 | 5·08581 | 50752 | 79017 | 6·00308 | 17393 | 31663 | 43916 | 54652 | 64205 | 72811 | 36 |
| 15 | 4·25768 | 5·09481 | 51307 | 79418 | 6·00622 | 17651 | 31882 | 44106 | 54820 | 64356 | 72947 | 37 |
| 30 | 4·28084 | 5·10372 | 51858 | 79818 | 6·00935 | 17908 | 32101 | 44296 | 54988 | 64506 | 73084 | 38 |
| 45 | 4·30340 | 5·11254 | 52406 | 80215 | 6·01247 | 18165 | 32319 | 44486 | 55156 | 64656 | 73220 | 39 |
| 10 0 | 4·32539 | 5·12127 | 52951 | 80611 | 6·01557 | 18421 | 32536 | 44675 | 55323 | 64806 | 73355 | 40 |
| 15 | 4·34684 | 5·12991 | 53492 | 81005 | 6·01867 | 18676 | 32753 | 44863 | 55490 | 64956 | 73491 | 41 |
| 30 | 4·36777 | 5·13847 | 54030 | 81397 | 6·02176 | 18930 | 32969 | 45052 | 55656 | 65105 | 73626 | 42 |
| 45 | 4·38821 | 5·14694 | 54564 | 81787 | 6·02483 | 19184 | 33185 | 45239 | 55822 | 65254 | 73761 | 43 |
| 11 0 | 4·40818 | 5·15534 | 55095 | 82176 | 6·02789 | 19437 | 33400 | 45427 | 55988 | 65403 | 73896 | 44 |
| 15 | 4·42770 | 5·16365 | 55623 | 82563 | 6·03095 | 19689 | 33615 | 45614 | 56154 | 65552 | 74031 | 45 |
| 30 | 4·44679 | 5·17188 | 56148 | 82948 | 6·03399 | 19940 | 33829 | 45800 | 56319 | 65700 | 74166 | 46 |
| 45 | 4·46547 | 5·18004 | 56670 | 83331 | 6·03702 | 20191 | 34043 | 45986 | 56484 | 65848 | 74300 | 47 |
| 12 0 | 4·48375 | 5·18812 | 57189 | 83713 | 6·04004 | 20441 | 34256 | 46172 | 56649 | 65996 | 74434 | 48 |
| 15 | 4·50166 | 5·19612 | 57704 | 84093 | 6·04305 | 20690 | 34469 | 46358 | 56813 | 66144 | 74568 | 49 |
| 30 | 4·51921 | 5·20406 | 58216 | 84472 | 6·04605 | 20938 | 34681 | 46543 | 56977 | 66291 | 74702 | 50 |
| 45 | 4·53641 | 5·21192 | 58726 | 84849 | 6·04904 | 21186 | 34892 | 46727 | 57141 | 66438 | 74835 | 51 |
| 13 0 | 4·55328 | 5·21971 | 59232 | 85224 | 6·05202 | 21433 | 35103 | 46911 | 57304 | 66585 | 74969 | 52 |
| 15 | 4·56982 | 5·22743 | 59736 | 85597 | 6·05499 | 21680 | 35314 | 47095 | 57467 | 66731 | 75102 | 53 |
| 30 | 4·58606 | 5·23508 | 60236 | 85969 | 6·05795 | 21925 | 35524 | 47279 | 57630 | 66878 | 75235 | 54 |
| 45 | 4·60200 | 5·24267 | 60734 | 86340 | 6·06090 | 22170 | 35734 | 47462 | 57792 | 67024 | 75367 | 55 |
| 14 0 | 4·61765 | 5·25019 | 61229 | 86709 | 6·06384 | 22415 | 35943 | 47644 | 57955 | 67170 | 75500 | 56 |
| 15 | 4·63302 | 5·25764 | 61721 | 87076 | 6·06677 | 22658 | 36151 | 47826 | 58117 | 67315 | 75632 | 57 |
| 30 | 4·64813 | 5·26503 | 62211 | 87442 | 6·06969 | 22901 | 36359 | 48008 | 58278 | 67461 | 75764 | 58 |
| 45 | 4·66298 | 5·27236 | 62697 | 87806 | 6·07260 | 23144 | 36567 | 48190 | 58439 | 67606 | 75896 | 59 |

* Same as log. haversine of Inman's Tables.

## LOG. SINE SQUARE

| | 2° 45′ | 3° 0′ | 3° 15′ | 3° 30′ | 3° 45′ | 4° 0′ | 4° 15′ | 4° 30′ | 4° 45′ | 5° 0′ | 5° 15′ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ′ ″ | 0ʰ 11ᵐ | 0ʰ 12ᵐ | 0ʰ 13ᵐ | 0ʰ 14ᵐ | 0ʰ 15ᵐ | 0ʰ 16ᵐ | 0ʰ 17ᵐ | 0ʰ 18ᵐ | 0ʰ 19ᵐ | 0ʰ 20ᵐ | 0ʰ 21ᵐ | s. |
| | 6· | 6· | 6· | | 7· | 7· | 7· | 7· | 7· | 7· | 7· | |
| 0 0 | 76028 | 83584 | 90535 | 6·96970 | 02960 | 08564 | 13827 | 18790 | 23483 | 27936 | 32171 | 0 |
| 15 | 76159 | 83704 | 90646 | 6·97073 | 03057 | 08654 | 13912 | 18870 | 23559 | 28008 | 32240 | 1 |
| 30 | 76290 | 83825 | 90757 | 6·97176 | 03153 | 08745 | 13997 | 18950 | 23635 | 28080 | 32309 | 2 |
| 45 | 76421 | 83945 | 90868 | 6·97279 | 03249 | 08835 | 14082 | 19030 | 23711 | 28153 | 32377 | 3 |
| 1 0 | 76552 | 84065 | 90979 | 6·97382 | 03345 | 08925 | 14167 | 19111 | 23787 | 28225 | 32446 | 4 |
| 15 | 76683 | 84185 | 91089 | 6·97485 | 03441 | 09015 | 14252 | 19191 | 23863 | 28297 | 32515 | 5 |
| 30 | 76814 | 84304 | 91200 | 6·97588 | 03537 | 09105 | 14337 | 19271 | 23939 | 28369 | 32583 | 6 |
| 45 | 76944 | 84424 | 91310 | 6·97690 | 03633 | 09195 | 14421 | 19350 | 24015 | 28441 | 32652 | 7 |
| 2 0 | 77074 | 84543 | 91421 | 6·97793 | 03729 | 09284 | 14506 | 19430 | 24090 | 28513 | 32720 | 8 |
| 15 | 77204 | 84663 | 91531 | 6·97895 | 03824 | 09374 | 14590 | 19510 | 24166 | 28584 | 32789 | 9 |
| 30 | 77334 | 84782 | 91641 | 6·97997 | 03920 | 09464 | 14674 | 19590 | 24241 | 28656 | 32857 | 10 |
| 45 | 77463 | 84900 | 91751 | 6·98099 | 04015 | 09553 | 14759 | 19669 | 24317 | 28728 | 32925 | 11 |
| 3 0 | 77592 | 85019 | 91860 | 6·98201 | 04110 | 09642 | 14843 | 19749 | 24392 | 28800 | 32994 | 12 |
| 15 | 77722 | 85138 | 91970 | 6·98303 | 04205 | 09732 | 14927 | 19828 | 24468 | 28871 | 33062 | 13 |
| 30 | 77851 | 85256 | 92079 | 6·98405 | 04300 | 09821 | 15011 | 19908 | 24543 | 28943 | 33130 | 14 |
| 45 | 77979 | 85374 | 92189 | 6·98506 | 04395 | 09910 | 15095 | 19987 | 24618 | 29014 | 33198 | 15 |
| 4 0 | 78108 | 85492 | 92298 | 6·98608 | 04490 | 09999 | 15179 | 20066 | 24693 | 29086 | 33266 | 16 |
| 15 | 78236 | 85610 | 92407 | 6·98709 | 04585 | 10088 | 15262 | 20145 | 24768 | 29157 | 33334 | 17 |
| 30 | 78364 | 85728 | 92516 | 6·98811 | 04680 | 10177 | 15346 | 20225 | 24843 | 29228 | 33402 | 18 |
| 45 | 78492 | 85846 | 92624 | 6·98912 | 04774 | 10265 | 15430 | 20304 | 24918 | 29299 | 33470 | 19 |
| 5 0 | 78620 | 85963 | 92733 | 6·99013 | 04869 | 10354 | 15513 | 20383 | 24993 | 29371 | 33538 | 20 |
| 15 | 78748 | 86080 | 92841 | 6·99114 | 04963 | 10443 | 15597 | 20461 | 25068 | 29442 | 33606 | 21 |
| 30 | 78875 | 86197 | 92950 | 6·99214 | 05057 | 10531 | 15680 | 20540 | 25143 | 29513 | 33673 | 22 |
| 45 | 79002 | 86314 | 93058 | 6·99315 | 05151 | 10619 | 15763 | 20619 | 25217 | 29584 | 33741 | 23 |
| 6 0 | 79129 | 86431 | 93166 | 6·99416 | 05245 | 10708 | 15846 | 20698 | 25292 | 29655 | 33809 | 24 |
| 15 | 79256 | 86548 | 93274 | 6·99516 | 05339 | 10796 | 15930 | 20776 | 25366 | 29726 | 33876 | 25 |
| 30 | 79383 | 86664 | 93382 | 6·99616 | 05433 | 10884 | 16013 | 20855 | 25441 | 29797 | 33944 | 26 |
| 45 | 79509 | 86781 | 93489 | 6·99717 | 05527 | 10972 | 16096 | 20933 | 25515 | 29867 | 34011 | 27 |
| 7 0 | 79636 | 86897 | 93597 | 6·99817 | 05620 | 11060 | 16178 | 21012 | 25590 | 29938 | 34079 | 28 |
| 15 | 79762 | 87013 | 93704 | 6·99917 | 05714 | 11148 | 16261 | 21090 | 25664 | 30009 | 34146 | 29 |
| 30 | 79888 | 87129 | 93812 | 7·00017 | 05807 | 11235 | 16344 | 21168 | 25738 | 30079 | 34213 | 30 |
| 45 | 80014 | 87244 | 93919 | 7·00116 | 05901 | 11323 | 16427 | 21246 | 25812 | 30150 | 34281 | 31 |
| 8 0 | 80139 | 87360 | 94026 | 7·00216 | 05994 | 11411 | 16509 | 21325 | 25886 | 30220 | 34348 | 32 |
| 15 | 80265 | 87475 | 94133 | 7·00315 | 06087 | 11498 | 16592 | 21403 | 25960 | 30291 | 34415 | 33 |
| 30 | 80390 | 87591 | 94239 | 7·00415 | 06180 | 11586 | 16674 | 21481 | 26034 | 30361 | 34482 | 34 |
| 45 | 80515 | 87706 | 94346 | 7·00514 | 06273 | 11673 | 16756 | 21558 | 26108 | 30431 | 34549 | 35 |
| 9 0 | 80640 | 87821 | 94453 | 7·00613 | 06366 | 11760 | 16839 | 21636 | 26182 | 30501 | 34616 | 36 |
| 15 | 80764 | 87935 | 94559 | 7·00712 | 06458 | 11847 | 16921 | 21714 | 26256 | 30572 | 34683 | 37 |
| 30 | 80889 | 88050 | 94665 | 7·00811 | 06551 | 11934 | 17003 | 21792 | 26330 | 30642 | 34750 | 38 |
| 45 | 81013 | 88165 | 94771 | 7·00910 | 06643 | 12021 | 17085 | 21869 | 26403 | 30712 | 34817 | 39 |
| 10 0 | 81137 | 88279 | 94877 | 7·01009 | 06736 | 12108 | 17167 | 21947 | 26477 | 30782 | 34884 | 40 |
| 15 | 81261 | 88393 | 94983 | 7·01107 | 06828 | 12195 | 17249 | 22024 | 26550 | 30852 | 34950 | 41 |
| 30 | 81385 | 88507 | 95089 | 7·01206 | 06920 | 12282 | 17331 | 22102 | 26624 | 30922 | 35017 | 42 |
| 45 | 81509 | 88621 | 95194 | 7·01304 | 07013 | 12368 | 17412 | 22179 | 26697 | 30992 | 35084 | 43 |
| 11 0 | 81632 | 88735 | 95300 | 7·01403 | 07105 | 12455 | 17494 | 22256 | 26771 | 31062 | 35150 | 44 |
| 15 | 81756 | 88848 | 95405 | 7·01501 | 07196 | 12541 | 17575 | 22333 | 26844 | 31131 | 35217 | 45 |
| 30 | 81879 | 88962 | 95510 | 7·01599 | 07288 | 12627 | 17657 | 22411 | 26917 | 31201 | 35283 | 46 |
| 45 | 82002 | 89075 | 95615 | 7·01697 | 07380 | 12714 | 17738 | 22488 | 26990 | 31271 | 35350 | 47 |
| 12 0 | 82124 | 89188 | 95720 | 7·01795 | 07472 | 12800 | 17820 | 22565 | 27063 | 31340 | 35416 | 48 |
| 15 | 82247 | 8930[illegible] | 95825 | 7·01892 | 07563 | 12886 | 17901 | 22642 | 27137 | 31410 | 35482 | 49 |
| 30 | 82369 | 89414 | 95930 | 7·01990 | 07655 | 12972 | 17982 | 22719 | 27210 | 31479 | 35549 | 50 |
| 45 | 82492 | 89527 | 96034 | 7·02088 | 07746 | 13058 | 18063 | 22795 | 27282 | 31549 | 35615 | 51 |
| 13 0 | 82613 | 89639 | 96139 | 7·02185 | 07837 | 13144 | 18144 | 22872 | 27355 | 31618 | 35681 | 52 |
| 15 | 82735 | 89752 | 96243 | 7·02282 | 07928 | 13229 | 18225 | 22949 | 27428 | 31687 | 35747 | 53 |
| 30 | 82857 | 89864 | 96347 | 7·02379 | 08019 | 13315 | 18306 | 23025 | 27501 | 31757 | 35813 | 54 |
| 45 | 82979 | 89976 | 96451 | 7·02476 | 08110 | 13401 | 18387 | 23102 | 27573 | 31826 | 35879 | 55 |
| 14 0 | 83100 | 90088 | 96555 | 7·02573 | 08201 | 13486 | 18468 | 23178 | 27646 | 31895 | 35945 | 56 |
| 15 | 83221 | 90200 | 96659 | 7·02670 | 08292 | 13572 | 18548 | 23255 | 27719 | 31964 | 36011 | 57 |
| 30 | 83342 | 90312 | 96763 | 7·02767 | 08383 | 13657 | 18629 | 23331 | 27791 | 32033 | 36077 | 58 |
| 45 | 83463 | 90423 | 96865 | 7·02864 | 08473 | 13742 | 18709 | 23407 | 27864 | 32102 | 36143 | 59 |

## LOG. SINE SQUARE

| | 5° | | 6° | | | | 7° | | | | 8° | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | |
| | 0ʰ 22ᵐ | 0ʰ 23ᵐ | 0ʰ 24ᵐ | 0ʰ 25ᵐ | 0ʰ 26ᵐ | 0ʰ 27ᵐ | 0ʰ 28ᵐ | 0ʰ 29ᵐ | 0ʰ 30ᵐ | 0ʰ 31ᵐ | 0ʰ 32ᵐ | s. |
| ′ ″ | 7. | 7. | 7. | 7. | 7. | 7. | 7. | 7. | 7. | 7. | 7. | |
| 0 0 | 36209 | 40067 | 43760 | 47302 | 50706 | 53980 | 57135 | 60179 | 63120 | 65964 | 68717 | 0 |
| 15 | 36274 | 40129 | 43820 | 47360 | 50761 | 54034 | 57187 | 60229 | 63168 | 66011 | 68762 | 1 |
| 30 | 36340 | 40192 | 43880 | 47418 | 50817 | 54087 | 57238 | 60279 | 63216 | 66057 | 68807 | 2 |
| 45 | 36406 | 40255 | 43941 | 47476 | 50872 | 54141 | 57290 | 60329 | 63264 | 66103 | 68852 | 3 |
| 1 0 | 36471 | 40318 | 44001 | 47533 | 50928 | 54194 | 57341 | 60378 | 63312 | 66150 | 68897 | 4 |
| 15 | 36537 | 40380 | 44061 | 47591 | 50983 | 54247 | 57393 | 60428 | 63360 | 66196 | 68942 | 5 |
| 30 | 36602 | 40443 | 44121 | 47649 | 51039 | 54301 | 57444 | 60478 | 63408 | 66243 | 68987 | 6 |
| 45 | 36668 | 40506 | 44181 | 47707 | 51094 | 54354 | 57496 | 60527 | 63456 | 66289 | 69032 | 7 |
| 2 0 | 36733 | 40568 | 44241 | 47764 | 51149 | 54407 | 57547 | 60577 | 63504 | 66336 | 69077 | 8 |
| 15 | 36798 | 40631 | 44301 | 47821 | 51205 | 54461 | 57598 | 60627 | 63552 | 66382 | 69122 | 9 |
| 30 | 36864 | 40693 | 44361 | 47879 | 51260 | 54514 | 57650 | 60676 | 63600 | 66429 | 69167 | 10 |
| 45 | 36929 | 40756 | 44420 | 47936 | 51315 | 54567 | 57701 | 60726 | 63648 | 66475 | 69212 | 11 |
| 3 0 | 36994 | 40818 | 44480 | 47994 | 51370 | 54620 | 57752 | 60775 | 63696 | 66521 | 69257 | 12 |
| 15 | 37059 | 40880 | 44540 | 48051 | 51426 | 54673 | 57804 | 60825 | 63744 | 66568 | 69302 | 13 |
| 30 | 37124 | 40943 | 44600 | 48109 | 51481 | 54727 | 57855 | 60874 | 63792 | 66614 | 69347 | 14 |
| 45 | 37189 | 41005 | 44659 | 48166 | 51536 | 54780 | 57906 | 60924 | 63839 | 66660 | 69392 | 15 |
| 4 0 | 37254 | 41067 | 44719 | 48223 | 51591 | 54833 | 57957 | 60973 | 63887 | 66706 | 69437 | 16 |
| 15 | 37319 | 41129 | 44779 | 48280 | 51646 | 54886 | 58008 | 61022 | 63935 | 66753 | 69481 | 17 |
| 30 | 37384 | 41191 | 44838 | 48337 | 51701 | 54939 | 58060 | 61072 | 63983 | 66799 | 69526 | 18 |
| 45 | 37449 | 41253 | 44898 | 48395 | 51756 | 54992 | 58111 | 61121 | 64030 | 66845 | 69571 | 19 |
| 5 0 | 37514 | 41315 | 44957 | 48452 | 51811 | 55045 | 58162 | 61170 | 64078 | 66891 | 69616 | 20 |
| 15 | 37579 | 41377 | 45016 | 48509 | 51866 | 55097 | 58213 | 61220 | 64126 | 66937 | 69660 | 21 |
| 30 | 37643 | 41439 | 45076 | 48566 | 51921 | 55150 | 58264 | 61269 | 64173 | 66983 | 69705 | 22 |
| 45 | 37708 | 41501 | 45135 | 48623 | 51975 | 55203 | 58315 | 61318 | 64221 | 67029 | 69750 | 23 |
| 6 0 | 37772 | 41563 | 45194 | 48680 | 52030 | 55256 | 58366 | 61367 | 64269 | 67075 | 69794 | 24 |
| 15 | 37837 | 41625 | 45254 | 48737 | 52085 | 55308 | 58416 | 61417 | 64316 | 67121 | 69839 | 25 |
| 30 | 37902 | 41686 | 45313 | 48794 | 52140 | 55361 | 58467 | 61466 | 64364 | 67167 | 69883 | 26 |
| 45 | 37966 | 41748 | 45372 | 48850 | 52194 | 55414 | 58518 | 61515 | 64411 | 67213 | 69928 | 27 |
| 7 0 | 38030 | 41810 | 45431 | 48907 | 52249 | 55467 | 58569 | 61564 | 64458 | 67259 | 69972 | 28 |
| 15 | 38095 | 41871 | 45490 | 48964 | 52304 | 55519 | 58620 | 61613 | 64506 | 67305 | 70017 | 29 |
| 30 | 38159 | 41933 | 45549 | 49021 | 52358 | 55572 | 58670 | 61662 | 64553 | 67351 | 70061 | 30 |
| 45 | 38223 | 41994 | 45608 | 49077 | 52413 | 55624 | 58721 | 61711 | 64601 | 67397 | 70106 | 31 |
| 8 0 | 38288 | 42056 | 45667 | 49134 | 52467 | 55677 | 58772 | 61760 | 64648 | 67443 | 70150 | 32 |
| 15 | 38352 | 42117 | 45726 | 49191 | 52522 | 55729 | 58823 | 61809 | 64695 | 67489 | 70195 | 33 |
| 30 | 38416 | 42179 | 45785 | 49247 | 52576 | 55782 | 58873 | 61858 | 64743 | 67535 | 70239 | 34 |
| 45 | 38480 | 42240 | 45844 | 49304 | 52631 | 55834 | 58924 | 61907 | 64790 | 67580 | 70283 | 35 |
| 9 0 | 38544 | 42301 | 45903 | 49360 | 52685 | 55887 | 58974 | 61955 | 64837 | 67626 | 70328 | 36 |
| 15 | 38608 | 42363 | 45962 | 49417 | 52739 | 55939 | 59025 | 62004 | 64885 | 67672 | 70372 | 37 |
| 30 | 38672 | 42424 | 46020 | 49473 | 52794 | 55992 | 59075 | 62053 | 64932 | 67717 | 70416 | 38 |
| 45 | 38736 | 42485 | 46079 | 49530 | 52848 | 56044 | 59126 | 62102 | 64979 | 67763 | 70461 | 39 |
| 10 0 | 38800 | 42546 | 46138 | 49586 | 52902 | 56096 | 59176 | 62151 | 65026 | 67809 | 70505 | 40 |
| 15 | 38863 | 42607 | 46196 | 49642 | 52956 | 56148 | 59227 | 62199 | 65073 | 67854 | 70549 | 41 |
| 30 | 38927 | 42668 | 46255 | 49699 | 53011 | 56201 | 59277 | 62248 | 65120 | 67900 | 70593 | 42 |
| 45 | 38991 | 42729 | 46313 | 49755 | 53065 | 56253 | 59327 | 62297 | 65167 | 67946 | 70638 | 43 |
| 11 0 | 39054 | 42790 | 46372 | 49811 | 53119 | 56305 | 59378 | 62345 | 65214 | 67991 | 70682 | 44 |
| 15 | 39118 | 42851 | 46430 | 49867 | 53173 | 56357 | 59428 | 62394 | 65261 | 68037 | 70726 | 45 |
| 30 | 39182 | 42912 | 46489 | 49923 | 53227 | 56409 | 59478 | 62442 | 65308 | 68082 | 70770 | 46 |
| 45 | 39245 | 42973 | 46547 | 49979 | 53281 | 56461 | 59529 | 62491 | 65355 | 68128 | 70814 | 47 |
| 12 0 | 39309 | 43034 | 46605 | 50036 | 53335 | 56513 | 59579 | 62540 | 65402 | 68173 | 70858 | 48 |
| 15 | 39372 | 43095 | 46664 | 50092 | 53389 | 56565 | 59629 | 62588 | 65449 | 68219 | 70902 | 49 |
| 30 | 39435 | 43155 | 46722 | 50148 | 53443 | 56617 | 59679 | 62636 | 65496 | 68264 | 70946 | 50 |
| 45 | 39499 | 43216 | 46780 | 50204 | 53497 | 56669 | 59729 | 62685 | 65543 | 68309 | 70990 | 51 |
| 13 0 | 39562 | 43277 | 46838 | 50259 | 53550 | 56721 | 59779 | 62733 | 65590 | 68355 | 71034 | 52 |
| 15 | 39625 | 43337 | 46896 | 50315 | 53604 | 56773 | 59829 | 62782 | 65637 | 68400 | 71078 | 53 |
| 30 | 39688 | 43398 | 46955 | 50371 | 53658 | 56825 | 59879 | 62830 | 65683 | 68445 | 71122 | 54 |
| 45 | 39752 | 43458 | 47013 | 50427 | 53712 | 56876 | 59929 | 62878 | 65730 | 68491 | 71166 | 55 |
| 14 0 | 39815 | 43519 | 47071 | 50483 | 53765 | 56928 | 59979 | 62927 | 65777 | 68536 | 71210 | 56 |
| 15 | 39878 | 43579 | 47129 | 50539 | 53819 | 56980 | 60029 | 62975 | 65824 | 68581 | 71254 | 57 |
| 30 | 39941 | 43639 | 47187 | 50594 | 53873 | 57032 | 60079 | 63023 | 65870 | 68627 | 71298 | 58 |
| 45 | 40004 | 43700 | 47245 | 50650 | 53926 | 57083 | 60129 | 63071 | 65917 | 68672 | 71341 | 59 |

| | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 64. | Parts | 4 | 9 | 13 | 17 | 21 | 26 | 30 | 34 | 38 | 43 | 47 | 51 | 55 | 60 | 64 |
| D. 45. | Parts | 3 | 6 | 9 | 12 | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 37 | 42 | 45 |

## LOG. SINE SQUARE

| | 8° 15′ | 8° 30′ | 8° 45′ | 9° 0′ | 9° 15′ | 9° 30′ | 9° 45′ | 10° 0′ | 10° 15′ | 10° 30′ | 10° 45′ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0h 33m | 0h 34m | 0h 35m | 0h 36m | 0h 37m | 0h 38m | 0h 39m | 0h 40m | 0h 41m | 0h 42m | 0h 43m | s. |
| ′ ″ | 7. | 7. | 7. | 7. | 7. | 7. | 7. | 7. | 7. | 7. | 7. | |
| 0 0 | 71385 | 73974 | 76487 | 78929 | 81303 | 83615 | 85866 | 88059 | 90198 | 92286 | 94324 | 0 |
| 15 | 71429 | 74016 | 76528 | 78969 | 81342 | 83653 | 85903 | 88095 | 90234 | 92320 | 94357 | 1 |
| 30 | 71473 | 74059 | 76569 | 79009 | 81382 | 83691 | 85940 | 88131 | 90269 | 92354 | 94391 | 2 |
| 45 | 71516 | 74101 | 76610 | 79049 | 81421 | 83729 | 85977 | 88167 | 90304 | 92389 | 94424 | 3 |
| 1 0 | 71560 | 74143 | 76652 | 79089 | 81459 | 83767 | 86014 | 88203 | 90339 | 92423 | 94458 | 4 |
| 15 | 71604 | 74186 | 76693 | 79129 | 81498 | 83804 | 86050 | 88239 | 90374 | 92457 | 94491 | 5 |
| 30 | 71648 | 74228 | 76734 | 79169 | 81537 | 83842 | 86087 | 88276 | 90409 | 92492 | 94525 | 6 |
| 45 | 71691 | 74271 | 76775 | 79209 | 81576 | 83880 | 86124 | 88312 | 90445 | 92526 | 94558 | 7 |
| 2 0 | 71735 | 74313 | 76816 | 79249 | 81615 | 83918 | 86161 | 88348 | 90480 | 92560 | 94592 | 8 |
| 15 | 71778 | 74355 | 76857 | 79289 | 81654 | 83956 | 86198 | 88383 | 90515 | 92595 | 94625 | 9 |
| 30 | 71822 | 74398 | 76898 | 79329 | 81693 | 83994 | 86235 | 88419 | 90550 | 92629 | 94659 | 10 |
| 45 | 71866 | 74440 | 76940 | 79369 | 81732 | 84032 | 86272 | 88455 | 90585 | 92663 | 94692 | 11 |
| 3 0 | 71909 | 74482 | 76981 | 79409 | 81771 | 84070 | 86309 | 88491 | 90620 | 92697 | 94726 | 12 |
| 15 | 71953 | 74524 | 77022 | 79449 | 81810 | 84107 | 86346 | 88527 | 90655 | 92731 | 94759 | 13 |
| 30 | 71996 | 74567 | 77063 | 79489 | 81848 | 84145 | 86382 | 88563 | 90690 | 92766 | 94792 | 14 |
| 45 | 72040 | 74609 | 77104 | 79529 | 81887 | 84183 | 86419 | 88599 | 90725 | 92800 | 94826 | 15 |
| 4 0 | 72083 | 74651 | 77145 | 79568 | 81926 | 84221 | 86456 | 88635 | 90760 | 92834 | 94859 | 16 |
| 15 | 72126 | 74693 | 77186 | 79608 | 81965 | 84258 | 86493 | 88671 | 90795 | 92868 | 94892 | 17 |
| 30 | 72170 | 74735 | 77227 | 79648 | 82003 | 84296 | 86530 | 88707 | 90830 | 92902 | 94926 | 18 |
| 45 | 72213 | 74777 | 77267 | 79688 | 82042 | 84334 | 86566 | 88742 | 90865 | 92936 | 94959 | 19 |
| 5 0 | 72257 | 74819 | 77308 | 79728 | 82081 | 84372 | 86603 | 88778 | 90900 | 92970 | 94992 | 20 |
| 15 | 72300 | 74861 | 77349 | 79767 | 82119 | 84409 | 86640 | 88814 | 90935 | 93005 | 95026 | 21 |
| 30 | 72343 | 74904 | 77390 | 79807 | 82158 | 84447 | 86676 | 88850 | 90970 | 93039 | 95059 | 22 |
| 45 | 72387 | 74946 | 77431 | 79847 | 82197 | 84484 | 86713 | 88885 | 91005 | 93073 | 95092 | 23 |
| 6 0 | 72430 | 74988 | 77472 | 79886 | 82235 | 84522 | 86750 | 88921 | 91039 | 93107 | 95126 | 24 |
| 15 | 72473 | 75030 | 77513 | 79926 | 82274 | 84560 | 86786 | 88957 | 91074 | 93141 | 95159 | 25 |
| 30 | 72516 | 75072 | 77553 | 79966 | 82313 | 84597 | 86823 | 88993 | 91109 | 93175 | 95192 | 26 |
| 45 | 72560 | 75114 | 77594 | 80005 | 82351 | 84635 | 86860 | 89028 | 91144 | 93209 | 95225 | 27 |
| 7 0 | 72603 | 75155 | 77635 | 80045 | 82390 | 84672 | 86896 | 89064 | 91179 | 93243 | 95259 | 28 |
| 15 | 72646 | 75197 | 77676 | 80085 | 82428 | 84710 | 86933 | 89100 | 91214 | 93277 | 95292 | 29 |
| 30 | 72689 | 75239 | 77716 | 80124 | 82467 | 84747 | 86969 | 89135 | 91248 | 93311 | 95325 | 30 |
| 45 | 72732 | 75281 | 77757 | 80164 | 82505 | 84785 | 87006 | 89171 | 91283 | 93345 | 95358 | 31 |
| 8 0 | 72775 | 75323 | 77798 | 80203 | 82544 | 84822 | 87042 | 89207 | 91318 | 93379 | 95391 | 32 |
| 15 | 72818 | 75365 | 77838 | 80243 | 82582 | 84860 | 87079 | 89242 | 91353 | 93413 | 95424 | 33 |
| 30 | 72861 | 75407 | 77879 | 80282 | 82621 | 84897 | 87115 | 89278 | 91387 | 93447 | 95458 | 34 |
| 45 | 72904 | 75448 | 77920 | 80322 | 82659 | 84935 | 87152 | 89314 | 91422 | 93480 | 95491 | 35 |
| 9 0 | 72947 | 75490 | 77960 | 80361 | 82698 | 84972 | 87188 | 89349 | 91457 | 93514 | 95524 | 36 |
| 15 | 72990 | 75532 | 78001 | 80401 | 82736 | 85010 | 87225 | 89385 | 91492 | 93548 | 95557 | 37 |
| 30 | 73033 | 75574 | 78041 | 80440 | 82774 | 85047 | 87261 | 89420 | 91526 | 93582 | 95590 | 38 |
| 45 | 73076 | 75615 | 78082 | 80480 | 82813 | 85084 | 87298 | 89456 | 91561 | 93616 | 95623 | 39 |
| 10 0 | 73119 | 75657 | 78122 | 80519 | 82851 | 85122 | 87334 | 89491 | 91596 | 93650 | 95656 | 40 |
| 15 | 73162 | 75699 | 78163 | 80558 | 82889 | 85159 | 87371 | 89527 | 91630 | 93684 | 95689 | 41 |
| 30 | 73205 | 75740 | 78203 | 80598 | 82928 | 85196 | 87407 | 89562 | 91665 | 93717 | 95722 | 42 |
| 45 | 73248 | 75782 | 78244 | 80637 | 82966 | 85234 | 87443 | 89598 | 91699 | 93751 | 95755 | 43 |
| 11 0 | 73291 | 75824 | 78284 | 80677 | 83004 | 85271 | 87480 | 89633 | 91734 | 93785 | 95788 | 44 |
| 15 | 73334 | 75865 | 78325 | 80716 | 83043 | 85308 | 87516 | 89668 | 91769 | 93819 | 95821 | 45 |
| 30 | 73377 | 75907 | 78365 | 80755 | 83081 | 85346 | 87552 | 89704 | 91803 | 93852 | 95854 | 46 |
| 45 | 73419 | 75948 | 78405 | 80794 | 83119 | 85383 | 87589 | 89740 | 91838 | 93886 | 95887 | 47 |
| 12 0 | 73462 | 75990 | 78446 | 80834 | 83157 | 85420 | 87625 | 89775 | 91872 | 93920 | 95920 | 48 |
| 15 | 73505 | 76031 | 78486 | 80873 | 83196 | 85457 | 87661 | 89810 | 91907 | 93954 | 95953 | 49 |
| 30 | 73548 | 76073 | 78526 | 80912 | 83234 | 85494 | 87697 | 89846 | 91941 | 93987 | 95986 | 50 |
| 45 | 73590 | 76114 | 78567 | 80951 | 83272 | 85532 | 87734 | 89881 | 91976 | 94021 | 96019 | 51 |
| 13 0 | 73633 | 76156 | 78607 | 80991 | 83310 | 85569 | 87770 | 89916 | 92010 | 94055 | 96052 | 52 |
| 15 | 73676 | 76197 | 78647 | 81030 | 83348 | 85606 | 87806 | 89952 | 92045 | 94088 | 96085 | 53 |
| 30 | 73718 | 76239 | 78688 | 81069 | 83386 | 85643 | 87842 | 89987 | 92079 | 94122 | 96118 | 54 |
| 45 | 73761 | 76280 | 78728 | 81108 | 83424 | 85680 | 87878 | 90022 | 92114 | 94156 | 96150 | 55 |
| 14 0 | 73803 | 76321 | 78768 | 81147 | 83462 | 85717 | 87915 | 90057 | 92148 | 94189 | 96183 | 56 |
| 15 | 73846 | 76363 | 78808 | 81186 | 83501 | 85754 | 87951 | 90093 | 92183 | 94223 | 96216 | 57 |
| 30 | 73889 | 76404 | 78848 | 81225 | 83539 | 85791 | 87987 | 90128 | 92217 | 94257 | 96249 | 58 |
| 45 | 73931 | 76445 | 78889 | 81264 | 83577 | 85829 | 88023 | 90163 | 92251 | 94290 | 96282 | 59 |

| | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 44 | Parts | 3 | 6 | 9 | 11 | 14 | 17 | 20 | 23 | 26 | 29 | 32 | 34 | 37 | 40 | 43 |
| D. 33 | Parts | 2 | 4 | 7 | 9 | 11 | 13 | 15 | 18 | 20 | 22 | 24 | 26 | 29 | 31 | 33 |

## LOG. SINE SQUARE

| | 11° | | | | 12° | | | | 13° | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | |
| | 0h 44m | 0h 45m | 0h 46m | 0h 47m | 0h 48m | 0h 49m | 0h 50m | 0h 51m | 0h 52m | 0h 53m | 0h 54m | s. |
| ′ ″ | 7·9 | | 8·0 | 8·0 | 8·0 | 8·0 | 8·0 | 8· | 8·1 | 8·1 | 8·1 | |
| 0 0 | 63146 | 7·982604 | 01632 | 20248 | 38469 | 56312 | 73792 | 090922 | 07717 | 24190 | 40352 | 0 |
| 15 | 63474 | 7·982925 | 01945 | 20555 | 38770 | 56606 | 74080 | 091205 | 07995 | 24462 | 40619 | 1 |
| 30 | 63801 | 7·983245 | 02259 | 20862 | 39070 | 56900 | 74368 | 091487 | 08272 | 24734 | 40886 | 2 |
| 45 | 64129 | 7·983565 | 02572 | 21168 | 39370 | 57194 | 74656 | 091770 | 08549 | 25006 | 41152 | 3 |
| 1 0 | 64457 | 7·983886 | 02886 | 21475 | 39670 | 57488 | 74944 | 092052 | 08826 | 25277 | 41419 | 4 |
| 15 | 64784 | 7·984206 | 03199 | 21781 | 39970 | 57782 | 75232 | 092334 | 09102 | 25549 | 41685 | 5 |
| 30 | 65111 | 7·984526 | 03512 | 22087 | 40270 | 58076 | 75520 | 092617 | 09379 | 25820 | 41952 | 6 |
| 45 | 65439 | 7·984846 | 03825 | 22394 | 40570 | 58370 | 75808 | 092899 | 09655 | 26091 | 42218 | 7 |
| 2 0 | 65766 | 7·985166 | 04137 | 22700 | 40870 | 58663 | 76095 | 093181 | 09932 | 26363 | 42484 | 8 |
| 15 | 66093 | 7·985485 | 04450 | 23006 | 41169 | 58957 | 76383 | 093463 | 10209 | 26634 | 42750 | 9 |
| 30 | 66420 | 7·985805 | 04763 | 23312 | 41469 | 59250 | 76670 | 093744 | 10485 | 26905 | 43016 | 10 |
| 45 | 66746 | 7·986124 | 05075 | 23617 | 41768 | 59543 | 76958 | 094026 | 10761 | 27176 | 43282 | 11 |
| 3 0 | 67073 | 7·986443 | 05388 | 23923 | 42067 | 59836 | 77245 | 094308 | 11037 | 27447 | 43557 | 12 |
| 15 | 67399 | 7·986762 | 05700 | 24229 | 42367 | 60129 | 77532 | 094589 | 11314 | 27718 | 43814 | 13 |
| 30 | 67726 | 7·987082 | 06012 | 24534 | 42666 | 60422 | 77819 | 094871 | 11590 | 27989 | 44080 | 14 |
| 45 | 68052 | 7·987400 | 06324 | 24839 | 42965 | 60715 | 78106 | 095152 | 11865 | 28259 | 44345 | 15 |
| 4 0 | 68378 | 7·987719 | 06636 | 25145 | 43264 | 61008 | 78393 | 095433 | 12141 | 28530 | 44611 | 16 |
| 15 | 68704 | 7·988038 | 06947 | 25450 | 43562 | 61301 | 78680 | 095714 | 12417 | 28800 | 44876 | 17 |
| 30 | 69030 | 7·988357 | 07259 | 25755 | 43861 | 61593 | 78967 | 095995 | 12693 | 29071 | 45142 | 18 |
| 45 | 69355 | 7·988675 | 07571 | 26060 | 44159 | 61886 | 79253 | 096276 | 12968 | 29341 | 45407 | 19 |
| 5 0 | 69681 | 7·988994 | 07882 | 26365 | 44458 | 62178 | 79540 | 096557 | 13244 | 29611 | 45672 | 20 |
| 15 | 70006 | 7·989312 | 08193 | 26669 | 44756 | 62470 | 79826 | 096838 | 13519 | 29882 | 45937 | 21 |
| 30 | 70332 | 7·989630 | 08505 | 26974 | 45055 | 62763 | 80113 | 097119 | 13794 | 30152 | 46203 | 22 |
| 45 | 70657 | 7·989948 | 08816 | 27278 | 45353 | 63055 | 80399 | 097399 | 14069 | 30422 | 46468 | 23 |
| 6 0 | 70982 | 7·990266 | 09127 | 27583 | 45651 | 63347 | 80685 | 097680 | 14345 | 30692 | 46732 | 24 |
| 15 | 71307 | 7·990583 | 09438 | 27887 | 45949 | 63638 | 80971 | 097960 | 14620 | 30961 | 46997 | 25 |
| 30 | 71632 | 7·990901 | 09748 | 28191 | 46247 | 63930 | 81257 | 098241 | 14895 | 31231 | 47262 | 26 |
| 45 | 71956 | 7·991219 | 10059 | 28495 | 46544 | 64222 | 81543 | 098521 | 15169 | 31501 | 47527 | 27 |
| 7 0 | 72281 | 7·991536 | 10370 | 28799 | 46842 | 64513 | 81828 | 098801 | 15444 | 31770 | 47791 | 28 |
| 15 | 72606 | 7·991853 | 10680 | 29103 | 47139 | 64805 | 82114 | 099081 | 15719 | 32040 | 48056 | 29 |
| 30 | 72930 | 7·992171 | 10990 | 29407 | 47437 | 65096 | 82400 | 099361 | 15993 | 32309 | 48320 | 30 |
| 45 | 73254 | 7·992488 | 11300 | 29710 | 47734 | 65387 | 82685 | 099641 | 16268 | 32579 | 48585 | 31 |
| 8 0 | 73578 | 7·992805 | 11611 | 30014 | 48031 | 65679 | 82970 | 099921 | 16542 | 32848 | 48849 | 32 |
| 15 | 73902 | 7·993121 | 11920 | 30317 | 48328 | 65970 | 83256 | 100200 | 16817 | 33117 | 49113 | 33 |
| 30 | 74226 | 7·993438 | 12230 | 30621 | 48626 | 66261 | 83541 | 100480 | 17091 | 33386 | 49377 | 34 |
| 45 | 74550 | 7·993755 | 12540 | 30924 | 48922 | 66551 | 83826 | 100759 | 17365 | 33655 | 49641 | 35 |
| 9 0 | 74873 | 7·994071 | 12850 | 31227 | 49219 | 66842 | 84111 | 101039 | 17639 | 33924 | 49905 | 36 |
| 15 | 75197 | 7·994387 | 13159 | 31530 | 49516 | 67133 | 84396 | 101318 | 17913 | 34193 | 50169 | 37 |
| 30 | 75520 | 7·994704 | 13469 | 31833 | 49813 | 67424 | 84681 | 101597 | 18187 | 34461 | 50433 | 38 |
| 45 | 75844 | 7·995020 | 13778 | 32135 | 50109 | 67714 | 84965 | 101876 | 18461 | 34730 | 50696 | 39 |
| 10 0 | 76167 | 7·995336 | 14087 | 32438 | 50405 | 68004 | 85250 | 102156 | 18734 | 34999 | 50960 | 40 |
| 15 | 76490 | 7·995652 | 14396 | 32741 | 50702 | 68295 | 85534 | 102434 | 19008 | 35267 | 51223 | 41 |
| 30 | 76813 | 7·995968 | 14705 | 33043 | 50998 | 68585 | 85819 | 102713 | 19281 | 35535 | 51487 | 42 |
| 45 | 77135 | 7·996283 | 15014 | 33345 | 51294 | 68875 | 86103 | 102992 | 19555 | 35804 | 51750 | 43 |
| 11 0 | 77458 | 7·996599 | 15323 | 33648 | 51590 | 69165 | 86387 | 103271 | 19828 | 36072 | 52013 | 44 |
| 15 | 77780 | 7·996914 | 15631 | 33950 | 51886 | 69455 | 86671 | 103549 | 20102 | 36340 | 52277 | 45 |
| 30 | 78103 | 7·997230 | 15940 | 34252 | 52182 | 69745 | 86956 | 103828 | 20375 | 36608 | 52540 | 46 |
| 45 | 78425 | 7·997545 | 16248 | 34554 | 52477 | 70034 | 87239 | 104106 | 20648 | 36876 | 52803 | 47 |
| 12 0 | 78747 | 7·997860 | 16557 | 34856 | 52773 | 70324 | 87523 | 104385 | 20921 | 37144 | 53066 | 48 |
| 15 | 79069 | 7·998175 | 16865 | 35157 | 53068 | 70613 | 87807 | 104663 | 21194 | 37412 | 53328 | 49 |
| 30 | 79391 | 7·998490 | 17173 | 35459 | 53364 | 70903 | 88091 | 104941 | 21467 | 37679 | 53591 | 50 |
| 45 | 79713 | 7·998804 | 17481 | 35760 | 53659 | 71192 | 88374 | 105219 | 21739 | 37947 | 53854 | 51 |
| 13 0 | 80035 | 7·999119 | 17789 | 36062 | 53954 | 71481 | 88658 | 105497 | 22012 | 38215 | 54117 | 52 |
| 15 | 80356 | 7·999433 | 18097 | 36363 | 54249 | 71770 | 88941 | 105775 | 22285 | 38482 | 54379 | 53 |
| 30 | 80678 | 7·999748 | 18404 | 36664 | 54544 | 72059 | 89224 | 106053 | 22557 | 38750 | 54642 | 54 |
| 45 | 80999 | 8·000062 | 18712 | 36965 | 54839 | 72348 | 89508 | 106330 | 22829 | 39017 | 54904 | 55 |
| 14 0 | 81320 | 8·000376 | 19019 | 37266 | 55134 | 72637 | 89791 | 106608 | 23102 | 39284 | 55166 | 56 |
| 15 | 81641 | 8·000690 | 19326 | 37567 | 55428 | 72926 | 90074 | 106885 | 23373 | 39551 | 55429 | 57 |
| 30 | 81962 | 8·001004 | 19634 | 37868 | 55723 | 73215 | 90357 | 107163 | 23645 | 39818 | 55691 | 58 |
| 45 | 82283 | 8·001318 | 19941 | 38169 | 56018 | 73503 | 90639 | 107441 | 23918 | 40085 | 55953 | 59 |

| | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 324. | Parts | 22 | 43 | 65 | 86 | 108 | 130 | 151 | 173 | 194 | 216 | 238 | 259 | 281 | 302 | 324 |
| D. 264. | Parts | 18 | 35 | 53 | 70 | 88 | 106 | 123 | 141 | 158 | 176 | 194 | 211 | 229 | 246 | 264 |

## LOG. SINE SQUARE

| | 13° | 14° | | | | 15° | | | | 16° | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | |
| | 0h 55m | 0h 56m | 0h 57m | 0h 58m | 0h 59m | 1h 0m | 1h 1m | 1h 2m | 1h 3m | 1h 4m | 1h 5m | s. |
| | 8·1 | 8·1 | 8· | 8·2 | 8·2 | 8·2 | 8·2 | 8·2 | 8·2 | 8· | 8·3 | |
| 0′ 0″ | 56215 | 71788 | 187085 | 02112 | 16879 | 31395 | 45669 | 59708 | 73519 | 287111 | 00488 | 0 |
| 15 | 56477 | 72046 | 187337 | 02360 | 17123 | 31635 | 45905 | 59940 | 73748 | 28733[illegible] | 00710 | 1 |
| 30 | 56738 | 72303 | 187590 | 02608 | 17367 | 31875 | 46141 | 60172 | 73976 | 287560 | 00931 | 2 |
| 45 | 57000 | 72560 | 187842 | 02856 | 17611 | 32115 | 46376 | 60404 | 74204 | 287784 | 01152 | 3 |
| 1 0 | 57262 | 72817 | 188095 | 03104 | 17854 | 32354 | 46612 | 60636 | 74432 | 288009 | 01373 | 4 |
| 15 | 57524 | 73074 | 188347 | 03352 | 18098 | 32594 | 46848 | 60867 | 74660 | 288233 | 01594 | 5 |
| 30 | 57785 | 73331 | 188599 | 03600 | 18342 | 32833 | 47083 | 61099 | 74888 | 288458 | 01815 | 6 |
| 45 | 58046 | 73588 | 188851 | 03848 | 18585 | 33073 | 47319 | 61331 | 75116 | 288682 | 02035 | 7 |
| 2 0 | 58308 | 73844 | 189104 | 04095 | 18829 | 33312 | 47554 | 61562 | 75344 | 288906 | 02256 | 8 |
| 15 | 58569 | 74101 | 189356 | 04343 | 19072 | 33552 | 47790 | 61794 | 75572 | 289131 | 02477 | 9 |
| 30 | 58830 | 74357 | 189608 | 04591 | 19316 | 33791 | 48025 | 62025 | 75800 | 289355 | 02698 | 10 |
| 45 | 59091 | 74614 | 189859 | 04838 | 19559 | 34030 | 48260 | 62257 | 76027 | 289579 | 02918 | 11 |
| 3 0 | 59352 | 74870 | 190111 | 05086 | 19802 | 34269 | 48495 | 62488 | 76255 | 289803 | 03139 | 12 |
| 15 | 59613 | 75126 | 190363 | 05333 | 20045 | 34508 | 48730 | 62719 | 76483 | 290027 | 03359 | 13 |
| 30 | 59874 | 75382 | 190615 | 05580 | 20288 | 34747 | 48965 | 62951 | 76710 | 290251 | 03580 | 14 |
| 45 | 60135 | 75639 | 190866 | 05827 | 20531 | 34986 | 49200 | 63182 | 76938 | 290475 | 03800 | 15 |
| 4 0 | 60396 | 75895 | 191118 | 06074 | 20774 | 35225 | 49435 | 63413 | 77165 | 290699 | 04021 | 16 |
| 15 | 60656 | 76150 | 191369 | 06322 | 21017 | 35464 | 49670 | 63643 | 77392 | 290922 | 04241 | 17 |
| 30 | 60917 | 76406 | 191620 | 06569 | 21263 | 35703 | 49905 | 63875 | 77620 | 291146 | 04461 | 18 |
| 45 | 61177 | 76662 | 191872 | 06816 | 21503 | 35941 | 50140 | 64106 | 77847 | 291370 | 04681 | 19 |
| 5 0 | 61438 | 76918 | 192123 | 07062 | 21745 | 36180 | 50374 | 64337 | 78074 | 291593 | 04901 | 20 |
| 15 | 61698 | 77174 | 192374 | 07309 | 21988 | 36418 | 50609 | 64567 | 78301 | 291817 | 05121 | 21 |
| 30 | 61958 | 77429 | 192625 | 07556 | 22230 | 36656 | 50843 | 64798 | 78528 | 292040 | 05341 | 22 |
| 45 | 62218 | 77685 | 192876 | 07803 | 22473 | 36895 | 51078 | 65029 | 78755 | 292264 | 05561 | 23 |
| 6 0 | 62478 | 77940 | 193127 | 08049 | 22715 | 37133 | 51312 | 65259 | 78982 | 292487 | 05781 | 24 |
| 15 | 62738 | 78195 | 193378 | 08296 | 22957 | 37372 | 51547 | 65490 | 79209 | 292710 | 06001 | 25 |
| 30 | 62998 | 78451 | 193629 | 08542 | 23200 | 37610 | 51781 | 65720 | 79436 | 292933 | 06221 | 26 |
| 45 | 63258 | 78706 | 193879 | 08788 | 23442 | 37848 | 52015 | 65951 | 79662 | 293157 | 06440 | 27 |
| 7 0 | 63518 | 78961 | 194130 | 09035 | 23684 | 38086 | 52249 | 66181 | 79889 | 293380 | 06660 | 28 |
| 15 | 63778 | 79216 | 194381 | 09281 | 23926 | 38324 | 52483 | 66411 | 80116 | 293603 | 06880 | 29 |
| 30 | 64037 | 79471 | 194631 | 09527 | 24168 | 38562 | 52717 | 66642 | 80342 | 293826 | 07099 | 30 |
| 45 | 64297 | 79726 | 194881 | 09773 | 24410 | 38800 | 52951 | 66872 | 80569 | 294049 | 07319 | 31 |
| 8 0 | 64556 | 79981 | 195132 | 10019 | 24652 | 39038 | 53185 | 67102 | 80795 | 294272 | 07538 | 32 |
| 15 | 64816 | 80235 | 195382 | 10265 | 24893 | 39275 | 53419 | 67332 | 81021 | 294494 | 07757 | 33 |
| 30 | 65075 | 80490 | 195632 | 10511 | 25135 | 39513 | 53653 | 67558 | 81248 | 294717 | 07977 | 34 |
| 45 | 65334 | 80745 | 195882 | 10757 | 25377 | 39751 | 53886 | 67792 | 81474 | 294940 | 08196 | 35 |
| 9 0 | 65593 | 80999 | 196132 | 11003 | 25618 | 39988 | 54120 | 68022 | 81700 | 295162 | 08415 | 36 |
| 15 | 65852 | 81254 | 196382 | 11248 | 25860 | 40226 | 54354 | 68251 | 81926 | 295385 | 08634 | 37 |
| 30 | 66111 | 81508 | 196632 | 11494 | 26101 | 40463 | 54587 | 68481 | 82152 | 295608 | 08853 | 38 |
| 45 | 66370 | 81762 | 196882 | 11739 | 26343 | 40700 | 54820 | 68711 | 82378 | 295830 | 09072 | 39 |
| 10 0 | 66629 | 82016 | 197132 | 11985 | 26584 | 40938 | 55054 | 68940 | 82604 | 296052 | 09291 | 40 |
| 15 | 66888 | 82260 | 197382 | 12230 | 26825 | 41175 | 55287 | 69170 | 82830 | 296275 | 09510 | 41 |
| 30 | 67146 | 82525 | 197631 | 12475 | 27066 | 41412 | 55520 | 69399 | 83056 | 296497 | 09729 | 42 |
| 45 | 67405 | 82778 | 197881 | 12721 | 27307 | 41649 | 55754 | 69629 | 83282 | 296719 | 09948 | 43 |
| 11 0 | 67663 | 83032 | 198130 | 12966 | 27548 | 41886 | 55987 | 69858 | 83507 | 296941 | 10167 | 44 |
| 15 | 67922 | 83286 | 198380 | 13211 | 27789 | 42123 | 56220 | 70087 | 83733 | 297164 | 10385 | 45 |
| 30 | 68180 | 83540 | 198629 | 13456 | 28030 | 42360 | 56453 | 70317 | 83957 | 297386 | 10604 | 46 |
| 45 | 68439 | 83794 | 198878 | 13701 | 28271 | 42597 | 56686 | 70546 | 84184 | 297608 | 10823 | 47 |
| 12 0 | 68697 | 84047 | 199127 | 13946 | 28512 | 42833 | 56919 | 70775 | 84410 | 297830 | 11041 | 48 |
| 15 | 68955 | 84301 | 199376 | 14191 | 28752 | 43070 | 57151 | 71004 | 84635 | 298051 | 11260 | 49 |
| 30 | 69213 | 84554 | 199625 | 14435 | 28993 | 43307 | 57384 | 71234 | 84860 | 298273 | 11478 | 50 |
| 45 | 69471 | 84807 | 199874 | 14680 | 29234 | 43543 | 57617 | 71462 | 85086 | 298495 | 11696 | 51 |
| 13 0 | 69729 | 85061 | 200123 | 14925 | 29474 | 43780 | 57849 | 71691 | 85311 | 298717 | 11915 | 52 |
| 15 | 69986 | 85314 | 200372 | 15169 | 29714 | 44016 | 58082 | 71919 | 85536 | 298938 | 12133 | 53 |
| 30 | 70244 | 85567 | 200621 | 15414 | 29955 | 44252 | 58314 | 72148 | 85761 | 299160 | 12351 | 54 |
| 45 | 70502 | 85819 | 200869 | 15658 | 30195 | 44489 | 58547 | 72377 | 85986 | 299381 | 12569 | 55 |
| 14 0 | 70759 | 86070 | 201118 | 15902 | 30435 | 44725 | 58779 | 72606 | 86211 | 299603 | 12787 | 56 |
| 15 | 71017 | 86326 | 201366 | 16147 | 30675 | 44961 | 59011 | 72834 | 86436 | 299824 | 13005 | 57 |
| 30 | 71274 | 86579 | 201615 | 16391 | 30915 | 45197 | 59244 | 73063 | 86661 | 300046 | 13223 | 58 |
| 45 | 71531 | 86832 | 201863 | 16635 | 31155 | 45433 | 59476 | 73291 | 86886 | 300267 | 13441 | 59 |

| | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 260. | Parts | 17 | 35 | 52 | 69 | 87 | 104 | 121 | 139 | 156 | 173 | 191 | 208 | 225 | 243 | 260 |
| D. 220. | Parts | 15 | 29 | 44 | 59 | 73 | 88 | 103 | 117 | 132 | 147 | 161 | 176 | 191 | 206 | 220 |

## LOG. SINE SQUARE

| | 16° | | 17° | | | | 18° | | | | 19° | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 30′ | 45′ | 0′ | 15′ | 30 | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | |
| | 1h 6m | 1h 7m | 1h 8m | 1h 9m | 1h 10m | 1h 11m | 1h 12m | 1h 13m | 1h 14m | 1h 15m | 1h 16m | s. |
| ′ ″ | 8·3 | 8·3 | 8·3 | 8·3 | 8·3 | 8·3 | 8· | 8·4 | 8·4 | 8·4 | 8·4 | |
| 0 0 | 13659 | 26629 | 39404 | 51990 | 64392 | 76615 | 388665 | 00546 | 12262 | 23818 | 35218 | 0 |
| 15 | 13877 | 26844 | 39615 | 52198 | 64597 | 76817 | 388864 | 00742 | 12456 | 24009 | 35407 | 1 |
| 30 | 14095 | 27058 | 39827 | 52406 | 64802 | 77020 | 389064 | 00939 | 12650 | 24201 | 35596 | 2 |
| 45 | 14312 | 27272 | 40038 | 52614 | 65007 | 77222 | 389263 | 01135 | 12843 | 24392 | 35784 | 3 |
| 1 0 | 14530 | 27487 | 40249 | 52822 | 65212 | 77424 | 389462 | 01332 | 13037 | 24583 | 35973 | 4 |
| 15 | 14748 | 27701 | 40460 | 53030 | 65417 | 77626 | 389661 | 01528 | 13231 | 24774 | 36161 | 5 |
| 30 | 14965 | 27915 | 40671 | 53238 | 65622 | 77828 | 389860 | 01724 | 13425 | 24965 | 36350 | 6 |
| 45 | 15182 | 28129 | 40882 | 53446 | 65827 | 78030 | 390059 | 01921 | 13618 | 25156 | 36538 | 7 |
| 2 0 | 15400 | 28344 | 41093 | 53654 | 66032 | 78232 | 390259 | 02117 | 13812 | 25347 | 36727 | 8 |
| 15 | 15617 | 28558 | 41304 | 53862 | 66237 | 78434 | 390458 | 02313 | 14005 | 25538 | 36915 | 9 |
| 30 | 15835 | 28772 | 41515 | 54070 | 66441 | 78635 | 390657 | 02510 | 14199 | 25729 | 37104 | 10 |
| 45 | 16052 | 28986 | 41726 | 54277 | 66646 | 78837 | 390855 | 02706 | 14392 | 25920 | 37292 | 11 |
| 3 0 | 16269 | 29200 | 41936 | 54485 | 66851 | 79039 | 391054 | 02902 | 14586 | 26110 | 37480 | 12 |
| 15 | 16486 | 29413 | 42147 | 54692 | 67055 | 79241 | 391253 | 03098 | 14779 | 26301 | 37668 | 13 |
| 30 | 16703 | 29627 | 42358 | 54900 | 67260 | 79442 | 391452 | 03294 | 14972 | 26492 | 37857 | 14 |
| 45 | 16920 | 29841 | 42568 | 55107 | 67464 | 79644 | 391651 | 03490 | 15166 | 26683 | 38045 | 15 |
| 4 0 | 17137 | 30055 | 42779 | 55315 | 67669 | 79845 | 391849 | 03686 | 15359 | 26873 | 38233 | 16 |
| 15 | 17354 | 30268 | 42989 | 55522 | 67873 | 80047 | 392048 | 03882 | 15552 | 27064 | 38421 | 17 |
| 30 | 17571 | 30482 | 43200 | 55730 | 68077 | 80248 | 392247 | 04077 | 15745 | 27254 | 38609 | 18 |
| 45 | 17788 | 30695 | 43410 | 55937 | 68282 | 80450 | 392445 | 04273 | 15938 | 27445 | 38797 | 19 |
| 5 0 | 18004 | 30909 | 43620 | 56144 | 68486 | 80651 | 392644 | 04469 | 16131 | 27635 | 38985 | 20 |
| 15 | 18221 | 31122 | 43830 | 56351 | 68690 | 80852 | 392842 | 04665 | 16324 | 27826 | 39173 | 21 |
| 30 | 18438 | 31336 | 44041 | 56558 | 68894 | 81053 | 393040 | 04860 | 16518 | 28016 | 39360 | 22 |
| 45 | 18654 | 31549 | 44251 | 56765 | 69098 | 81255 | 393239 | 05056 | 16710 | 28206 | 39548 | 23 |
| 6 0 | 18871 | 31762 | 44461 | 56973 | 69302 | 81456 | 393437 | 05252 | 16903 | 28397 | 39736 | 24 |
| 15 | 19087 | 31975 | 44671 | 57179 | 69506 | 81657 | 393635 | 05447 | 17096 | 28587 | 39924 | 25 |
| 30 | 19304 | 32189 | 44881 | 57386 | 69710 | 81858 | 393834 | 05643 | 17289 | 28777 | 40111 | 26 |
| 45 | 19520 | 32402 | 45091 | 57593 | 69914 | 82059 | 394032 | 05838 | 17482 | 28967 | 40299 | 27 |
| 7 0 | 19736 | 32615 | 45301 | 57800 | 70118 | 82260 | 394230 | 06033 | 17674 | 29157 | 40486 | 28 |
| 15 | 19953 | 32828 | 45511 | 58007 | 70322 | 82461 | 394428 | 06229 | 17867 | 29347 | 40674 | 29 |
| 30 | 20169 | 33041 | 45720 | 58214 | 70526 | 82661 | 394626 | 06424 | 18060 | 29537 | 40862 | 30 |
| 45 | 20385 | 33254 | 45930 | 58420 | 70729 | 82862 | 394824 | 06619 | 18252 | 29727 | 41049 | 31 |
| 8 0 | 20601 | 33466 | 46140 | 58627 | 70933 | 83063 | 395022 | 06814 | 18445 | 29917 | 41236 | 32 |
| 15 | 20817 | 33679 | 46349 | 58833 | 71137 | 83264 | 395220 | 07009 | 18637 | 30107 | 41424 | 33 |
| 30 | 21033 | 33892 | 46559 | 59040 | 71340 | 83464 | 395418 | 07205 | 18830 | 30297 | 41611 | 34 |
| 45 | 21249 | 34105 | 46768 | 59246 | 71544 | 83665 | 395615 | 07400 | 19022 | 30487 | 41798 | 35 |
| 9 0 | 21465 | 34317 | 46978 | 59453 | 71747 | 83866 | 395813 | 07595 | 19214 | 30677 | 41986 | 36 |
| 15 | 21681 | 34530 | 47187 | 59659 | 71950 | 84066 | 396011 | 07790 | 19407 | 30866 | 42173 | 37 |
| 30 | 21896 | 34742 | 47397 | 59866 | 72154 | 84267 | 396209 | 07985 | 19599 | 31056 | 42360 | 38 |
| 45 | 22112 | 34955 | 47606 | 60072 | 72357 | 84467 | 396406 | 08179 | 19791 | 31246 | 42547 | 39 |
| 10 0 | 22328 | 35167 | 47815 | 60278 | 72560 | 84667 | 396604 | 08374 | 19983 | 31435 | 42734 | 40 |
| 15 | 22543 | 35379 | 48025 | 60484 | 72764 | 84868 | 396801 | 08569 | 20176 | 31625 | 42921 | 41 |
| 30 | 22759 | 35592 | 48234 | 60690 | 72967 | 85068 | 396999 | 08764 | 20368 | 31814 | 43108 | 42 |
| 45 | 22974 | 35804 | 48443 | 60896 | 73170 | 85268 | 397196 | 08959 | 20560 | 32004 | 43295 | 43 |
| 11 0 | 23190 | 36016 | 48652 | 61102 | 73373 | 85468 | 397394 | 09153 | 20752 | 32193 | 43482 | 44 |
| 15 | 23405 | 36228 | 48861 | 61308 | 73576 | 85668 | 397591 | 09348 | 20944 | 32383 | 43669 | 45 |
| 30 | 23620 | 36440 | 49070 | 61514 | 73779 | 85869 | 397788 | 09542 | 21136 | 32572 | 43856 | 46 |
| 45 | 23836 | 36652 | 49279 | 61720 | 73982 | 86069 | 397985 | 09737 | 21328 | 32761 | 44043 | 47 |
| 12 0 | 24051 | 36864 | 49488 | 61926 | 74185 | 86269 | 398183 | 09931 | 21519 | 32951 | 44229 | 48 |
| 15 | 24266 | 37076 | 49696 | 62132 | 74387 | 86469 | 398380 | 10126 | 21711 | 33140 | 44416 | 49 |
| 30 | 24481 | 37288 | 49905 | 62338 | 74590 | 86668 | 398577 | 10320 | 21903 | 33329 | 44603 | 50 |
| 45 | 24696 | 37500 | 50114 | 62543 | 74793 | 86868 | 398774 | 10515 | 22095 | 33518 | 44789 | 51 |
| 13 0 | 24911 | 37712 | 50323 | 62749 | 74996 | 87068 | 398971 | 10709 | 22286 | 33707 | 44976 | 52 |
| 15 | 25126 | 37924 | 50531 | 62954 | 75198 | 87268 | 399168 | 10963 | 22478 | 33896 | 45162 | 53 |
| 30 | 25341 | 38135 | 50740 | 63160 | 75401 | 87468 | 399365 | 11097 | 22669 | 34085 | 45349 | 54 |
| 45 | 25556 | 38347 | 50948 | 63365 | 75603 | 87667 | 399562 | 11292 | 22861 | 34274 | 45535 | 55 |
| 14 0 | 25771 | 38558 | 51157 | 63571 | 75806 | 87867 | 399759 | 11486 | 23053 | 34463 | 45722 | 56 |
| 15 | 25985 | 38770 | 51365 | 63776 | 76008 | 88066 | 399955 | 11680 | 23244 | 34652 | 45908 | 57 |
| 30 | 26200 | 38981 | 51573 | 63981 | 76211 | 88266 | 400152 | 11874 | 23435 | 34841 | 46095 | 58 |
| 45 | 26415 | 39193 | 51782 | 64187 | 76413 | 88465 | 400349 | 12068 | 23627 | 35030 | 46281 | 59 |

| | Sec. | 1′ | 2′ | 3′ | 4′ | 5′ | 6′ | 7′ | 8′ | 9′ | 10′ | 11′ | 12′ | 13′ | 14′ | 15′ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 216. | Parts | 14 | 29 | 43 | 58 | 72 | 86 | 101 | 115 | 130 | 144 | 158 | 173 | 187 | 202 | 216 |
| D. 187. | Parts | 12 | 25 | 37 | 50 | 62 | 75 | 87 | 100 | 112 | 125 | 137 | 150 | 162 | 175 | 187 |

## LOG. SINE SQUARE

| | 19° | | | 20° | | | | 21° | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | |
| | 1ʰ 17ᵐ | 1ʰ 18ᵐ | 1ʰ 19ᵐ | 1ʰ 20ᵐ | 1ʰ 21ᵐ | 1ʰ 22ᵐ | 1ʰ 23ᵐ | 1ʰ 24ᵐ | 1ʰ 25ᵐ | 1ʰ 26ᵐ | 1ʰ 27ᵐ | s. |
| ′ ″ | 8·4 | 8·4 | 8·4 | 8·4 | 8· | 8·5 | 8·5 | 8·5 | 8·5 | 8·5 | 8·5 | |
| 0 0 | 46467 | 57568 | 68524 | 79340 | 490019 | 00564 | 10979 | 21266 | 31429 | 41470 | 51392 | 0 |
| 15 | 46653 | 57752 | 68706 | 79520 | 490196 | 00739 | 11151 | 21436 | 31597 | 41636 | 51556 | 1 |
| 30 | 46839 | 57935 | 68887 | 79699 | 490373 | 00914 | 11324 | 21607 | 31765 | 41802 | 51720 | 2 |
| 45 | 47026 | 58119 | 69068 | 79878 | 490550 | 01088 | 11496 | 21777 | 31934 | 41968 | 51885 | 3 |
| 1 0 | 47212 | 58303 | 69250 | 80057 | 490726 | 01263 | 11669 | 21947 | 32102 | 42135 | 52049 | 4 |
| 15 | 47398 | 58486 | 69431 | 80235 | 490903 | 01437 | 11841 | 22118 | 32270 | 42301 | 52213 | 5 |
| 30 | 47584 | 58670 | 69612 | 80414 | 491080 | 01612 | 12013 | 22288 | 32438 | 42467 | 52377 | 6 |
| 45 | 47770 | 58853 | 69793 | 80593 | 491256 | 01786 | 12186 | 22458 | 32606 | 42633 | 52542 | 7 |
| 2 0 | 47956 | 59037 | 69975 | 80772 | 491433 | 01961 | 12358 | 22628 | 32774 | 42799 | 52706 | 8 |
| 15 | 48142 | 59220 | 70156 | 80951 | 491609 | 02135 | 12530 | 22798 | 32942 | 42965 | 52870 | 9 |
| 30 | 48327 | 59404 | 70337 | 81130 | 491786 | 02309 | 12702 | 22968 | 33111 | 43131 | 53034 | 10 |
| 45 | 48513 | 59587 | 70518 | 81308 | 491962 | 02483 | 12874 | 23138 | 33278 | 43297 | 53198 | 11 |
| 3 0 | 48699 | 59771 | 70699 | 81487 | 492139 | 02658 | 13047 | 23308 | 33446 | 43463 | 53362 | 12 |
| 15 | 48885 | 59954 | 70880 | 81666 | 492315 | 02832 | 13219 | 23478 | 33614 | 43629 | 53526 | 13 |
| 30 | 49070 | 60137 | 71061 | 81844 | 492492 | 03006 | 13391 | 23648 | 33782 | 43795 | 53690 | 14 |
| 45 | 49256 | 60320 | 71241 | 82023 | 492668 | 03180 | 13563 | 23818 | 33950 | 43961 | 53854 | 15 |
| 4 0 | 49442 | 60504 | 71422 | 82201 | 492844 | 03354 | 13735 | 23988 | 34118 | 44127 | 54018 | 16 |
| 15 | 49627 | 60687 | 71603 | 82380 | 493021 | 03528 | 13906 | 24158 | 34286 | 44293 | 54182 | 17 |
| 30 | 49813 | 60870 | 71784 | 82558 | 493197 | 03702 | 14078 | 24328 | 34454 | 44459 | 54346 | 18 |
| 45 | 49998 | 61053 | 71964 | 82737 | 493373 | 03876 | 14250 | 24498 | 34621 | 44624 | 54509 | 19 |
| 5 0 | 50184 | 61236 | 72145 | 82915 | 493549 | 04050 | 14422 | 24667 | 34789 | 44790 | 54673 | 20 |
| 15 | 50369 | 61419 | 72326 | 83093 | 493725 | 04224 | 14594 | 24837 | 34957 | 44956 | 54837 | 21 |
| 30 | 50554 | 61602 | 72506 | 83272 | 493901 | 04398 | 14766 | 25007 | 35124 | 45121 | 55001 | 22 |
| 45 | 50740 | 61785 | 72687 | 83450 | 494077 | 04572 | 14937 | 25176 | 35292 | 45287 | 55164 | 23 |
| 6 0 | 50925 | 61968 | 72868 | 83628 | 494253 | 04746 | 15109 | 25346 | 35459 | 45453 | 55328 | 24 |
| 15 | 51110 | 62150 | 73048 | 83806 | 494429 | 04919 | 15281 | 25515 | 35627 | 45618 | 55491 | 25 |
| 30 | 51295 | 62333 | 73228 | 83985 | 494605 | 05093 | 15452 | 25685 | 35795 | 45784 | 55655 | 26 |
| 45 | 51480 | 62516 | 73409 | 84163 | 494781 | 05267 | 15624 | 25854 | 35962 | 45949 | 55819 | 27 |
| 7 0 | 51666 | 62699 | 73589 | 84341 | 494957 | 05441 | 15795 | 26024 | 36129 | 46115 | 55982 | 28 |
| 15 | 51851 | 62881 | 73769 | 84519 | 495133 | 05614 | 15967 | 26193 | 36297 | 46280 | 56146 | 29 |
| 30 | 52036 | 63064 | 73950 | 84697 | 495308 | 05788 | 16138 | 26363 | 36464 | 46445 | 56309 | 30 |
| 45 | 52221 | 63247 | 74130 | 84875 | 495484 | 05961 | 16310 | 26532 | 36631 | 46611 | 56472 | 31 |
| 8 0 | 52406 | 63429 | 74310 | 85053 | 495660 | 06135 | 16481 | 26701 | 36799 | 46776 | 56636 | 32 |
| 15 | 52591 | 63612 | 74490 | 85231 | 495835 | 06308 | 16652 | 26871 | 36966 | 46941 | 56799 | 33 |
| 30 | 52775 | 63794 | 74671 | 85408 | 496011 | 06482 | 16824 | 27040 | 37133 | 47107 | 56963 | 34 |
| 45 | 52960 | 63976 | 74851 | 85586 | 496187 | 06655 | 16995 | 27209 | 37300 | 47272 | 57126 | 35 |
| 9 0 | 53145 | 64160 | 75031 | 85764 | 496362 | 06829 | 17166 | 27378 | 37468 | 47437 | 57289 | 36 |
| 15 | 53330 | 64341 | 75211 | 85942 | 496538 | 07002 | 17338 | 27548 | 37635 | 47602 | 57452 | 37 |
| 30 | 53515 | 64524 | 75391 | 86119 | 496713 | 07175 | 17509 | 27717 | 37802 | 47767 | 57615 | 38 |
| 45 | 53699 | 64706 | 75571 | 86297 | 496889 | 07349 | 17680 | 27886 | 37969 | 47932 | 57779 | 39 |
| 10 0 | 53884 | 64888 | 75751 | 86475 | 497064 | 07522 | 17851 | 28055 | 38136 | 48097 | 57942 | 40 |
| 15 | 54068 | 65070 | 75930 | 86652 | 497239 | 07695 | 18022 | 28224 | 38303 | 48262 | 58105 | 41 |
| 30 | 54253 | 65252 | 76110 | 86830 | 497415 | 07868 | 18193 | 28393 | 38470 | 48427 | 58268 | 42 |
| 45 | 54437 | 65434 | 76290 | 87007 | 497590 | 08041 | 18364 | 28562 | 38637 | 48592 | 5843: | 43 |
| 11 0 | 54622 | 65617 | 76470 | 87185 | 497765 | 08214 | 18535 | 28731 | 38804 | 48757 | 58594 | 44 |
| 15 | 54806 | 65799 | 76649 | 87362 | 497941 | 08387 | 18706 | 28899 | 38971 | 48922 | 58757 | 45 |
| 30 | 54991 | 65981 | 76829 | 87540 | 498116 | 08560 | 18877 | 29068 | 39137 | 49087 | 58920 | 46 |
| 45 | 55175 | 66162 | 77009 | 87717 | 498291 | 08733 | 19048 | 29237 | 39304 | 49252 | 59083 | 47 |
| 12 0 | 55359 | 66344 | 77188 | 87894 | 498466 | 08906 | 19219 | 29406 | 39471 | 49417 | 59246 | 48 |
| 15 | 55544 | 66526 | 77368 | 88072 | 498641 | 09079 | 19390 | 29575 | 39638 | 49581 | 59408 | 49 |
| 30 | 55728 | 66708 | 77547 | 88249 | 498816 | 09252 | 19560 | 29743 | 39804 | 49746 | 59571 | 50 |
| 45 | 55912 | 66890 | 77727 | 88426 | 498991 | 09425 | 19731 | 29912 | 39971 | 49911 | 59734 | 51 |
| 13 0 | 56096 | 67072 | 77906 | 88603 | 499166 | 09598 | 19902 | 30081 | 40138 | 50076 | 59897 | 52 |
| 15 | 56280 | 67253 | 78086 | 88780 | 499341 | 09771 | 20072 | 30249 | 40304 | 50240 | 60059 | 53 |
| 30 | 56464 | 67435 | 78265 | 88958 | 499516 | 09943 | 20243 | 30418 | 40471 | 50405 | 60222 | 54 |
| 45 | 56648 | 67617 | 78444 | 89135 | 499691 | 10116 | 20414 | 30586 | 40637 | 50569 | 60385 | 55 |
| 14 0 | 56832 | 67798 | 78624 | 89312 | 499866 | 10289 | 20584 | 30755 | 40804 | 50734 | 60548 | 56 |
| 15 | 57016 | 67980 | 78803 | 89489 | 500040 | 10461 | 20755 | 30923 | 40970 | 50898 | 60710 | 57 |
| 30 | 57200 | 68161 | 78982 | 89666 | 500215 | 10634 | 20925 | 31092 | 41137 | 51063 | 60873 | 58 |
| 45 | 57384 | 68343 | 79161 | 89842 | 500390 | 10807 | 21096 | 31260 | 41303 | 51227 | 61035 | 59 |

| | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 185. | Parts | 12 | 25 | 37 | 49 | 62 | 74 | 85 | 99 | 111 | 123 | 136 | 148 | 160 | 173 | 185 |
| D. 164. | Parts | 11 | 22 | 33 | 44 | 55 | 66 | 76 | 87 | 98 | 109 | 120 | 131 | 142 | 153 | 164 |

LOG. SINE SQUARE

| | 22° | | | | 23° | | | | 24° | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | |
| | 1h 28m | 1h 29m | 1h 30m | 1h 31m | 1h 32m | 1h 33m | 1h 34m | 1h 35m | 1h 36m | 1h 37m | 1h 38m | s. |
| ′ ″ | 8·5 | 8·5 | 8·5 | 8·5 | 8· | 8·6 | 8·6 | 8·6 | 8·6 | 8·6 | 8·6 | |
| 0 0 | 61198 | 70890 | 80471 | 89944 | 599311 | 08573 | 17734 | 26795 | 35758 | 44625 | 53399 | 0 |
| 15 | 61360 | 71051 | 80630 | 90101 | 599466 | 08726 | 17885 | 26945 | 35906 | 44772 | 53545 | 1 |
| 30 | 61523 | 71211 | 80789 | 90258 | 599621 | 08880 | 18037 | 27095 | 36055 | 44919 | 53690 | 2 |
| 45 | 61685 | 71372 | 80948 | 90415 | 599776 | 09033 | 18189 | 27245 | 36203 | 45066 | 53836 | 3 |
| 1 0 | 61847 | 71532 | 81106 | 90572 | 599931 | 09187 | 18341 | 27395 | 36352 | 45213 | 53981 | 4 |
| 15 | 62010 | 71693 | 81265 | 90729 | 600086 | 09340 | 18492 | 27545 | 36500 | 45360 | 54126 | 5 |
| 30 | 62172 | 71853 | 81424 | 90886 | 600242 | 09494 | 18644 | 27695 | 36649 | 45507 | 54272 | 6 |
| 45 | 62334 | 72014 | 81582 | 91042 | 600397 | 09647 | 18796 | 27845 | 36797 | 45654 | 54417 | 7 |
| 2 0 | 62497 | 72174 | 81741 | 91199 | 600552 | 09800 | 18947 | 27995 | 36946 | 45801 | 54562 | 8 |
| 15 | 62659 | 72334 | 81899 | 91356 | 600707 | 09954 | 19099 | 28145 | 37094 | 45947 | 54707 | 9 |
| 30 | 62821 | 72495 | 82058 | 91512 | 600862 | 10107 | 19251 | 28295 | 37242 | 46094 | 54853 | 10 |
| 45 | 62983 | 72655 | 82216 | 91669 | 601016 | 10260 | 19402 | 28445 | 37391 | 46241 | 54998 | 11 |
| 3 0 | 63145 | 72815 | 82375 | 91826 | 601171 | 10413 | 19554 | 28595 | 37539 | 46388 | 55143 | 12 |
| 15 | 63307 | 72975 | 82533 | 91982 | 601326 | 10566 | 19705 | 28745 | 37687 | 46534 | 55288 | 13 |
| 30 | 63469 | 73136 | 82691 | 92139 | 601481 | 10720 | 19857 | 28895 | 37835 | 46681 | 55433 | 14 |
| 45 | 63631 | 73296 | 82850 | 92296 | 601636 | 10873 | 20008 | 29044 | 37984 | 46828 | 55578 | 15 |
| 4 0 | 63793 | 73456 | 83008 | 92452 | 601791 | 11026 | 20160 | 29194 | 38132 | 46974 | 55723 | 16 |
| 15 | 63955 | 73616 | 83166 | 92609 | 601945 | 11179 | 20311 | 29344 | 38280 | 47121 | 55868 | 17 |
| 30 | 64117 | 73776 | 83325 | 92765 | 602100 | 11332 | 20462 | 29494 | 38428 | 47267 | 56014 | 18 |
| 45 | 64279 | 73936 | 83483 | 92922 | 602255 | 11485 | 20614 | 29643 | 38576 | 47414 | 56159 | 19 |
| 5 0 | 64441 | 74096 | 83641 | 93078 | 602410 | 11638 | 20765 | 29793 | 38724 | 47560 | 56304 | 20 |
| 15 | 64603 | 74256 | 83799 | 93234 | 602564 | 11791 | 20916 | 29943 | 38872 | 47707 | 56448 | 21 |
| 30 | 64765 | 74416 | 83957 | 93391 | 602719 | 11944 | 21067 | 30092 | 39020 | 47853 | 56593 | 22 |
| 45 | 64926 | 74576 | 84115 | 93547 | 602873 | 12096 | 21219 | 30242 | 39168 | 48000 | 56738 | 23 |
| 6 0 | 65088 | 74736 | 84273 | 93703 | 603028 | 12249 | 21370 | 30391 | 39316 | 48146 | 56883 | 24 |
| 15 | 65250 | 74896 | 84431 | 93860 | 603182 | 12402 | 21521 | 30541 | 39464 | 48293 | 57028 | 25 |
| 30 | 65412 | 75056 | 84589 | 94016 | 603337 | 12555 | 21672 | 30690 | 39612 | 48439 | 57173 | 26 |
| 45 | 65573 | 75215 | 84747 | 94172 | 603491 | 12708 | 21823 | 30840 | 39760 | 48585 | 57318 | 27 |
| 7 0 | 65735 | 75375 | 84905 | 94328 | 603646 | 12861 | 21974 | 30989 | 39908 | 48731 | 57462 | 28 |
| 15 | 65896 | 75535 | 85063 | 94484 | 603800 | 13013 | 22125 | 31139 | 40056 | 48878 | 57607 | 29 |
| 30 | 66058 | 75695 | 85221 | 94641 | 603955 | 13166 | 22276 | 31288 | 40203 | 49024 | 57752 | 30 |
| 45 | 66219 | 75854 | 85379 | 94797 | 604109 | 13319 | 22427 | 31438 | 40351 | 49170 | 57896 | 31 |
| 8 0 | 66381 | 76014 | 85537 | 94953 | 604263 | 13471 | 22578 | 31587 | 40499 | 49316 | 58041 | 32 |
| 15 | 66542 | 76173 | 85695 | 95109 | 604418 | 13624 | 22729 | 31736 | 40647 | 49463 | 58186 | 33 |
| 30 | 66704 | 76333 | 85853 | 95265 | 604572 | 13776 | 22880 | 31886 | 40794 | 49609 | 58330 | 34 |
| 45 | 66865 | 76493 | 86010 | 95421 | 604726 | 13929 | 23031 | 32035 | 40942 | 49755 | 58475 | 35 |
| 9 0 | 67027 | 76652 | 86168 | 95577 | 604880 | 14081 | 23182 | 32184 | 41090 | 49901 | 58620 | 36 |
| 15 | 67188 | 76812 | 86326 | 95732 | 605035 | 14234 | 23333 | 32333 | 41237 | 50047 | 58764 | 37 |
| 30 | 67349 | 76971 | 86483 | 95888 | 605189 | 14386 | 23484 | 32482 | 41385 | 50193 | 58909 | 38 |
| 45 | 67510 | 77130 | 86641 | 96044 | 605343 | 14539 | 23634 | 32632 | 41532 | 50339 | 59053 | 39 |
| 10 0 | 67672 | 77290 | 86799 | 96200 | 605497 | 14691 | 23785 | 32781 | 41680 | 50485 | 59198 | 40 |
| 15 | 67833 | 77449 | 86956 | 96356 | 605651 | 14844 | 23936 | 32930 | 41828 | 50631 | 59342 | 41 |
| 30 | 67994 | 77609 | 87114 | 96512 | 605805 | 14996 | 24087 | 33079 | 41975 | 50777 | 59486 | 42 |
| 45 | 68155 | 77768 | 87271 | 96667 | 605959 | 15148 | 24237 | 33228 | 42123 | 50923 | 59631 | 43 |
| 11 0 | 68316 | 77927 | 87429 | 96823 | 606113 | 15301 | 24388 | 33377 | 42270 | 51069 | 59775 | 44 |
| 15 | 68477 | 78086 | 87586 | 96979 | 606267 | 15453 | 24539 | 33526 | 42417 | 51215 | 59919 | 45 |
| 30 | 68639 | 78246 | 87743 | 97134 | 606421 | 15605 | 24689 | 33675 | 42565 | 51360 | 60064 | 46 |
| 45 | 68880 | 78405 | 87901 | 97290 | 606575 | 15757 | 24840 | 33824 | 42712 | 51506 | 60208 | 47 |
| 12 0 | 68961 | 78564 | 88058 | 97446 | 606729 | 15910 | 24990 | 33973 | 42859 | 51652 | 60352 | 48 |
| 15 | 69121 | 78723 | 88216 | 97601 | 606883 | 16062 | 25141 | 34122 | 43007 | 51798 | 60496 | 49 |
| 30 | 69282 | 78882 | 88373 | 97757 | 607036 | 16214 | 25291 | 34271 | 43154 | 51943 | 60641 | 50 |
| 45 | 69443 | 79041 | 88530 | 97912 | 607190 | 16366 | 25442 | 34419 | 43301 | 52089 | 60785 | 51 |
| 13 0 | 69604 | 79200 | 88687 | 98068 | 607344 | 16518 | 25592 | 34568 | 43449 | 52235 | 60929 | 52 |
| 15 | 69765 | 79359 | 88845 | 98223 | 607498 | 16670 | 25742 | 34717 | 43596 | 52380 | 61073 | 53 |
| 30 | 69926 | 79518 | 89002 | 98379 | 607651 | 16822 | 25893 | 34866 | 43743 | 52526 | 61217 | 54 |
| 45 | 70087 | 79677 | 89159 | 98534 | 607805 | 16974 | 26043 | 35015 | 43890 | 52672 | 61361 | 55 |
| 14 0 | 70257 | 79836 | 89316 | 98689 | 607959 | 17126 | 26194 | 35163 | 44037 | 52817 | 61505 | 56 |
| 15 | 70408 | 79995 | 89473 | 98845 | 608112 | 17278 | 26344 | 35312 | 44184 | 52963 | 61649 | 57 |
| 30 | 70569 | 80154 | 89630 | 99000 | 608266 | 17430 | 26494 | 35461 | 44331 | 53108 | 61793 | 58 |
| 45 | 70729 | 80313 | 89787 | 99155 | 608419 | 17582 | 26644 | 35609 | 44478 | 53254 | 61937 | 59 |

| | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 162 | Parts | 11 | 22 | 32 | 43 | 54 | 65 | 76 | 86 | 97 | 108 | 119 | 130 | 140 | 151 | 162 |
| D. 145 | Parts | 10 | 19 | 29 | 39 | 48 | 58 | 68 | 77 | 87 | 97 | 106 | 116 | 126 | 135 | 145 |

## LOG. SINE SQUARE

| | | 24° | 25° | | | | 26° | | | | 27° | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | |
| | | 1h 39m | 1h 40m | 1h 41m | 1h 42m | 1h 43m | 1h 44m | 1h 45m | 1h 46m | 1h 47m | 1h 48m | 1h 49m | s. |
| m | s | 8·6 | 8·6 | 8·6 | 8·6 | 8· | 8·7 | 8·7 | 8·7 | 8·7 | 8·7 | 8·7 | |
| 0 | 0 | 62081 | 70674 | 79177 | 87595 | 695927 | 04176 | 12343 | 20431 | 28439 | 36371 | 44226 | 0 |
| | 15 | 62225 | 70816 | 79318 | 87734 | 696065 | 04313 | 12479 | 20565 | 28572 | 36502 | 44356 | 1 |
| | 30 | 62369 | 70958 | 79459 | 87974 | 696203 | 04450 | 12614 | 20699 | 28705 | 36634 | 44486 | 2 |
| | 45 | 62513 | 71101 | 79600 | 88013 | 696341 | 04586 | 12750 | 20833 | 28838 | 36765 | 44617 | 3 |
| 1 | 0 | 62657 | 71243 | 79741 | 88153 | 696479 | 04723 | 12885 | 20967 | 28970 | 36896 | 44747 | 4 |
| | 15 | 62801 | 71385 | 79882 | 88292 | 696618 | 04860 | 13020 | 21101 | 29103 | 37028 | 44877 | 5 |
| | 30 | 62945 | 71528 | 80023 | 88432 | 696756 | 04996 | 13156 | 21235 | 29236 | 37159 | 45007 | 6 |
| | 45 | 63088 | 71670 | 80164 | 88571 | 696894 | 05133 | 13291 | 21369 | 29368 | 37291 | 45137 | 7 |
| 2 | 0 | 63232 | 71812 | 80305 | 88710 | 697032 | 05270 | 13426 | 21503 | 29501 | 37422 | 45268 | 8 |
| | 15 | 63376 | 71955 | 80445 | 88850 | 697170 | 05406 | 13562 | 21637 | 29634 | 37554 | 45398 | 9 |
| | 30 | 63520 | 72097 | 80586 | 88989 | 697308 | 05543 | 13697 | 21771 | 29766 | 37685 | 45528 | 10 |
| | 45 | 63663 | 72239 | 80727 | 89129 | 697445 | 05679 | 13832 | 21905 | 29899 | 37816 | 45658 | 11 |
| 3 | 0 | 63807 | 72381 | 80868 | 89268 | 697583 | 05816 | 13967 | 22039 | 30032 | 37948 | 45788 | 12 |
| | 15 | 63951 | 72523 | 81008 | 89407 | 697721 | 05952 | 14102 | 22173 | 30164 | 38079 | 45918 | 13 |
| | 30 | 64094 | 72666 | 81149 | 89546 | 697859 | 06089 | 14238 | 22306 | 30297 | 38210 | 46048 | 14 |
| | 45 | 64238 | 72808 | 81290 | 89686 | 697997 | 06225 | 14373 | 22440 | 30429 | 38341 | 46178 | 15 |
| 4 | 0 | 64381 | 72950 | 81430 | 89825 | 698135 | 06362 | 14508 | 22574 | 30562 | 38473 | 46308 | 16 |
| | 15 | 64525 | 73092 | 81571 | 89964 | 698273 | 06498 | 14643 | 22708 | 30694 | 38604 | 46438 | 17 |
| | 30 | 64668 | 73234 | 81711 | 90103 | 698410 | 06635 | 14778 | 22841 | 30827 | 38735 | 46568 | 18 |
| | 45 | 64812 | 73376 | 81852 | 90242 | 698548 | 06771 | 14913 | 22975 | 30959 | 38866 | 46698 | 19 |
| 5 | 0 | 64955 | 73518 | 81993 | 90381 | 698686 | 06908 | 15048 | 23109 | 31092 | 38997 | 46828 | 20 |
| | 15 | 65099 | 73660 | 82133 | 90520 | 698823 | 07044 | 15183 | 23242 | 31224 | 39128 | 46958 | 21 |
| | 30 | 65242 | 73802 | 82274 | 90660 | 698961 | 07180 | 15318 | 23376 | 31356 | 39259 | 47087 | 22 |
| | 45 | 65386 | 73944 | 82414 | 90799 | 699099 | 07316 | 15453 | 23510 | 31489 | 39391 | 47217 | 23 |
| 6 | 0 | 65529 | 74086 | 82555 | 90938 | 699237 | 07453 | 15588 | 23643 | 31621 | 39522 | 47347 | 24 |
| | 15 | 65672 | 74227 | 82695 | 91077 | 699374 | 07589 | 15723 | 23777 | 31753 | 39653 | 47477 | 25 |
| | 30 | 65816 | 74369 | 82835 | 91216 | 699512 | 07725 | 15858 | 23911 | 31886 | 39784 | 47607 | 26 |
| | 45 | 65959 | 74511 | 82976 | 91355 | 699649 | 07861 | 15993 | 24044 | 32018 | 39915 | 47736 | 27 |
| 7 | 0 | 66102 | 74653 | 83116 | 91493 | 699787 | 07998 | 16127 | 24178 | 32150 | 40046 | 47866 | 28 |
| | 15 | 66245 | 74795 | 83256 | 91632 | 699924 | 08134 | 16262 | 24311 | 32282 | 40177 | 47996 | 29 |
| | 30 | 66389 | 74936 | 83397 | 91771 | 700062 | 08270 | 16397 | 24445 | 32414 | 40308 | 48126 | 30 |
| | 45 | 66532 | 75078 | 83537 | 91910 | 700199 | 08406 | 16532 | 24578 | 32547 | 40438 | 48255 | 31 |
| 8 | 0 | 66675 | 75220 | 83677 | 92049 | 700337 | 08542 | 16667 | 24712 | 32679 | 40569 | 48385 | 32 |
| | 15 | 66818 | 75361 | 83817 | 92188 | 700474 | 08678 | 16801 | 24845 | 32811 | 40700 | 48515 | 33 |
| | 30 | 66961 | 75503 | 83958 | 92327 | 700612 | 08814 | 16936 | 24978 | 32943 | 40831 | 48644 | 34 |
| | 45 | 67104 | 75645 | 84098 | 92465 | 700749 | 08950 | 17071 | 25112 | 33075 | 40962 | 48774 | 35 |
| 9 | 0 | 67247 | 75786 | 84238 | 92604 | 700886 | 09086 | 17205 | 25245 | 33207 | 41093 | 48903 | 36 |
| | 15 | 67390 | 75928 | 84378 | 92743 | 701024 | 09222 | 17340 | 25378 | 33339 | 41224 | 49033 | 37 |
| | 30 | 67533 | 76069 | 84518 | 92881 | 701161 | 09358 | 17475 | 25512 | 33471 | 41354 | 49162 | 38 |
| | 45 | 67676 | 76211 | 84658 | 93020 | 701298 | 09494 | 17609 | 25645 | 33603 | 41485 | 49292 | 39 |
| 10 | 0 | 67819 | 76352 | 84798 | 93159 | 701436 | 09630 | 17744 | 25778 | 33735 | 41616 | 49421 | 40 |
| | 15 | 67962 | 76494 | 84938 | 93297 | 701573 | 09766 | 17878 | 25912 | 33867 | 41747 | 49551 | 41 |
| | 30 | 68105 | 76635 | 85078 | 93436 | 701710 | 09902 | 18013 | 26045 | 35999 | 41877 | 49680 | 42 |
| | 45 | 68248 | 76777 | 85218 | 93575 | 701847 | 10038 | 18147 | 26178 | 34131 | 42008 | 49810 | 43 |
| 11 | 0 | 68391 | 76918 | 85358 | 93713 | 701984 | 10173 | 18282 | 26311 | 34263 | 42138 | 49939 | 44 |
| | 15 | 68534 | 77060 | 85498 | 93852 | 702121 | 10309 | 18416 | 26444 | 34395 | 42269 | 50068 | 45 |
| | 30 | 68677 | 77201 | 85638 | 93990 | 702259 | 10445 | 18551 | 26578 | 34527 | 42400 | 50198 | 46 |
| | 45 | 68819 | 77342 | 85778 | 94129 | 702396 | 10581 | 18685 | 26711 | 34659 | 42530 | 50327 | 47 |
| 12 | 0 | 68962 | 77484 | 85918 | 94267 | 702533 | 10716 | 18820 | 26844 | 34790 | 42661 | 50457 | 48 |
| | 15 | 69105 | 77625 | 86058 | 94406 | 702670 | 10852 | 18954 | 26977 | 34922 | 42791 | 50586 | 49 |
| | 30 | 69248 | 77766 | 86198 | 94544 | 702807 | 10988 | 19088 | 27110 | 35054 | 42922 | 50715 | 50 |
| | 45 | 69390 | 77907 | 86377 | 94682 | 702944 | 11123 | 19223 | 27243 | 35186 | 43052 | 50844 | 51 |
| 13 | 0 | 69533 | 78049 | 86477 | 94821 | 703081 | 11259 | 19357 | 27376 | 35317 | 43183 | 50974 | 52 |
| | 15 | 69676 | 78190 | 86617 | 94959 | 703218 | 11395 | 19491 | 27509 | 35449 | 43313 | 51103 | 53 |
| | 30 | 69818 | 78331 | 86757 | 95097 | 703355 | 11530 | 19626 | 27642 | 35581 | 43444 | 51232 | 54 |
| | 45 | 69961 | 78472 | 86896 | 95236 | 703492 | 11666 | 19760 | 27775 | 35712 | 43574 | 51361 | 55 |
| 14 | 0 | 70103 | 78613 | 87036 | 95374 | 703629 | 11801 | 19894 | 27908 | 35844 | 43705 | 51490 | 56 |
| | 15 | 70246 | 78754 | 87176 | 95512 | 703765 | 11937 | 20028 | 28041 | 35976 | 43835 | 51619 | 57 |
| | 30 | 70389 | 78895 | 87315 | 95651 | 703902 | 12073 | 20162 | 28174 | 36107 | 43965 | 51749 | 58 |
| | 45 | 70531 | 79036 | 87455 | 95789 | 704039 | 12208 | 20297 | 28306 | 36239 | 44096 | 51878 | 59 |

| | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 143. | Parts | 9 | 19 | 28 | 38 | 48 | 57 | 67 | 76 | 86 | 95 | 105 | 114 | 123 | 133 | 143 |
| D. 130. | Parts | 9 | 17 | 26 | 35 | 43 | 52 | 61 | 69 | 78 | 87 | 95 | 104 | 113 | 121 | 130 |

## LOG. SINE SQUARE

| | 27° 30′ | 27° 45′ | 28° 0′ | 28° 15′ | 28° 30′ | 28° 45′ | 29° 0′ | 29° 15′ | 29° 30′ | 29° 45′ | 30° 0′ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| m s | 1h 50m | 1h 51m | 1h 52m | 1h 53m | 1h 54m | 1h 55m | 1h 56m | 1h 57m | 1h 58m | 1h 59m | 2h 0m | s. |
| | 8·7 | 8·7 | 8·7 | 8·7 | 8·7 | 8·7 | 8· | 8·8 | 8·8 | 8·8 | 8·8 | |
| 0 0 | 52007 | 59715 | 67350 | 74910 | 82411 | 89839 | 797199 | 04494 | 11723 | 18889 | 25992 | 0 |
| 15 | 52136 | 59842 | 67477 | 75041 | 82536 | 89962 | 797321 | 04615 | 11843 | 19008 | 26110 | 1 |
| 30 | 52265 | 59970 | 67604 | 75167 | 82660 | 90085 | 797443 | 04736 | 11963 | 19127 | 26228 | 2 |
| 45 | 52394 | 60098 | 67730 | 75292 | 82784 | 90208 | 797566 | 04857 | 12083 | 19246 | 26346 | 3 |
| 1 0 | 52523 | 60226 | 67857 | 75417 | 82909 | 90332 | 797688 | 04978 | 12203 | 19365 | 26464 | 4 |
| 15 | 52652 | 60354 | 67983 | 75543 | 83033 | 90455 | 797810 | 05099 | 12323 | 19484 | 26582 | 5 |
| 30 | 52781 | 60481 | 68110 | 75668 | 83157 | 90578 | 797932 | 05220 | 12443 | 19602 | 26699 | 6 |
| 45 | 52910 | 60609 | 68237 | 75794 | 83281 | 90701 | 798054 | 05341 | 12563 | 19721 | 26817 | 7 |
| 2 0 | 53039 | 60737 | 68363 | 75919 | 83406 | 90824 | 798176 | 05461 | 12683 | 19840 | 26935 | 8 |
| 15 | 53168 | 60864 | 68490 | 76044 | 83530 | 90947 | 798298 | 05582 | 12802 | 19959 | 27053 | 9 |
| 30 | 53296 | 60992 | 68616 | 76170 | 83654 | 91070 | 798420 | 05703 | 12922 | 20078 | 27170 | 10 |
| 45 | 53425 | 61120 | 68743 | 76295 | 83778 | 91193 | 798542 | 05824 | 13042 | 20196 | 27288 | 11 |
| 3 0 | 53554 | 61247 | 68869 | 76420 | 83902 | 91316 | 798663 | 05945 | 13162 | 20315 | 27406 | 12 |
| 15 | 53683 | 61375 | 68995 | 76545 | 84026 | 91439 | 798785 | 06066 | 13281 | 20434 | 27523 | 13 |
| 30 | 53812 | 61503 | 69122 | 76671 | 84150 | 91562 | 798907 | 06186 | 13401 | 20552 | 27641 | 14 |
| 45 | 53941 | 61630 | 69248 | 76796 | 84275 | 91685 | 799029 | 06307 | 13521 | 20671 | 27759 | 15 |
| 4 0 | 54069 | 61758 | 69375 | 76921 | 84399 | 91808 | 799151 | 06428 | 13641 | 20790 | 27876 | 16 |
| 15 | 54198 | 61885 | 69501 | 77046 | 84523 | 91931 | 799273 | 06549 | 13760 | 20908 | 27994 | 17 |
| 30 | 54327 | 62013 | 69627 | 77172 | 84647 | 92054 | 799395 | 06669 | 13880 | 21027 | 28111 | 18 |
| 45 | 54455 | 62140 | 69754 | 77297 | 84771 | 92177 | 799516 | 06790 | 13999 | 21145 | 28229 | 19 |
| 5 0 | 54584 | 62268 | 69880 | 77422 | 84895 | 92300 | 799638 | 06911 | 14119 | 21264 | 28346 | 20 |
| 15 | 54713 | 62395 | 70006 | 77547 | 85019 | 92423 | 799760 | 07031 | 14239 | 21382 | 28464 | 21 |
| 30 | 54841 | 62523 | 70132 | 77672 | 85143 | 92545 | 799882 | 07152 | 14358 | 21501 | 28581 | 22 |
| 45 | 54970 | 62650 | 70259 | 77797 | 85266 | 92668 | 800003 | 07273 | 14478 | 21619 | 28699 | 23 |
| 6 0 | 55099 | 62777 | 70385 | 77922 | 85390 | 92791 | 800125 | 07393 | 14597 | 21738 | 28816 | 24 |
| 15 | 55227 | 62905 | 70511 | 78047 | 85514 | 92914 | 800247 | 07514 | 14717 | 21856 | 28934 | 25 |
| 30 | 55356 | 63032 | 70637 | 78172 | 85638 | 93037 | 800368 | 07635 | 14836 | 21975 | 29051 | 26 |
| 45 | 55484 | 63159 | 70763 | 78297 | 85762 | 93159 | 800490 | 07755 | 14956 | 22093 | 29169 | 27 |
| 7 0 | 55613 | 63287 | 70889 | 78422 | 85886 | 93282 | 800612 | 07876 | 15075 | 22212 | 29286 | 28 |
| 15 | 55741 | 63414 | 71016 | 78547 | 86010 | 93405 | 800733 | 07996 | 15195 | 22330 | 29403 | 29 |
| 30 | 55870 | 63541 | 71142 | 78672 | 86134 | 93527 | 800855 | 08117 | 15314 | 22449 | 29521 | 30 |
| 45 | 55998 | 63669 | 71268 | 78797 | 86257 | 93650 | 800976 | 08237 | 15434 | 22567 | 29638 | 31 |
| 8 0 | 56127 | 63796 | 71394 | 78922 | 86381 | 93773 | 801098 | 08358 | 15553 | 22685 | 29756 | 32 |
| 15 | 56255 | 63923 | 71520 | 79047 | 86505 | 93895 | 801219 | 08478 | 15672 | 22804 | 29873 | 33 |
| 30 | 56383 | 64050 | 71646 | 79172 | 86629 | 94018 | 801341 | 08598 | 15792 | 22922 | 29990 | 34 |
| 45 | 56512 | 64177 | 71772 | 79296 | 86752 | 94140 | 801462 | 08719 | 15911 | 23040 | 30107 | 35 |
| 9 0 | 56640 | 64305 | 71898 | 79421 | 86876 | 94263 | 801584 | 08839 | 16031 | 23159 | 30225 | 36 |
| 15 | 56768 | 64432 | 72024 | 79546 | 87000 | 94386 | 801705 | 08960 | 16150 | 23277 | 30342 | 37 |
| 30 | 56897 | 64559 | 72150 | 79671 | 87123 | 94508 | 801827 | 09080 | 16269 | 23395 | 30459 | 38 |
| 45 | 57025 | 64686 | 72276 | 79796 | 87247 | 94631 | 801948 | 09200 | 16388 | 23513 | 30576 | 39 |
| 10 0 | 57153 | 64813 | 72402 | 79920 | 87370 | 94753 | 802070 | 09321 | 16508 | 23632 | 30694 | 40 |
| 15 | 57282 | 64940 | 72527 | 80045 | 87494 | 94876 | 802191 | 09441 | 16627 | 23750 | 30811 | 41 |
| 30 | 57410 | 65067 | 72653 | 80170 | 87618 | 94998 | 802312 | 09561 | 16746 | 23868 | 30928 | 42 |
| 45 | 57538 | 65194 | 72779 | 80294 | 87741 | 95121 | 802434 | 09682 | 16865 | 23986 | 31045 | 43 |
| 11 0 | 57666 | 65321 | 72905 | 80419 | 87865 | 95243 | 802555 | 09802 | 16985 | 24104 | 31162 | 44 |
| 15 | 57794 | 65448 | 73031 | 80544 | 87988 | 95365 | 802676 | 09922 | 17104 | 24223 | 31279 | 45 |
| 30 | 57923 | 65575 | 73157 | 80668 | 88112 | 95488 | 802798 | 10042 | 17223 | 24341 | 31396 | 46 |
| 45 | 58051 | 65702 | 73282 | 80793 | 88235 | 95610 | 802919 | 10162 | 17342 | 24459 | 31513 | 47 |
| 12 0 | 58179 | 65829 | 73408 | 80918 | 88359 | 95733 | 803040 | 10283 | 17461 | 24577 | 31631 | 48 |
| 15 | 58307 | 65956 | 73534 | 81042 | 88482 | 95855 | 803161 | 10403 | 17580 | 24695 | 31748 | 49 |
| 30 | 58435 | 66083 | 73660 | 81167 | 88606 | 95977 | 803283 | 10523 | 17699 | 24813 | 31865 | 50 |
| 45 | 58563 | 66210 | 73785 | 81291 | 88729 | 96099 | 803404 | 10643 | 17818 | 24931 | 31982 | 51 |
| 13 0 | 58691 | 66336 | 73911 | 81416 | 88852 | 96222 | 803525 | 10763 | 17938 | 25049 | 32099 | 52 |
| 15 | 58819 | 66463 | 74037 | 81540 | 88976 | 96344 | 803646 | 10883 | 18057 | 25167 | 32216 | 53 |
| 30 | 58947 | 66590 | 74162 | 81665 | 89099 | 96466 | 803767 | 11003 | 18176 | 25285 | 32332 | 54 |
| 45 | 59075 | 66717 | 74288 | 81789 | 89222 | 96588 | 803888 | 11123 | 18295 | 25403 | 32449 | 55 |
| 14 0 | 59203 | 66844 | 74413 | 81914 | 89346 | 96711 | 804010 | 11243 | 18414 | 25521 | 32566 | 56 |
| 15 | 59331 | 66970 | 74539 | 82038 | 89469 | 96833 | 804131 | 11363 | 18533 | 25639 | 32683 | 57 |
| 30 | 59459 | 67097 | 74664 | 82163 | 89592 | 96955 | 804252 | 11483 | 18652 | 25757 | 32800 | 58 |
| 45 | 59587 | 67224 | 74790 | 82287 | 89716 | 97077 | 804373 | 11603 | 18770 | 25875 | 32917 | 59 |

| | Sec. | 1′ | 2′ | 3′ | 4′ | 5′ | 6′ | 7′ | 8′ | 9′ | 10′ | 11′ | 12′ | 13′ | 14′ | 15′ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 129. | Parts | 9 | 17 | 26 | 34 | 43 | 52 | 60 | 69 | 78 | 86 | 95 | 103 | 112 | 121 | 129 |
| D. 117. | Parts | 8 | 16 | 23 | 31 | 39 | 47 | 55 | 62 | 70 | 78 | 86 | 94 | 101 | 109 | 117 |

## LOG. SINE SQUARE

| | 30° | | | 31° | | | | 32° | | | | 33° | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | |
| | 2h 1m | 2h 2m | 2h 3m | 2h 4m | 2h 5m | 2h 6m | 2h 7m | 2h 8m | 2h 9m | 2h 10m | 2h 11m | 2h 12m | s. |
| ′ ″ | 8·83 | 8·84 | 8·8 | 8·8 | 8·86 | 8·8 | 8·8 | 8·88 | 8·8 | 8· | 8·90 | 8·9 | |
| 0 0 | 3034 | 0015 | 46936 | 53798 | 0602 | 67349 | 74040 | 0676 | 87258 | 893785 | 0261 | 06684 | 0 |
| 15 | 3151 | 0130 | 47050 | 53911 | 0715 | 67461 | 74151 | 0786 | 87367 | 893894 | 0368 | 06790 | 1 |
| 30 | 3268 | 0246 | 47165 | 54025 | 0828 | 67573 | 74262 | 0896 | 87476 | 894002 | 0476 | 06897 | 2 |
| 45 | 3384 | 0362 | 47280 | 54139 | 0941 | 67685 | 74373 | 1006 | 87585 | 894110 | 0583 | 07003 | 3 |
| 1 0 | 3501 | 0478 | 47395 | 54253 | 1053 | 67797 | 74484 | 1117 | 87694 | 894219 | 0690 | 07110 | 4 |
| 15 | 3618 | 0594 | 47510 | 54367 | 1166 | 67909 | 74595 | 1227 | 87804 | 894327 | 0798 | 07217 | 5 |
| 30 | 3735 | 0709 | 47624 | 54481 | 1279 | 68021 | 74706 | 1337 | 87913 | 894435 | 0905 | 07323 | 6 |
| 45 | 3851 | 0825 | 47739 | 54594 | 1392 | 68133 | 74817 | 1447 | 88022 | 894544 | 1013 | 07430 | 7 |
| 2 0 | 3968 | 0941 | 47854 | 54708 | 1505 | 68245 | 74928 | 1557 | 88131 | 894652 | 1120 | 07536 | 8 |
| 15 | 4085 | 1056 | 47968 | 54822 | 1618 | 68356 | 75039 | 1667 | 88240 | 894760 | 1227 | 07643 | 9 |
| 30 | 4201 | 1172 | 48083 | 54936 | 1730 | 68468 | 75150 | 1777 | 88349 | 894868 | 1335 | 07749 | 10 |
| 45 | 4318 | 1288 | 48198 | 55049 | 1843 | 68580 | 75261 | 1887 | 88458 | 894976 | 1442 | 07856 | 11 |
| 3 0 | 4435 | 1404 | 48313 | 55163 | 1956 | 68692 | 75372 | 1997 | 88567 | 895085 | 1549 | 07962 | 12 |
| 15 | 4551 | 1519 | 48427 | 55277 | 2069 | 68804 | 75483 | 2107 | 88676 | 895193 | 1657 | 08068 | 13 |
| 30 | 4668 | 1635 | 48542 | 55390 | 2181 | 68915 | 75594 | 2217 | 88786 | 895301 | 1764 | 08175 | 14 |
| 45 | 4785 | 1750 | 48657 | 55504 | 2294 | 69027 | 75704 | 2327 | 88895 | 895409 | 1871 | 08281 | 15 |
| 4 0 | 4901 | 1866 | 48771 | 55618 | 2407 | 69139 | 75815 | 2436 | 89004 | 895517 | 1978 | 08388 | 16 |
| 15 | 5018 | 1982 | 48886 | 55731 | 2519 | 69251 | 75926 | 2546 | 89113 | 895625 | 2086 | 08494 | 17 |
| 30 | 5134 | 2097 | 49000 | 55845 | 2632 | 69362 | 76037 | 2656 | 89222 | 895734 | 2193 | 08600 | 18 |
| 45 | 5251 | 2213 | 49115 | 55959 | 2745 | 69474 | 76148 | 2766 | 89330 | 895842 | 2300 | 08707 | 19 |
| 5 0 | 5367 | 2328 | 49229 | 56072 | 2857 | 69586 | 76258 | 2876 | 89439 | 895950 | 2407 | 08813 | 20 |
| 15 | 5484 | 2444 | 49344 | 56186 | 2970 | 69697 | 76369 | 2986 | 89548 | 896058 | 2514 | 08919 | 21 |
| 30 | 5600 | 2559 | 49458 | 56299 | 3082 | 69809 | 76480 | 3096 | 89657 | 896166 | 2622 | 09026 | 22 |
| 45 | 5717 | 2675 | 49573 | 56413 | 3195 | 69921 | 76590 | 3205 | 89766 | 896274 | 2729 | 09132 | 23 |
| 6 0 | 5833 | 2790 | 49687 | 56526 | 3308 | 70032 | 76701 | 3315 | 89875 | 896382 | 2836 | 09238 | 24 |
| 15 | 5950 | 2905 | 49802 | 56640 | 3420 | 70144 | 76812 | 3425 | 89984 | 896490 | 2943 | 09345 | 25 |
| 30 | 6066 | 3021 | 49916 | 56753 | 3533 | 70255 | 76923 | 3535 | 90093 | 896598 | 3050 | 09451 | 26 |
| 45 | 6183 | 3136 | 50031 | 56867 | 3645 | 70367 | 77033 | 3644 | 90202 | 896706 | 3157 | 09557 | 27 |
| 7 0 | 6299 | 3251 | 50145 | 56980 | 3758 | 70479 | 77144 | 3754 | 90311 | 896814 | 3264 | 09663 | 28 |
| 15 | 6415 | 3367 | 50259 | 57094 | 3870 | 70590 | 77254 | 3864 | 90419 | 896922 | 3371 | 09770 | 29 |
| 30 | 6532 | 3482 | 50374 | 57207 | 3983 | 70702 | 77365 | 3974 | 90528 | 897030 | 3479 | 09876 | 30 |
| 45 | 6648 | 3598 | 50488 | 57320 | 4095 | 70813 | 77476 | 4083 | 90637 | 897137 | 3586 | 09982 | 31 |
| 8 0 | 6764 | 3713 | 50603 | 57434 | 4207 | 70925 | 77586 | 4193 | 90746 | 897245 | 3693 | 10088 | 32 |
| 15 | 6881 | 3828 | 50717 | 57547 | 4320 | 71036 | 77697 | 4303 | 90854 | 897353 | 3800 | 10194 | 33 |
| 30 | 6997 | 3944 | 50831 | 57660 | 4432 | 71148 | 77807 | 4412 | 90963 | 897461 | 3907 | 10301 | 34 |
| 45 | 7113 | 4059 | 50945 | 57774 | 4545 | 71259 | 77918 | 4522 | 91072 | 897569 | 4014 | 10407 | 35 |
| 9 0 | 7230 | 4174 | 51060 | 57887 | 4657 | 71370 | 78028 | 4632 | 91181 | 897677 | 4121 | 10513 | 36 |
| 15 | 7346 | 4289 | 51174 | 58000 | 4769 | 71482 | 78139 | 4741 | 91289 | 897785 | 4228 | 10619 | 37 |
| 30 | 7462 | 4405 | 51288 | 58114 | 4882 | 71593 | 78249 | 4851 | 91398 | 897892 | 4334 | 10725 | 38 |
| 45 | 7578 | 4520 | 51403 | 58227 | 4994 | 71705 | 78360 | 4960 | 91507 | 898000 | 4441 | 10831 | 39 |
| 10 0 | 7694 | 4635 | 51517 | 58340 | 5106 | 71816 | 78470 | 5070 | 91615 | 898108 | 4548 | 10937 | 40 |
| 15 | 7811 | 4750 | 51631 | 58453 | 5219 | 71927 | 78581 | 5179 | 91724 | 898216 | 4655 | 11043 | 41 |
| 30 | 7927 | 4865 | 51745 | 58567 | 5331 | 72039 | 78691 | 5289 | 91833 | 898324 | 4762 | 11149 | 42 |
| 45 | 8043 | 4981 | 51859 | 58680 | 5443 | 72150 | 78802 | 5398 | 91941 | 898431 | 4869 | 11255 | 43 |
| 11 0 | 8159 | 5096 | 51973 | 58793 | 5555 | 72261 | 78912 | 5508 | 92050 | 898539 | 4976 | 11361 | 44 |
| 15 | 8275 | 5211 | 52088 | 58906 | 5668 | 72373 | 79022 | 5617 | 92158 | 898647 | 5083 | 11467 | 45 |
| 30 | 8391 | 5326 | 52202 | 59019 | 5780 | 72484 | 79133 | 5727 | 92267 | 898754 | 5190 | 11573 | 46 |
| 45 | 8507 | 5441 | 52316 | 59132 | 5892 | 72595 | 79243 | 5836 | 92376 | 898862 | 5296 | 11679 | 47 |
| 12 0 | 8623 | 5556 | 52430 | 59246 | 6004 | 72706 | 79353 | 5946 | 92484 | 898970 | 5403 | 11785 | 48 |
| 15 | 8739 | 5671 | 52544 | 59359 | 6116 | 72818 | 79464 | 6055 | 92593 | 899077 | 5510 | 11891 | 49 |
| 30 | 8855 | 5786 | 52658 | 59472 | 6229 | 72929 | 79574 | 6164 | 92701 | 899185 | 5617 | 11997 | 50 |
| 45 | 8971 | 5901 | 52772 | 59585 | 6341 | 73040 | 79684 | 6274 | 92810 | 899293 | 5723 | 12103 | 51 |
| 13 0 | 9087 | 6016 | 52886 | 59698 | 6453 | 73151 | 79795 | 6383 | 92918 | 899400 | 5830 | 12209 | 52 |
| 15 | 9203 | 6131 | 53000 | 59811 | 6565 | 73262 | 79905 | 6492 | 93027 | 899508 | 5937 | 12315 | 53 |
| 30 | 9319 | 6246 | 53114 | 59924 | 6677 | 73374 | 80015 | 6602 | 93135 | 899615 | 6044 | 12421 | 54 |
| 45 | 9435 | 6361 | 53228 | 60037 | 6789 | 73485 | 80125 | 6711 | 93244 | 899723 | 6150 | 12526 | 55 |
| 14 0 | 9551 | 6476 | 53342 | 60150 | 6901 | 73596 | 80235 | 6821 | 93352 | 899831 | 6257 | 12632 | 56 |
| 15 | 9667 | 6591 | 53456 | 60263 | 7013 | 73707 | 80346 | 6930 | 93460 | 899938 | 6364 | 12738 | 57 |
| 30 | 9783 | 6706 | 53570 | 60376 | 7125 | 73818 | 80456 | 7039 | 93569 | 900046 | 6470 | 12844 | 58 |
| 45 | 9899 | 6821 | 53684 | 60489 | 7237 | 73929 | 80566 | 7148 | 93677 | 900153 | 6577 | 12950 | 59 |

| | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 116. | Parts | 8 | 15 | 23 | 31 | 39 | 46 | 54 | 62 | 68 | 77 | 85 | 93 | 100 | 108 | 116 |
| D. 106. | Parts | 7 | 14 | 21 | 29 | 36 | 43 | 49 | 56 | 63 | 71 | 78 | 85 | 92 | 99 | 106 |

## LOG. SINE SQUARE

| | 33° | | | 34° | | | | 35° | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | |
| | 2ʰ 13ᵐ | 2ʰ 14ᵐ | 2ʰ 15ᵐ | 2ʰ 16ᵐ | 2ʰ 17ᵐ | 2ʰ 18ᵐ | 2ʰ 19ᵐ | 2ʰ 20ᵐ | 2ʰ 21ᵐ | 2ʰ 22ᵐ | 2ʰ 23ᵐ | s. |
| ′ ″ | 8·9 | 8·9 | 8·9 | 8·9 | 8·9 | 8·9 | 8·9 | 8·9 | 8·9 | 8·9 | 8·9 | |
| 0 0 | 13055 | 19377 | 25648 | 31871 | 38045 | 44171 | 50251 | 56284 | 62271 | 68213 | 74111 | 0 |
| 15 | 13161 | 19482 | 25752 | 31974 | 38147 | 44273 | 50351 | 56384 | 62370 | 68312 | 74209 | 1 |
| 30 | 13267 | 19587 | 25856 | 32077 | 38250 | 44375 | 50452 | 56484 | 62470 | 68410 | 74307 | 2 |
| 45 | 13373 | 19691 | 25960 | 32181 | 38352 | 44476 | 50553 | 56584 | 62569 | 68509 | 74405 | 3 |
| 1 0 | 13478 | 19796 | 26065 | 32284 | 38455 | 44578 | 50654 | 56684 | 62668 | 68608 | 74502 | 4 |
| 15 | 13584 | 19901 | 26169 | 32387 | 38557 | 44680 | 50755 | 56784 | 62768 | 68706 | 74600 | 5 |
| 30 | 13690 | 20006 | 26273 | 32490 | 38660 | 44781 | 50856 | 56884 | 62867 | 68805 | 74698 | 6 |
| 45 | 13795 | 20111 | 26377 | 32593 | 38762 | 44883 | 50957 | 56984 | 62966 | 68903 | 74796 | 7 |
| 2 0 | 13901 | 20216 | 26481 | 32697 | 38864 | 44984 | 51058 | 57085 | 63066 | 69002 | 74894 | 8 |
| 15 | 14007 | 20321 | 26585 | 32800 | 38967 | 45086 | 51158 | 57185 | 63165 | 69101 | 74992 | 9 |
| 30 | 14112 | 20425 | 26689 | 32903 | 39069 | 45188 | 51259 | 57285 | 63264 | 69199 | 75090 | 10 |
| 45 | 14218 | 20530 | 26793 | 33006 | 39171 | 45289 | 51360 | 57385 | 63364 | 69298 | 75187 | 11 |
| 3 0 | 14324 | 20635 | 26897 | 33109 | 39274 | 45391 | 51461 | 57485 | 63463 | 69396 | 75285 | 12 |
| 15 | 14429 | 20740 | 27000 | 33212 | 39376 | 45492 | 51562 | 57585 | 63562 | 69495 | 75383 | 13 |
| 30 | 14535 | 20844 | 27104 | 33316 | 39479 | 45594 | 51662 | 57685 | 63661 | 69593 | 75481 | 14 |
| 45 | 14640 | 20949 | 27208 | 33419 | 39581 | 45695 | 51763 | 57785 | 63761 | 69692 | 75578 | 15 |
| 4 0 | 14746 | 21054 | 27312 | 33522 | 39683 | 45797 | 51864 | 57885 | 63860 | 69790 | 75676 | 16 |
| 15 | 14852 | 21159 | 27416 | 33625 | 39785 | 45898 | 51965 | 57985 | 63959 | 69889 | 75774 | 17 |
| 30 | 14957 | 21263 | 27520 | 33728 | 39888 | 46000 | 52065 | 58085 | 64058 | 69987 | 75872 | 18 |
| 45 | 15063 | 21368 | 27624 | 33831 | 39990 | 46101 | 52166 | 58185 | 64157 | 70086 | 75969 | 19 |
| 5 0 | 15168 | 21473 | 27728 | 33934 | 40092 | 46203 | 52267 | 58284 | 64257 | 70184 | 76067 | 20 |
| 15 | 15274 | 21577 | 27832 | 34037 | 40194 | 46304 | 52367 | 58384 | 64356 | 70282 | 76165 | 21 |
| 30 | 15379 | 21682 | 27935 | 34140 | 40297 | 46406 | 52468 | 58484 | 64455 | 70381 | 76262 | 22 |
| 45 | 15484 | 21787 | 28039 | 34243 | 40399 | 46507 | 52569 | 58584 | 64554 | 70479 | 76360 | 23 |
| 6 0 | 15590 | 21891 | 28143 | 34346 | 40501 | 46609 | 52669 | 58684 | 64653 | 70578 | 76458 | 24 |
| 15 | 15695 | 21996 | 28247 | 34449 | 40603 | 46710 | 52770 | 58784 | 64752 | 70676 | 76555 | 25 |
| 30 | 15801 | 22100 | 28351 | 34552 | 40705 | 46811 | 52871 | 58884 | 64851 | 70774 | 76653 | 26 |
| 45 | 15906 | 22205 | 28454 | 34655 | 40807 | 46915 | 52971 | 58984 | 64950 | 70873 | 76750 | 27 |
| 7 0 | 16012 | 22310 | 28558 | 34758 | 40910 | 47014 | 53072 | 59083 | 65050 | 70971 | 76848 | 28 |
| 15 | 16117 | 22414 | 28662 | 34861 | 41012 | 47115 | 53172 | 59183 | 65149 | 71069 | 76946 | 29 |
| 30 | 16222 | 22519 | 28766 | 34964 | 41114 | 47217 | 53273 | 59283 | 65248 | 71168 | 77043 | 30 |
| 45 | 16328 | 22623 | 28869 | 35067 | 41216 | 47318 | 53373 | 59383 | 65347 | 71266 | 77141 | 31 |
| 8 0 | 16433 | 22728 | 28973 | 35170 | 41318 | 47419 | 53474 | 59482 | 65446 | 71364 | 77238 | 32 |
| 15 | 16538 | 22832 | 29077 | 35272 | 41420 | 47521 | 53574 | 59582 | 65545 | 71462 | 77336 | 33 |
| 30 | 16644 | 22937 | 29180 | 35375 | 41522 | 47622 | 53675 | 59682 | 65644 | 71561 | 77433 | 34 |
| 45 | 16749 | 23041 | 29284 | 35478 | 41624 | 47723 | 53775 | 59782 | 65743 | 71659 | 77531 | 35 |
| 9 0 | 16854 | 23146 | 29388 | 35581 | 41726 | 47824 | 53876 | 59881 | 65842 | 71757 | 77628 | 36 |
| 15 | 16959 | 23250 | 29491 | 35684 | 41828 | 47926 | 53976 | 59981 | 65941 | 71855 | 77726 | 37 |
| 30 | 17065 | 23354 | 29595 | 35787 | 41930 | 48027 | 54077 | 60081 | 66040 | 71953 | 77823 | 38 |
| 45 | 17170 | 23459 | 29698 | 35889 | 42032 | 48128 | 54177 | 60180 | 66138 | 72052 | 77921 | 39 |
| 10 0 | 17275 | 23563 | 29802 | 35992 | 42134 | 48229 | 54278 | 60280 | 66237 | 72150 | 78018 | 40 |
| 15 | 17380 | 23668 | 29905 | 36095 | 42236 | 48330 | 54378 | 60380 | 66336 | 72248 | 78116 | 41 |
| 30 | 17486 | 23772 | 30009 | 36198 | 42338 | 48432 | 54479 | 60479 | 66435 | 72346 | 78213 | 42 |
| 45 | 17591 | 23876 | 30113 | 36300 | 42440 | 48533 | 54579 | 60579 | 66534 | 72444 | 78311 | 43 |
| 11 0 | 17696 | 23981 | 30216 | 36403 | 42542 | 48634 | 54679 | 60679 | 66633 | 72542 | 78408 | 44 |
| 15 | 17801 | 24085 | 30320 | 36506 | 42644 | 48735 | 54780 | 60778 | 66732 | 72641 | 78505 | 45 |
| 30 | 17906 | 24189 | 30423 | 36608 | 42746 | 48836 | 54880 | 60878 | 66831 | 72739 | 78603 | 46 |
| 45 | 18011 | 24294 | 30527 | 36711 | 42848 | 48937 | 54980 | 60977 | 66929 | 72837 | 78700 | 47 |
| 12 0 | 18116 | 24398 | 30630 | 36814 | 42950 | 49038 | 55081 | 61077 | 67028 | 72935 | 78797 | 48 |
| 15 | 18221 | 24502 | 30734 | 36916 | 43052 | 49139 | 55181 | 61177 | 67127 | 73033 | 78895 | 49 |
| 30 | 18327 | 24606 | 30837 | 37019 | 43153 | 49241 | 55281 | 61276 | 67226 | 73131 | 78992 | 50 |
| 45 | 18432 | 24711 | 30940 | 37122 | 43255 | 49342 | 55382 | 61376 | 67325 | 73229 | 79089 | 51 |
| 13 0 | 18537 | 24815 | 31044 | 37224 | 43357 | 49443 | 55482 | 61475 | 67423 | 73327 | 79187 | 52 |
| 15 | 18642 | 24919 | 31147 | 37327 | 43459 | 49544 | 55582 | 61575 | 67522 | 73425 | 79284 | 53 |
| 30 | 18747 | 25023 | 31251 | 37430 | 43561 | 49645 | 55682 | 61674 | 67621 | 73523 | 79381 | 54 |
| 45 | 18852 | 25127 | 31354 | 37532 | 43662 | 49746 | 55783 | 61774 | 67720 | 73621 | 79479 | 55 |
| 14 0 | 18957 | 25232 | 31457 | 37635 | 43764 | 49847 | 55883 | 61873 | 67818 | 73719 | 79576 | 56 |
| 15 | 19062 | 25336 | 31561 | 37737 | 43866 | 49948 | 55983 | 61973 | 67917 | 73817 | 79673 | 57 |
| 30 | 19167 | 25440 | 31664 | 37840 | 43968 | 50049 | 56083 | 62072 | 68016 | 73915 | 79770 | 58 |
| 45 | 19272 | 25544 | 31767 | 37942 | 44069 | 50150 | 56183 | 62171 | 68114 | 74013 | 79868 | 59 |

| | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 105. | Parts | 7 | 14 | 21 | 28 | 35 | 42 | 49 | 56 | 63 | 70 | 77 | 84 | 91 | 98 | 105 |
| D. 97. | Parts | 6 | 13 | 19 | 26 | 32 | 39 | 45 | 52 | 58 | 65 | 71 | 78 | 84 | 91 | 97 |

## LOG. SINE SQUARE

| | 36° | | | | 37° | | | | 38° | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | |
| ′ ″ | 2h 24m | 2h 25m | 2h 26m | 2h 27m | 2h 28m | 2h 29m | 2h 30m | 2h 31m | 2h 32m | 2h 33m | 2h 34m | s. |
| | 8·9 | 8·9 | 8·9 | | 9·0 | 9·0 | 9·0 | 9·0 | 9·0 | 9·0 | 9·0 | |
| 0 0 | 79965 | 85775 | 91543 | 8·997269 | 02953 | 08596 | 14198 | 19761 | 25284 | 30768 | 36213 | 0 |
| 15 | 80062 | 85872 | 91639 | 8·997364 | 03047 | 08690 | 14291 | 19853 | 25375 | 30859 | 36304 | 1 |
| 30 | 80159 | 85968 | 91735 | 8·997459 | 03142 | 08783 | 14384 | 19946 | 25467 | 30950 | 36394 | 2 |
| 45 | 80256 | 86065 | 91830 | 8·997554 | 03236 | 08877 | 14477 | 20038 | 25559 | 31041 | 36485 | 3 |
| 1 0 | 80353 | 86161 | 91926 | 8·997649 | 03330 | 08971 | 14570 | 20130 | 25651 | 31132 | 36575 | 4 |
| 15 | 80451 | 86258 | 92022 | 8·997744 | 03425 | 09064 | 14663 | 20223 | 25742 | 31223 | 36665 | 5 |
| 30 | 80548 | 86354 | 92118 | 8·997839 | 03519 | 09158 | 14757 | 20315 | 25834 | 31314 | 36756 | 6 |
| 45 | 80645 | 86450 | 92213 | 8·997934 | 03613 | 09252 | 14849 | 20407 | 25926 | 31405 | 36846 | 7 |
| 2 0 | 80742 | 86547 | 92309 | 8·998029 | 03708 | 09345 | 14942 | 20500 | 26017 | 31496 | 36936 | 8 |
| 15 | 80839 | 86643 | 92405 | 8·998124 | 03802 | 09439 | 15035 | 20592 | 26109 | 31587 | 37027 | 9 |
| 30 | 80936 | 86740 | 92500 | 8·998219 | 03896 | 09532 | 15128 | 20684 | 26201 | 31678 | 37117 | 10 |
| 45 | 81033 | 86836 | 92596 | 8·998314 | 03990 | 09626 | 15221 | 20776 | 26292 | 31769 | 37207 | 11 |
| 3 0 | 81130 | 86932 | 92692 | 8·998409 | 04085 | 09720 | 15314 | 20869 | 26384 | 31860 | 37298 | 12 |
| 15 | 81227 | 87029 | 92787 | 8·998504 | 04179 | 09813 | 15407 | 20961 | 26475 | 31951 | 37388 | 13 |
| 30 | 81324 | 87125 | 92883 | 8·998599 | 04273 | 09907 | 15500 | 21053 | 26567 | 32042 | 37478 | 14 |
| 45 | 81421 | 87221 | 92978 | 8·998694 | 04367 | 10000 | 15593 | 21145 | 26658 | 32133 | 37569 | 15 |
| 4 0 | 81518 | 87318 | 93074 | 8·998789 | 04462 | 10094 | 15686 | 21237 | 26750 | 32224 | 37659 | 16 |
| 15 | 81615 | 87414 | 93170 | 8·998883 | 04556 | 10187 | 15778 | 21330 | 26842 | 32315 | 37749 | 17 |
| 30 | 81712 | 87510 | 93265 | 8·998978 | 04650 | 10281 | 15871 | 21422 | 26933 | 32405 | 37839 | 18 |
| 45 | 81809 | 87606 | 93361 | 8·999073 | 04744 | 10374 | 15964 | 21514 | 27025 | 32496 | 37930 | 19 |
| 5 0 | 81906 | 87703 | 93456 | 8·999168 | 04838 | 10468 | 16057 | 21606 | 27116 | 32587 | 38020 | 20 |
| 15 | 82003 | 87799 | 93552 | 8·999263 | 04933 | 10561 | 16150 | 21698 | 27208 | 32678 | 38110 | 21 |
| 30 | 82100 | 87895 | 93647 | 8·999358 | 05027 | 10654 | 16243 | 21791 | 27299 | 32769 | 38200 | 22 |
| 45 | 82197 | 87991 | 93743 | 8·999453 | 05121 | 10748 | 16335 | 21883 | 27391 | 32860 | 38291 | 23 |
| 6 0 | 82294 | 88088 | 93838 | 8·999547 | 05215 | 10842 | 16428 | 21975 | 27482 | 32951 | 38381 | 24 |
| 15 | 82391 | 88184 | 93934 | 8·999642 | 05309 | 10935 | 16521 | 22067 | 27574 | 33041 | 38471 | 25 |
| 30 | 82488 | 88280 | 94029 | 8·999737 | 05403 | 11029 | 16614 | 22159 | 27665 | 33132 | 38561 | 26 |
| 45 | 82585 | 88376 | 94125 | 8·999832 | 05497 | 11122 | 16706 | 22251 | 27756 | 33223 | 38651 | 27 |
| 7 0 | 82682 | 88472 | 94220 | 8·999927 | 05591 | 11215 | 16799 | 22343 | 27848 | 33314 | 38741 | 28 |
| 15 | 82779 | 88568 | 94316 | 9·000021 | 05685 | 11309 | 16893 | 22435 | 27939 | 33405 | 38832 | 29 |
| 30 | 82875 | 88665 | 94411 | 9·000116 | 05780 | 11402 | 16985 | 22527 | 28031 | 33495 | 38922 | 30 |
| 45 | 82972 | 88761 | 94507 | 9·000211 | 05874 | 11496 | 17077 | 22619 | 28122 | 33586 | 39012 | 31 |
| 8 0 | 83069 | 88857 | 94602 | 9·000305 | 05968 | 11589 | 17170 | 22711 | 28213 | 33677 | 39102 | 32 |
| 15 | 83166 | 88953 | 94697 | 9·000400 | 06062 | 11682 | 17263 | 22803 | 28305 | 33768 | 39192 | 33 |
| 30 | 83263 | 89049 | 94793 | 9·000495 | 06156 | 11776 | 17355 | 22895 | 28396 | 33858 | 39282 | 34 |
| 45 | 83359 | 89145 | 94888 | 9·000590 | 06250 | 11869 | 17448 | 22987 | 28488 | 33949 | 39372 | 35 |
| 9 0 | 83456 | 89241 | 94984 | 9·000684 | 06344 | 11962 | 17541 | 23079 | 28579 | 34040 | 39462 | 36 |
| 15 | 83553 | 89337 | 95079 | 9·000779 | 06438 | 12055 | 17633 | 23171 | 28670 | 34130 | 39552 | 37 |
| 30 | 83650 | 89433 | 95174 | 9·000874 | 06532 | 12149 | 17726 | 23263 | 28762 | 34221 | 39642 | 38 |
| 45 | 83746 | 89529 | 95269 | 9·000968 | 06625 | 12242 | 17819 | 23355 | 28853 | 34312 | 39732 | 39 |
| 10 0 | 83843 | 89625 | 95365 | 9·001063 | 06719 | 12335 | 17911 | 23447 | 28944 | 34402 | 39822 | 40 |
| 15 | 83940 | 89721 | 95460 | 9·001157 | 06813 | 12429 | 18004 | 23539 | 29035 | 34493 | 39912 | 41 |
| 30 | 84037 | 89817 | 95555 | 9·001252 | 06907 | 12522 | 18096 | 23631 | 29127 | 34584 | 40002 | 42 |
| 45 | 84133 | 89913 | 95651 | 9·001347 | 07001 | 12615 | 18189 | 23723 | 29218 | 34674 | 40092 | 43 |
| 11 0 | 84230 | 90009 | 95746 | 9·001441 | 07095 | 12708 | 18281 | 23815 | 29309 | 34765 | 40182 | 44 |
| 15 | 84327 | 90105 | 95841 | 9·001536 | 07189 | 12802 | 18374 | 23907 | 29400 | 34855 | 40272 | 45 |
| 30 | 84423 | 90201 | 95937 | 9·001630 | 07283 | 12895 | 18467 | 23999 | 29492 | 34946 | 40362 | 46 |
| 45 | 84520 | 90297 | 96032 | 9·001725 | 07377 | 12988 | 18559 | 24091 | 29583 | 35037 | 40452 | 47 |
| 12 0 | 84617 | 90393 | 96127 | 9·001819 | 07471 | 13081 | 18652 | 24182 | 29674 | 35127 | 40542 | 48 |
| 15 | 84713 | 90489 | 96222 | 9·001914 | 07564 | 13174 | 18744 | 24274 | 29765 | 35218 | 40632 | 49 |
| 30 | 84810 | 90585 | 96317 | 9·002008 | 07658 | 13267 | 18837 | 24366 | 29856 | 35308 | 40722 | 50 |
| 45 | 84906 | 90681 | 96413 | 9·002103 | 07752 | 13361 | 18929 | 24458 | 29948 | 35399 | 40812 | 51 |
| 13 0 | 85003 | 90777 | 96508 | 9·002197 | 07846 | 13454 | 19021 | 24550 | 30039 | 35489 | 40902 | 52 |
| 15 | 85100 | 90872 | 96603 | 9·002292 | 07940 | 13547 | 19114 | 24642 | 30130 | 35580 | 40992 | 53 |
| 30 | 85196 | 90968 | 96698 | 9·002386 | 08033 | 13640 | 19206 | 24733 | 30221 | 35670 | 41082 | 54 |
| 45 | 85293 | 91064 | 96793 | 9·002481 | 08127 | 13733 | 19299 | 24825 | 30312 | 35761 | 41171 | 55 |
| 14 0 | 85389 | 91160 | 96888 | 9·002575 | 08221 | 13826 | 19391 | 24917 | 30403 | 35851 | 41261 | 56 |
| 15 | 85486 | 91256 | 96983 | 9·002670 | 08315 | 13919 | 19484 | 25009 | 30495 | 35942 | 41351 | 57 |
| 30 | 85582 | 91352 | 97079 | 9·002764 | 08408 | 14012 | 19576 | 25100 | 30586 | 36032 | 41441 | 58 |
| 45 | 85679 | 91447 | 97174 | 9·002858 | 08502 | 14105 | 19668 | 25192 | 30677 | 36123 | 41531 | 59 |

| | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 97. | Parts | 6 | 13 | 19 | 26 | 32 | 39 | 45 | 52 | 58 | 65 | 71 | 78 | 84 | 91 | 97 |
| D. 90. | Parts | 6 | 12 | 18 | 24 | 30 | 36 | 42 | 48 | 54 | 60 | 66 | 72 | 78 | 84 | 90 |

## LOG. SINE SQUARE

| | 38° | 39° | | | | 40° | | | | 41° | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | |
| | $2^h\,35^m$ | $2^h\,36^m$ | $2^h\,37^m$ | $2^h\,38^m$ | $2^h\,39^m$ | $2^h\,40^m$ | $2^h\,41^m$ | $2^h\,42^m$ | $2^h\,43^m$ | $2^h\,44^m$ | $2^h\,45^m$ | s. |
| ′ ″ | 9·0 | 9·0 | 9·0 | 9·0 | 9·0 | 9·0 | 9·0 | 9·0 | 9·0 | 9·0 | 9·0 | |
| 0 0 | 41621 | 46991 | 52323 | 57619 | 62879 | 68103 | 73292 | 78446 | 83565 | 88651 | 93702 | 0 |
| 15 | 41710 | 47080 | 52412 | 57707 | 62967 | 68190 | 73378 | 78532 | 83650 | 88735 | 93786 | 1 |
| 30 | 41800 | 47169 | 52500 | 57795 | 63054 | 68277 | 73465 | 78617 | 83735 | 88819 | 93870 | 2 |
| 45 | 41890 | 47258 | 52589 | 57883 | 63141 | 68364 | 73551 | 78703 | 83820 | 88904 | 93954 | 3 |
| 1 0 | 41980 | 47347 | 52677 | 57971 | 63229 | 68450 | 73637 | 78788 | 83905 | 88988 | 94038 | 4 |
| 15 | 42070 | 47436 | 52766 | 58059 | 63316 | 68537 | 73723 | 78874 | 83990 | 89073 | 94122 | 5 |
| 30 | 42159 | 47525 | 52855 | 58147 | 63403 | 68624 | 73809 | 78960 | 84075 | 89157 | 94205 | 6 |
| 45 | 42249 | 47615 | 52943 | 58235 | 63491 | 68710 | 73895 | 79045 | 84160 | 89242 | 94289 | 7 |
| 2 0 | 42339 | 47704 | 53032 | 58323 | 63578 | 68797 | 73981 | 79131 | 84245 | 89326 | 94373 | 8 |
| 15 | 42428 | 47793 | 53120 | 58411 | 63665 | 68884 | 74067 | 79216 | 84330 | 89410 | 94457 | 9 |
| 30 | 42518 | 47882 | 53208 | 58499 | 63752 | 68971 | 74154 | 79302 | 84415 | 89495 | 94541 | 10 |
| 45 | 42608 | 47971 | 53297 | 58586 | 63840 | 69057 | 74240 | 79387 | 84500 | 89579 | 94625 | 11 |
| 3 0 | 42698 | 48060 | 53385 | 58674 | 63927 | 69144 | 74326 | 79473 | 84585 | 89664 | 94708 | 12 |
| 15 | 42787 | 48149 | 53474 | 58762 | 64014 | 69231 | 74412 | 79558 | 84670 | 89748 | 94792 | 13 |
| 30 | 42877 | 48238 | 53562 | 58850 | 64101 | 69317 | 74498 | 79644 | 84755 | 89832 | 94876 | 14 |
| 45 | 42967 | 48327 | 53651 | 58938 | 64189 | 69404 | 74584 | 79729 | 84840 | 89917 | 94960 | 15 |
| 4 0 | 43056 | 48416 | 53739 | 59025 | 64276 | 69490 | 74670 | 79815 | 84925 | 90001 | 95044 | 16 |
| 15 | 43146 | 48505 | 53828 | 59113 | 64363 | 69577 | 74756 | 79900 | 85010 | 90085 | 95127 | 17 |
| 30 | 43236 | 48594 | 53916 | 59201 | 64450 | 69664 | 74842 | 79985 | 85094 | 90170 | 95211 | 18 |
| 45 | 43325 | 48683 | 54004 | 59289 | 64537 | 69750 | 74928 | 80071 | 85179 | 90254 | 95295 | 19 |
| 5 0 | 43415 | 48772 | 54093 | 59377 | 64625 | 69837 | 75014 | 80156 | 85264 | 90338 | 95379 | 20 |
| 15 | 43504 | 48861 | 54181 | 59464 | 64712 | 69923 | 75100 | 80242 | 85349 | 90422 | 95462 | 21 |
| 30 | 43594 | 48950 | 54269 | 59552 | 64799 | 70010 | 75186 | 80327 | 85434 | 90507 | 95546 | 22 |
| 45 | 43684 | 49039 | 54358 | 59640 | 64886 | 70107 | 75272 | 80412 | 85519 | 90591 | 95630 | 23 |
| 6 0 | 43773 | 49128 | 54446 | 59728 | 64973 | 70183 | 75358 | 80498 | 85603 | 90675 | 95713 | 24 |
| 15 | 43863 | 49217 | 54534 | 59815 | 65060 | 70270 | 75444 | 80583 | 85688 | 90759 | 95797 | 25 |
| 30 | 43952 | 49306 | 54623 | 59903 | 65147 | 70356 | 75530 | 80669 | 85773 | 90844 | 95881 | 26 |
| 45 | 44042 | 49395 | 54711 | 59991 | 65234 | 70443 | 75616 | 80754 | 85858 | 90928 | 95964 | 27 |
| 7 0 | 44131 | 49484 | 54799 | 60079 | 65322 | 70529 | 75702 | 80839 | 85943 | 91012 | 96048 | 28 |
| 15 | 44221 | 49573 | 54888 | 60166 | 65409 | 70616 | 75787 | 80925 | 86027 | 91096 | 96132 | 29 |
| 30 | 44310 | 49662 | 54976 | 60254 | 65496 | 70702 | 75873 | 81010 | 86112 | 91181 | 96215 | 30 |
| 45 | 44400 | 49750 | 55064 | 60341 | 65583 | 70789 | 75959 | 81095 | 86197 | 91265 | 96299 | 31 |
| 8 0 | 44489 | 49839 | 55152 | 60429 | 65670 | 70875 | 76045 | 81181 | 86282 | 91349 | 96383 | 32 |
| 15 | 44579 | 49928 | 55241 | 60517 | 65757 | 70961 | 76131 | 81266 | 86366 | 91433 | 96466 | 33 |
| 30 | 44668 | 50017 | 55329 | 60604 | 65844 | 71048 | 76217 | 81351 | 86451 | 91517 | 96550 | 34 |
| 45 | 44758 | 50106 | 55417 | 60692 | 65931 | 71134 | 76303 | 81436 | 86536 | 91601 | 96633 | 35 |
| 9 0 | 44847 | 50195 | 55505 | 60780 | 66018 | 71221 | 76389 | 81522 | 86621 | 91685 | 96717 | 36 |
| 15 | 44936 | 50283 | 55593 | 60867 | 66105 | 71307 | 76474 | 81607 | 86705 | 91770 | 96801 | 37 |
| 30 | 45026 | 50372 | 55682 | 60955 | 66192 | 71394 | 76560 | 81692 | 86790 | 91854 | 96884 | 38 |
| 45 | 45115 | 50461 | 55770 | 61042 | 66279 | 71480 | 76646 | 81778 | 86875 | 91938 | 96968 | 39 |
| 10 0 | 45205 | 50550 | 55858 | 61130 | 66366 | 71566 | 76732 | 81863 | 86959 | 92022 | 97051 | 40 |
| 15 | 45294 | 50639 | 55946 | 61218 | 66453 | 71653 | 76818 | 81948 | 87044 | 92106 | 97135 | 41 |
| 30 | 45383 | 50727 | 56034 | 61305 | 66540 | 71739 | 76903 | 82033 | 87128 | 92190 | 97218 | 42 |
| 45 | 45473 | 50816 | 56122 | 61393 | 66627 | 71826 | 76989 | 82118 | 87213 | 92274 | 97302 | 43 |
| 11 0 | 45562 | 50905 | 56211 | 61480 | 66714 | 71912 | 77075 | 82203 | 87298 | 92358 | 97385 | 44 |
| 15 | 45652 | 50994 | 56299 | 61568 | 66801 | 71998 | 77161 | 82289 | 87382 | 92442 | 97469 | 45 |
| 30 | 45741 | 51082 | 56387 | 61655 | 66888 | 72085 | 77247 | 82374 | 87467 | 92526 | 97552 | 46 |
| 45 | 45830 | 51171 | 56475 | 61743 | 66974 | 72171 | 77332 | 82459 | 87552 | 92610 | 97636 | 47 |
| 12 0 | 45920 | 51260 | 56563 | 61830 | 67061 | 72257 | 77418 | 82544 | 87636 | 92694 | 97719 | 48 |
| 15 | 46009 | 51348 | 56651 | 61918 | 67148 | 72343 | 77504 | 82629 | 87721 | 92778 | 97803 | 49 |
| 30 | 46098 | 51437 | 56739 | 62015 | 67235 | 72430 | 77589 | 82714 | 87805 | 92862 | 97886 | 50 |
| 45 | 46187 | 51526 | 56827 | 62093 | 67322 | 72516 | 77675 | 82800 | 87890 | 92946 | 97970 | 51 |
| 13 0 | 46277 | 51614 | 56915 | 62180 | 67409 | 72602 | 77761 | 82885 | 87975 | 93030 | 98053 | 52 |
| 15 | 46366 | 51703 | 57003 | 62267 | 67496 | 72689 | 77846 | 82970 | 88059 | 93114 | 98137 | 53 |
| 30 | 46455 | 51792 | 57091 | 62355 | 67583 | 72775 | 77932 | 83055 | 88144 | 93198 | 98220 | 54 |
| 45 | 46544 | 51880 | 57179 | 62442 | 67669 | 72861 | 78018 | 83140 | 88228 | 93282 | 98303 | 55 |
| 14 0 | 46634 | 51969 | 57267 | 62530 | 67756 | 72947 | 78103 | 83225 | 88313 | 93366 | 98387 | 56 |
| 15 | 46723 | 52057 | 57355 | 62617 | 67843 | 73034 | 78189 | 83310 | 88397 | 93450 | 98470 | 57 |
| 30 | 46812 | 52146 | 57443 | 62704 | 67930 | 73120 | 78275 | 83395 | 88482 | 93534 | 98554 | 58 |
| 45 | 46901 | 52235 | 57531 | 62792 | 68017 | 73206 | 78360 | 83480 | 88566 | 93618 | 98637 | 59 |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
| D. 90. | Parts | 6 | 12 | 18 | 24 | 30 | 36 | 42 | 48 | 54 | 60 | 66 | 72 | 78 | 84 | 90 |
| D. 84. | Parts | 6 | 11 | 17 | 22 | 28 | 34 | 39 | 45 | 50 | 56 | 62 | 67 | 73 | 78 | 84 |

## LOG. SINE SQUARE

| | | 41° | | 42° | | | | 43° | | | | 44° | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | |
| ′ | ″ | 2h 46m | 2h 47m | 2h 48m | 2h 49m | 2h 50m | 2h 51m | 2h 52m | 2h 53m | 2h 54m | 2h 55m | 2h 56m | s. |
| | | 9· | 9·1 | 9·1 | 9·1 | 9·1 | 9·1 | 9·1 | 9·1 | 9·1 | 9·1 | 9·1 | |
| 0 | 0 | 098720 | 03706 | 08658 | 13579 | 18468 | 23325 | 28151 | 32946 | 37711 | 42446 | 47151 | 0 |
| | 15 | 098804 | 03788 | 08741 | 13661 | 18549 | 23405 | 28231 | 33026 | 37790 | 42524 | 47229 | 1 |
| | 30 | 098887 | 03871 | 08823 | 13742 | 18630 | 23486 | 28311 | 33105 | 37869 | 42603 | 47307 | 2 |
| | 45 | 098970 | 03954 | 08905 | 13824 | 18711 | 23567 | 28391 | 33185 | 37948 | 42682 | 47385 | 3 |
| 1 | 0 | 099054 | 04037 | 08987 | 13906 | 18792 | 23647 | 28471 | 33265 | 38028 | 42760 | 47463 | 4 |
| | 15 | 099137 | 04120 | 09070 | 13987 | 18873 | 23728 | 28552 | 33344 | 38107 | 42839 | 47542 | 5 |
| | 30 | 099220 | 04202 | 09152 | 14069 | 18955 | 23809 | 28632 | 33424 | 38186 | 42918 | 47620 | 6 |
| | 45 | 099304 | 04285 | 09234 | 14151 | 19036 | 23889 | 28712 | 33504 | 38265 | 42996 | 47698 | 7 |
| 2 | 0 | 099387 | 04368 | 09316 | 14232 | 19117 | 23970 | 28792 | 33583 | 38344 | 43075 | 47776 | 8 |
| | 15 | 099470 | 04451 | 09398 | 14314 | 19198 | 24051 | 28872 | 33663 | 38423 | 43153 | 47854 | 9 |
| | 30 | 099553 | 04533 | 09481 | 14396 | 19279 | 24131 | 28952 | 33742 | 38502 | 43232 | 47932 | 10 |
| | 45 | 099637 | 04616 | 09563 | 14477 | 19360 | 24212 | 29032 | 33822 | 38581 | 43311 | 48010 | 11 |
| 3 | 0 | 099720 | 04699 | 09645 | 14559 | 19441 | 24292 | 29112 | 33902 | 38660 | 43389 | 48088 | 12 |
| | 15 | 099803 | 04781 | 09727 | 14641 | 19523 | 24373 | 29192 | 33981 | 38739 | 43468 | 48166 | 13 |
| | 30 | 099886 | 04864 | 09809 | 14722 | 19604 | 24454 | 29272 | 34061 | 38819 | 43546 | 48244 | 14 |
| | 45 | 099970 | 04947 | 09891 | 14804 | 19685 | 24534 | 29353 | 34140 | 38898 | 43625 | 48322 | 15 |
| 4 | 0 | 100053 | 05030 | 09974 | 14886 | 19766 | 24615 | 29433 | 34220 | 38977 | 43703 | 48401 | 16 |
| | 15 | 100136 | 05112 | 10055 | 14967 | 19847 | 24695 | 29513 | 34299 | 39056 | 43782 | 48479 | 17 |
| | 30 | 100219 | 05195 | 10138 | 15049 | 19928 | 24776 | 29593 | 34379 | 39135 | 43860 | 48557 | 18 |
| | 45 | 100303 | 05277 | 10220 | 15130 | 20009 | 24856 | 29673 | 34458 | 39214 | 43939 | 48635 | 19 |
| 5 | 0 | 100386 | 05360 | 10302 | 15212 | 20090 | 24937 | 29753 | 34538 | 39293 | 44018 | 48713 | 20 |
| | 15 | 100469 | 05443 | 10384 | 15293 | 20171 | 25017 | 29833 | 34617 | 39372 | 44096 | 48791 | 21 |
| | 30 | 100552 | 05525 | 10466 | 15375 | 20252 | 25098 | 29913 | 34697 | 39451 | 44174 | 48869 | 22 |
| | 45 | 100635 | 05608 | 10548 | 15457 | 20333 | 25178 | 29993 | 34776 | 39530 | 44253 | 48947 | 23 |
| 6 | 0 | 100718 | 05691 | 10630 | 15538 | 20414 | 25259 | 30073 | 34856 | 39609 | 44331 | 49025 | 24 |
| | 15 | 100801 | 05773 | 10712 | 15620 | 20495 | 25339 | 30153 | 34935 | 39688 | 44410 | 49102 | 25 |
| | 30 | 100885 | 05856 | 10794 | 15701 | 20576 | 25420 | 30233 | 35015 | 39766 | 44488 | 49180 | 26 |
| | 45 | 100968 | 05938 | 10877 | 15783 | 20657 | 25500 | 30313 | 35094 | 39845 | 44567 | 49258 | 27 |
| 7 | 0 | 101051 | 06021 | 10959 | 15864 | 20738 | 25581 | 30393 | 35174 | 39924 | 44645 | 49336 | 28 |
| | 15 | 101134 | 06103 | 11041 | 15946 | 20819 | 25661 | 30472 | 35253 | 40003 | 44724 | 49414 | 29 |
| | 30 | 101217 | 06186 | 11123 | 16027 | 20900 | 25742 | 30552 | 35332 | 40082 | 44802 | 49492 | 30 |
| | 45 | 101300 | 06269 | 11205 | 16109 | 20981 | 25822 | 30632 | 35412 | 40161 | 44880 | 49570 | 31 |
| 8 | 0 | 101383 | 06351 | 11287 | 16190 | 21062 | 25902 | 30712 | 35491 | 40240 | 44959 | 49648 | 32 |
| | 15 | 101466 | 06434 | 11369 | 16272 | 21143 | 25983 | 30792 | 35571 | 40319 | 45037 | 49726 | 33 |
| | 30 | 101549 | 06516 | 11451 | 16353 | 21224 | 26063 | 30872 | 35650 | 40398 | 45116 | 49804 | 34 |
| | 45 | 101632 | 06599 | 11533 | 16434 | 21305 | 26144 | 30952 | 35729 | 40477 | 45194 | 49882 | 35 |
| 9 | 0 | 101715 | 06681 | 11614 | 16516 | 21385 | 26224 | 31032 | 35809 | 40556 | 45272 | 49960 | 36 |
| | 15 | 101798 | 06764 | 11696 | 16597 | 21466 | 26305 | 31112 | 35888 | 40634 | 45351 | 50038 | 37 |
| | 30 | 101881 | 06846 | 11778 | 16679 | 21547 | 26385 | 31191 | 35967 | 40713 | 45429 | 50115 | 38 |
| | 45 | 101964 | 06929 | 11860 | 16760 | 21628 | 26465 | 31271 | 36047 | 40792 | 45507 | 50193 | 39 |
| 10 | 0 | 102047 | 07011 | 11942 | 16841 | 21709 | 26546 | 31351 | 36126 | 40871 | 45586 | 50271 | 40 |
| | 15 | 102130 | 07093 | 12024 | 16923 | 21790 | 26626 | 31431 | 36205 | 40950 | 45664 | 50349 | 41 |
| | 30 | 102213 | 07176 | 12106 | 17004 | 21871 | 26706 | 31511 | 36285 | 41029 | 45742 | 50427 | 42 |
| | 45 | 102296 | 07258 | 12188 | 17086 | 21952 | 26787 | 31591 | 36364 | 41107 | 45821 | 50505 | 43 |
| 11 | 0 | 102379 | 07341 | 12270 | 17167 | 22033 | 26867 | 31670 | 36443 | 41186 | 45899 | 50582 | 44 |
| | 15 | 102462 | 07423 | 12352 | 17248 | 22113 | 26947 | 31750 | 36523 | 41265 | 45977 | 50660 | 45 |
| | 30 | 102545 | 07506 | 12434 | 17330 | 22194 | 27028 | 31830 | 36602 | 41344 | 46056 | 50738 | 46 |
| | 45 | 102628 | 07588 | 12515 | 17411 | 22275 | 27108 | 31910 | 36681 | 41423 | 46134 | 50816 | 47 |
| 12 | 0 | 102781 | 07670 | 12597 | 17492 | 22356 | 27188 | 31990 | 36761 | 41501 | 46212 | 50894 | 48 |
| | 15 | 102794 | 07753 | 12679 | 17574 | 22437 | 27268 | 32069 | 36840 | 41580 | 46290 | 50971 | 49 |
| | 30 | 102877 | 07835 | 12761 | 17655 | 22517 | 27349 | 32149 | 36919 | 41659 | 46369 | 51049 | 50 |
| | 45 | 102960 | 07917 | 12843 | 17736 | 22598 | 27429 | 32229 | 36998 | 41738 | 46447 | 51127 | 51 |
| 13 | 0 | 103043 | 08000 | 12925 | 17818 | 22679 | 27509 | 32309 | 37077 | 41816 | 46525 | 51205 | 52 |
| | 15 | 103126 | 08082 | 13006 | 17899 | 22759 | 27589 | 32388 | 37157 | 41895 | 46603 | 51282 | 53 |
| | 30 | 103209 | 08164 | 13088 | 17980 | 22840 | 27670 | 32468 | 37236 | 41974 | 46682 | 51360 | 54 |
| | 45 | 103291 | 08247 | 13170 | 18061 | 22921 | 27750 | 32548 | 37315 | 42052 | 46760 | 51438 | 55 |
| 14 | 0 | 103374 | 08329 | 13252 | 18143 | 23002 | 27830 | 32627 | 37394 | 42131 | 46838 | 51516 | 56 |
| | 15 | 103457 | 08411 | 13334 | 18224 | 23083 | 27910 | 32707 | 37474 | 42210 | 46916 | 51593 | 57 |
| | 30 | 103540 | 08494 | 13415 | 18305 | 23163 | 27990 | 32787 | 37553 | 42288 | 46994 | 51671 | 58 |
| | 45 | 103623 | 08576 | 13497 | 18386 | 23244 | 28071 | 32867 | 37632 | 42367 | 47073 | 51749 | 59 |

| | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 83. | Parts | 5 | 11 | 16 | 22 | 28 | 33 | 39 | 44 | 50 | 55 | 61 | 66 | 72 | 77 | 83 |
| D. 78. | Parts | 5 | 10 | 16 | 21 | 26 | 31 | 36 | 42 | 47 | 52 | 57 | 62 | 68 | 73 | 78 |

## LOG. SINE SQUARE

| | 44° | | | 45° | | | | 46° | | | | 47° | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | |
| | 2h 57m | 2h 58m | 2h 59m | 3h 0m | 3h 1m | 3h 2m | 3h 3m | 3h 4m | 3h 5m | 3h 6m | 3h 7m | 3h 8m | s. |
| ′ ″ | 9·1 | 9·1 | 9·1 | 9·1 | 9·17 | 9·17 | 9·1 | 9·18 | 9·1 | 9·19 | 9· | 9·20 | |
| 0 0 | 51826 | 56473 | 61090 | 65679 | 0240 | 4773 | 79278 | 3756 | 88207 | 2631 | 197028 | 1399 | 0 |
| 15 | 51904 | 56550 | 61167 | 65756 | 0316 | 4848 | 79353 | 3830 | 88281 | 2704 | 197101 | 1472 | 1 |
| 30 | 51982 | 56627 | 61244 | 65832 | 0392 | 4924 | 79428 | 3905 | 88355 | 2778 | 197174 | 1545 | 2 |
| 45 | 52059 | 56704 | 61320 | 65908 | 0467 | 4999 | 79503 | 3979 | 88429 | 2851 | 197247 | 1617 | 3 |
| 1 0 | 52137 | 56781 | 61397 | 65984 | 0543 | 5074 | 79578 | 4054 | 88503 | 2925 | 197320 | 1690 | 4 |
| 15 | 52215 | 56859 | 61474 | 66060 | 0619 | 5149 | 79652 | 4128 | 88576 | 2998 | 197393 | 1762 | 5 |
| 30 | 52292 | 56936 | 61550 | 66137 | 0695 | 5225 | 79727 | 4202 | 88650 | 3072 | 197466 | 1835 | 6 |
| 45 | 52370 | 57013 | 61627 | 66213 | 0770 | 5300 | 79802 | 4277 | 88724 | 3145 | 197539 | 1908 | 7 |
| 2 0 | 52448 | 57090 | 61704 | 66289 | 0846 | 5375 | 79877 | 4351 | 88798 | 3219 | 197613 | 1980 | 8 |
| 15 | 52525 | 57167 | 61780 | 66365 | 0922 | 5450 | 79952 | 4425 | 88872 | 3292 | 197686 | 2053 | 9 |
| 30 | 52603 | 57244 | 61857 | 66441 | 0998 | 5526 | 80026 | 4500 | 88946 | 3366 | 197759 | 2125 | 10 |
| 45 | 52680 | 57321 | 61934 | 66518 | 1073 | 5601 | 80101 | 4574 | 89020 | 3439 | 197832 | 2198 | 11 |
| 3 0 | 52758 | 57399 | 62010 | 66594 | 1149 | 5676 | 80176 | 4648 | 89094 | 3512 | 197905 | 2270 | 12 |
| 15 | 52836 | 57476 | 62087 | 66670 | 1225 | 5751 | 80251 | 4723 | 89168 | 3586 | 197977 | 2343 | 13 |
| 30 | 52913 | 57553 | 62164 | 66746 | 1300 | 5827 | 80325 | 4797 | 89241 | 3659 | 198050 | 2416 | 14 |
| 45 | 52991 | 57630 | 62240 | 66822 | 1376 | 5902 | 80400 | 4871 | 89315 | 3733 | 198123 | 2488 | 15 |
| 4 0 | 53068 | 57707 | 62317 | 66898 | 1452 | 5977 | 80475 | 4946 | 89389 | 3806 | 198196 | 2561 | 16 |
| 15 | 53146 | 57784 | 62393 | 66974 | 1527 | 6052 | 80550 | 5020 | 89463 | 3879 | 198269 | 2633 | 17 |
| 30 | 53233 | 57861 | 62470 | 67051 | 1603 | 6127 | 80624 | 5094 | 89537 | 3953 | 198342 | 2706 | 18 |
| 45 | 53301 | 57938 | 62547 | 67127 | 1679 | 6203 | 80699 | 5168 | 89611 | 4026 | 198415 | 2778 | 19 |
| 5 0 | 53378 | 58015 | 62623 | 67203 | 1754 | 6278 | 80774 | 5243 | 89684 | 4100 | 198488 | 2851 | 20 |
| 15 | 53456 | 58092 | 62700 | 67279 | 1830 | 6353 | 80849 | 5317 | 89758 | 4173 | 198561 | 2923 | 21 |
| 30 | 53533 | 58169 | 62776 | 67355 | 1905 | 6428 | 80923 | 5391 | 89832 | 4246 | 198634 | 2996 | 22 |
| 45 | 53611 | 58246 | 62853 | 67431 | 1981 | 6503 | 80998 | 5465 | 89906 | 4320 | 198707 | 3068 | 23 |
| 6 0 | 53688 | 58323 | 62929 | 67507 | 2057 | 6578 | 81073 | 5540 | 89980 | 4393 | 198780 | 3141 | 24 |
| 15 | 53766 | 58400 | 63006 | 67583 | 2132 | 6653 | 81147 | 5614 | 90053 | 4466 | 198853 | 3213 | 25 |
| 30 | 53843 | 58477 | 63082 | 67659 | 2208 | 6729 | 81222 | 5688 | 90127 | 4540 | 198926 | 3285 | 26 |
| 45 | 53921 | 58554 | 63159 | 67735 | 2283 | 6804 | 81297 | 5762 | 90201 | 4613 | 198998 | 3358 | 27 |
| 7 0 | 53998 | 58631 | 63235 | 67811 | 2359 | 6879 | 81371 | 5836 | 90275 | 4686 | 199071 | 3430 | 28 |
| 15 | 54076 | 58708 | 63312 | 67887 | 2435 | 6954 | 81446 | 5911 | 90348 | 4759 | 199144 | 3503 | 29 |
| 30 | 54153 | 58785 | 63388 | 67963 | 2510 | 7029 | 81521 | 5985 | 90422 | 4833 | 199217 | 3575 | 30 |
| 45 | 54231 | 58862 | 63465 | 68039 | 2586 | 7104 | 81595 | 6059 | 90496 | 4906 | 199290 | 3648 | 31 |
| 8 0 | 54308 | 58939 | 63541 | 68115 | 2661 | 7179 | 81670 | 6133 | 90570 | 4979 | 199363 | 3720 | 32 |
| 15 | 54385 | 59016 | 63618 | 68191 | 2737 | 7254 | 81744 | 6207 | 90643 | 5053 | 199436 | 3792 | 33 |
| 30 | 54463 | 59093 | 63694 | 68267 | 2812 | 7329 | 81819 | 6281 | 90717 | 5126 | 199508 | 3865 | 34 |
| 45 | 54540 | 59170 | 63771 | 68343 | 2888 | 7404 | 81894 | 6356 | 90791 | 5199 | 199581 | 3937 | 35 |
| 9 0 | 54618 | 59247 | 63847 | 68419 | 2963 | 7479 | 81968 | 6430 | 90864 | 5272 | 199654 | 4010 | 36 |
| 15 | 54695 | 59324 | 63924 | 68495 | 3039 | 7554 | 82043 | 6504 | 90938 | 5346 | 199727 | 4082 | 37 |
| 30 | 54772 | 59401 | 64000 | 68571 | 3114 | 7629 | 82117 | 6578 | 91012 | 5419 | 199800 | 4154 | 38 |
| 45 | 54850 | 59477 | 64076 | 68647 | 3190 | 7704 | 82192 | 6652 | 91085 | 5492 | 199872 | 4227 | 39 |
| 10 0 | 54927 | 59554 | 64153 | 68723 | 3265 | 7779 | 82266 | 6726 | 91159 | 5565 | 199945 | 4299 | 40 |
| 15 | 55005 | 59631 | 64229 | 68799 | 3341 | 7854 | 82341 | 6800 | 91233 | 5639 | 200018 | 4371 | 41 |
| 30 | 55082 | 59708 | 64306 | 68875 | 3416 | 7929 | 82416 | 6874 | 91306 | 5712 | 200091 | 4444 | 42 |
| 45 | 55159 | 59785 | 64382 | 68951 | 3491 | 8004 | 82490 | 6948 | 91380 | 5785 | 200164 | 4516 | 43 |
| 11 0 | 55237 | 59862 | 64458 | 69027 | 3567 | 8079 | 82565 | 7023 | 91454 | 5858 | 200236 | 4588 | 44 |
| 15 | 55314 | 59939 | 64535 | 69103 | 3642 | 8154 | 82639 | 7097 | 91527 | 5931 | 200309 | 4661 | 45 |
| 30 | 55391 | 60015 | 64611 | 69178 | 3718 | 8229 | 82714 | 7171 | 91601 | 6004 | 200382 | 4733 | 46 |
| 45 | 55468 | 60092 | 64687 | 69254 | 3793 | 8304 | 82788 | 7245 | 91674 | 6078 | 200455 | 4805 | 47 |
| 12 0 | 55546 | 60169 | 64764 | 69330 | 3869 | 8379 | 82863 | 7319 | 91748 | 6151 | 200527 | 4878 | 48 |
| 15 | 55623 | 60246 | 64840 | 69406 | 3944 | 8454 | 82937 | 7393 | 91822 | 6224 | 200600 | 4950 | 49 |
| 30 | 55700 | 60323 | 64916 | 69482 | 4019 | 8529 | 83012 | 7467 | 91895 | 6297 | 200673 | 5022 | 50 |
| 45 | 55778 | 60399 | 64993 | 69558 | 4095 | 8604 | 83086 | 7541 | 91969 | 6370 | 200745 | 5094 | 51 |
| 13 0 | 55855 | 60476 | 65069 | 69634 | 4170 | 8679 | 83161 | 7615 | 92042 | 6443 | 200818 | 5167 | 52 |
| 15 | 55932 | 60553 | 65145 | 69709 | 4246 | 8754 | 83235 | 7689 | 92116 | 6517 | 200891 | 5239 | 53 |
| 30 | 56009 | 60630 | 65222 | 69785 | 4321 | 8829 | 83309 | 7763 | 92190 | 6590 | 200963 | 5311 | 54 |
| 45 | 56087 | 60707 | 65298 | 69861 | 4396 | 8904 | 83384 | 7837 | 92263 | 6663 | 201036 | 5383 | 55 |
| 14 0 | 56164 | 60783 | 65374 | 69937 | 4472 | 8979 | 83458 | 7911 | 92337 | 6736 | 201109 | 5456 | 56 |
| 15 | 56241 | 60860 | 65450 | 70013 | 4547 | 9054 | 83533 | 7985 | 92410 | 6809 | 201181 | 5528 | 57 |
| 30 | 56318 | 60937 | 65527 | 70089 | 4622 | 9128 | 83607 | 8059 | 92484 | 6882 | 201254 | 5600 | 58 |
| 45 | 56396 | 61014 | 65603 | 70164 | 4698 | 9203 | 83682 | 8133 | 92557 | 6955 | 201327 | 5672 | 59 |

| | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 78. | Parts | 5 | 10 | 16 | 21 | 26 | 31 | 36 | 42 | 47 | 52 | 57 | 62 | 68 | 73 | 78 |
| D. 72. | Parts | 5 | 10 | 14 | 19 | 24 | 29 | 34 | 38 | 43 | 48 | 53 | 58 | 62 | 67 | 72 |

## LOG. SINE SQUARE

| | 47° | | | 48° | | | | 49° | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | |
| | 3h 9m | 3h 10m | 3h 11m | 3h 12m | 3h 13m | 3h 14m | 3h 15m | 3h 16m | 3h 17m | 3h 18m | 3h 19m | s. |
| ′ ″ | 9·2 | 9·2 | 9·2 | 9·2 | 9·2 | 9·2 | 9·2 | 9·2 | 9·2 | 9·2 | 9·2 | |
| 0 0 | 05745 | 10064 | 14358 | 18627 | 22870 | 27089 | 31284 | 35454 | 39600 | 43722 | 47821 | 0 |
| 15 | 05817 | 10136 | 14429 | 18698 | 22941 | 27159 | 31353 | 35523 | 39669 | 43791 | 47889 | 1 |
| 30 | 05889 | 10207 | 14501 | 18768 | 23011 | 27229 | 31423 | 35593 | 39738 | 43859 | 47957 | 2 |
| 45 | 05961 | 10279 | 14572 | 18839 | 23082 | 27300 | 31493 | 35662 | 39807 | 43928 | 48025 | 3 |
| 1 0 | 06033 | 10351 | 14643 | 18910 | 23152 | 27370 | 31502 | 35731 | 39876 | 43996 | 48094 | 4 |
| 15 | 06105 | 10423 | 14715 | 18981 | 23223 | 27440 | 31632 | 35800 | 39944 | 44065 | 48162 | 5 |
| 30 | 06178 | 10494 | 14786 | 19052 | 23293 | 27510 | 31702 | 35870 | 40013 | 44133 | 48230 | 6 |
| 45 | 06250 | 10566 | 14857 | 19123 | 23364 | 27580 | 31772 | 35939 | 40082 | 44202 | 48298 | 7 |
| 2 0 | 06322 | 10638 | 14929 | 19194 | 23434 | 27650 | 31841 | 36008 | 40151 | 44270 | 48366 | 8 |
| 15 | 06394 | 10710 | 15000 | 19265 | 23505 | 27720 | 31911 | 36077 | 40220 | 44339 | 48434 | 9 |
| 30 | 06466 | 10781 | 15071 | 19336 | 23575 | 27790 | 31980 | 36147 | 40289 | 44407 | 48502 | 10 |
| 45 | 06538 | 10853 | 15142 | 19406 | 23646 | 27860 | 32050 | 36216 | 40358 | 44476 | 48570 | 11 |
| 3 0 | 06610 | 10925 | 15214 | 19477 | 23716 | 27930 | 32120 | 36285 | 40426 | 44544 | 48638 | 12 |
| 15 | 06682 | 10996 | 15285 | 19548 | 23786 | 28000 | 32189 | 36354 | 40495 | 44612 | 48706 | 13 |
| 30 | 06755 | 11068 | 15356 | 19619 | 23857 | 28070 | 32259 | 36423 | 40564 | 44681 | 48774 | 14 |
| 45 | 06827 | 11140 | 15427 | 19690 | 23927 | 28140 | 32329 | 36493 | 40633 | 44749 | 48842 | 15 |
| 4 0 | 06899 | 11211 | 15499 | 19761 | 23998 | 28210 | 32398 | 36562 | 40702 | 44818 | 48910 | 16 |
| 15 | 06971 | 11283 | 15570 | 19831 | 24068 | 28280 | 32468 | 36631 | 40770 | 44886 | 48978 | 17 |
| 30 | 07043 | 11355 | 15641 | 19902 | 24139 | 28350 | 32537 | 36700 | 40839 | 44954 | 49046 | 18 |
| 45 | 07115 | 11426 | 15712 | 19973 | 24209 | 28420 | 32607 | 36769 | 40908 | 45023 | 49114 | 19 |
| 5 0 | 07187 | 11498 | 15784 | 20044 | 24279 | 28490 | 32676 | 36839 | 40977 | 45091 | 49182 | 20 |
| 15 | 07259 | 11570 | 15855 | 20115 | 24350 | 28560 | 32746 | 36908 | 41046 | 45160 | 49250 | 21 |
| 30 | 07331 | 11641 | 15926 | 20186 | 24420 | 28630 | 32816 | 36977 | 41114 | 45228 | 49318 | 22 |
| 45 | 07403 | 11713 | 15997 | 20256 | 24491 | 28700 | 32885 | 37046 | 41183 | 45296 | 49386 | 23 |
| 6 0 | 07475 | 11785 | 16068 | 20327 | 24561 | 28770 | 32955 | 37115 | 41252 | 45365 | 49454 | 24 |
| 15 | 07547 | 11856 | 16140 | 20398 | 24631 | 28840 | 33024 | 37184 | 41321 | 45433 | 49522 | 25 |
| 30 | 07619 | 11928 | 16211 | 20469 | 24702 | 28910 | 33094 | 37254 | 41389 | 45501 | 49590 | 26 |
| 45 | 07691 | 11999 | 16282 | 20539 | 24772 | 28980 | 33163 | 37323 | 41458 | 45570 | 49658 | 27 |
| 7 0 | 07763 | 12071 | 16353 | 20610 | 24842 | 29050 | 33233 | 37392 | 41527 | 45638 | 49726 | 28 |
| 15 | 07835 | 12142 | 16424 | 20681 | 24913 | 29120 | 33302 | 37461 | 41595 | 45706 | 49794 | 29 |
| 30 | 07907 | 12214 | 16495 | 20752 | 24983 | 29190 | 33372 | 37530 | 41664 | 45775 | 49862 | 30 |
| 45 | 07979 | 12286 | 16567 | 20822 | 25053 | 29259 | 33441 | 37599 | 41733 | 45843 | 49930 | 31 |
| 8 0 | 08051 | 12357 | 16638 | 20893 | 25123 | 29329 | 33511 | 37668 | 41802 | 45911 | 49998 | 32 |
| 15 | 08123 | 12429 | 16709 | 20964 | 25194 | 29399 | 33580 | 37737 | 41870 | 45980 | 50065 | 33 |
| 30 | 08195 | 12500 | 16780 | 21034 | 25264 | 29469 | 33650 | 37806 | 41939 | 46048 | 50133 | 34 |
| 45 | 08267 | 12572 | 16851 | 21105 | 25334 | 29539 | 33719 | 37875 | 42008 | 46116 | 50201 | 35 |
| 9 0 | 08339 | 12643 | 16922 | 21176 | 25405 | 29609 | 33789 | 37944 | 42076 | 46184 | 50269 | 36 |
| 15 | 08411 | 12715 | 16993 | 21246 | 25475 | 29679 | 33858 | 38013 | 42145 | 46253 | 50337 | 37 |
| 30 | 08483 | 12786 | 17064 | 21317 | 25545 | 29749 | 33928 | 38083 | 42214 | 46321 | 50405 | 38 |
| 45 | 08555 | 12858 | 17135 | 21388 | 25615 | 29818 | 33997 | 38152 | 42282 | 46389 | 50473 | 39 |
| 10 0 | 08627 | 12929 | 17206 | 21459 | 25686 | 29888 | 34067 | 38221 | 42351 | 46457 | 50541 | 40 |
| 15 | 08699 | 13001 | 17278 | 21529 | 25756 | 29958 | 34136 | 38290 | 42420 | 46526 | 50608 | 41 |
| 30 | 08771 | 13072 | 17349 | 21600 | 25826 | 30028 | 34205 | 38359 | 42488 | 46594 | 50676 | 42 |
| 45 | 08843 | 13144 | 17420 | 21670 | 25896 | 30098 | 34275 | 38428 | 42557 | 46662 | 50744 | 43 |
| 11 0 | 08915 | 13215 | 17491 | 21741 | 25967 | 30168 | 34344 | 38497 | 42625 | 46730 | 50812 | 44 |
| 15 | 08987 | 13287 | 17562 | 21812 | 26037 | 30237 | 34414 | 38566 | 42694 | 46798 | 50880 | 45 |
| 30 | 09058 | 13358 | 17633 | 21882 | 26107 | 30307 | 34483 | 38635 | 42763 | 46867 | 50948 | 46 |
| 45 | 09130 | 13430 | 17704 | 21953 | 26177 | 30377 | 34552 | 38704 | 42831 | 46935 | 51015 | 47 |
| 12 0 | 09202 | 13501 | 17775 | 22024 | 26247 | 30447 | 34622 | 38773 | 42900 | 47003 | 51083 | 48 |
| 15 | 09274 | 13573 | 17846 | 22094 | 26318 | 30517 | 34691 | 38842 | 42968 | 47071 | 51151 | 49 |
| 30 | 09346 | 13644 | 17917 | 22165 | 26388 | 30586 | 34761 | 38911 | 43037 | 47140 | 51219 | 50 |
| 45 | 09418 | 13715 | 17988 | 22235 | 26458 | 30656 | 34830 | 38980 | 43106 | 47208 | 51287 | 51 |
| 13 0 | 09490 | 13787 | 18059 | 22306 | 26528 | 30726 | 34899 | 39049 | 43174 | 47276 | 51354 | 52 |
| 15 | 09561 | 13858 | 18130 | 22376 | 26598 | 30796 | 34969 | 39118 | 43243 | 47344 | 51422 | 53 |
| 30 | 09633 | 13930 | 18201 | 22447 | 26668 | 30865 | 35038 | 39187 | 43311 | 47412 | 51490 | 54 |
| 45 | 09705 | 14001 | 18272 | 22518 | 26739 | 30935 | 35107 | 39255 | 43380 | 47480 | 51558 | 55 |
| 14 0 | 09777 | 14072 | 18343 | 22588 | 26809 | 31005 | 35177 | 39324 | 43448 | 47549 | 51626 | 56 |
| 15 | 09849 | 14144 | 18414 | 22659 | 26879 | 31075 | 35246 | 39393 | 43517 | 47617 | 51693 | 57 |
| 30 | 09920 | 14215 | 18485 | 22729 | 26949 | 31144 | 35315 | 39462 | 43585 | 47685 | 51761 | 58 |
| 45 | 09992 | 14287 | 18556 | 22800 | 27019 | 31214 | 35385 | 39531 | 43654 | 47753 | 51829 | 59 |

| | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 72. | Parts | 5 | 10 | 14 | 19 | 24 | 29 | 34 | 38 | 43 | 48 | 53 | 58 | 62 | 67 | 72 |
| D. 68. | Parts | 4 | 9 | 13 | 18 | 23 | 27 | 31 | 36 | 40 | 45 | 50 | 54 | 59 | 63 | 68 |

## LOG. SINE SQUARE

| ′ | ″ | 50° | | | | 51° | | | | 52° | | | s. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | |
| | | 3h 20m | 3h 21m | 3h 22m | 3h 23m | 3h 24m | 3h 25m | 3h 26m | 3h 27m | 3h 28m | 3h 29m | 3h 30m | |
| | | 9·2 | 9·2 | 9·2 | 9·2 | 9·2 | 9·2 | 9·2 | 9·2 | 9·2 | 9·2 | 9·2 | |
| 0 | 0 | 51897 | 55949 | 59978 | 63985 | 67969 | 71930 | 75870 | 79788 | 83684 | 87558 | 91412 | 0 |
| | 15 | 51964 | 56016 | 60045 | 64051 | 68035 | 71996 | 75936 | 79853 | 83749 | 87623 | 91476 | 1 |
| | 30 | 52032 | 56083 | 60112 | 64118 | 68101 | 72062 | 76001 | 79918 | 83813 | 87687 | 91540 | 2 |
| | 45 | 52100 | 56151 | 60179 | 64184 | 68177 | 72128 | 76067 | 79983 | 83878 | 87752 | 91604 | 3 |
| 1 | 0 | 52167 | 56218 | 60246 | 64251 | 68234 | 72194 | 76132 | 80048 | 83943 | 87816 | 91668 | 4 |
| | 15 | 52235 | 56285 | 60313 | 64318 | 68300 | 72260 | 76197 | 80113 | 84008 | 87880 | 91732 | 5 |
| | 30 | 52303 | 56353 | 60380 | 64384 | 68366 | 72325 | 76263 | 80178 | 84072 | 87945 | 91796 | 6 |
| | 45 | 52360 | 56420 | 60447 | 64451 | 68432 | 72391 | 76328 | 80244 | 84138 | 88009 | 91860 | 7 |
| 2 | 0 | 52438 | 56487 | 60514 | 64517 | 68498 | 72457 | 76394 | 80309 | 84202 | 88073 | 91924 | 8 |
| | 15 | 52506 | 56555 | 60580 | 64584 | 68564 | 72523 | 76459 | 80374 | 84266 | 88138 | 91988 | 9 |
| | 30 | 52573 | 56622 | 60647 | 64650 | 68631 | 72589 | 76525 | 80439 | 84331 | 88202 | 92052 | 10 |
| | 45 | 52641 | 56689 | 60714 | 64717 | 68697 | 72654 | 76590 | 80504 | 84396 | 88266 | 92116 | 11 |
| 3 | 0 | 52709 | 56756 | 60781 | 64783 | 68764 | 72720 | 76655 | 80569 | 84461 | 88331 | 92180 | 12 |
| | 15 | 52776 | 56824 | 60848 | 64850 | 68829 | 72786 | 76721 | 80634 | 84525 | 88395 | 92244 | 13 |
| | 30 | 52844 | 56891 | 60915 | 64916 | 68895 | 72852 | 76786 | 80699 | 84590 | 88459 | 92308 | 14 |
| | 45 | 52912 | 56958 | 60982 | 64983 | 68961 | 72917 | 76852 | 80764 | 84655 | 88524 | 92372 | 15 |
| 4 | 0 | 52979 | 57025 | 61049 | 65049 | 69027 | 72983 | 76917 | 80829 | 84719 | 88588 | 92436 | 16 |
| | 15 | 53047 | 57093 | 61116 | 65116 | 69093 | 73049 | 76982 | 80894 | 84784 | 88652 | 92500 | 17 |
| | 30 | 53115 | 57160 | 61182 | 65182 | 69160 | 73115 | 77048 | 80959 | 84849 | 88717 | 92564 | 18 |
| | 45 | 53182 | 57227 | 61249 | 65249 | 69226 | 73180 | 77113 | 81024 | 84913 | 88781 | 92627 | 19 |
| 5 | 0 | 53250 | 57294 | 61316 | 65315 | 69292 | 73246 | 77178 | 81089 | 84978 | 88845 | 92691 | 20 |
| | 15 | 53317 | 57362 | 61383 | 65382 | 69358 | 73312 | 77244 | 81154 | 85042 | 88909 | 92755 | 21 |
| | 30 | 53385 | 57429 | 61450 | 65448 | 69424 | 73378 | 77309 | 81219 | 85107 | 88974 | 92819 | 22 |
| | 45 | 53453 | 57496 | 61517 | 65514 | 69490 | 73443 | 77374 | 81284 | 85172 | 89038 | 92883 | 23 |
| 6 | 0 | 53520 | 57563 | 61583 | 65581 | 69556 | 73509 | 77440 | 81349 | 85236 | 89102 | 92947 | 24 |
| | 15 | 53588 | 57630 | 61650 | 65647 | 69622 | 73575 | 77505 | 81414 | 85301 | 89167 | 93011 | 25 |
| | 30 | 53655 | 57698 | 61717 | 65714 | 69688 | 73640 | 77570 | 81479 | 85366 | 89231 | 93075 | 26 |
| | 45 | 53723 | 57765 | 61784 | 65780 | 69754 | 73706 | 77636 | 81544 | 85430 | 89295 | 93139 | 27 |
| 7 | 0 | 53790 | 57832 | 61851 | 65847 | 69820 | 73772 | 77701 | 81609 | 85495 | 89359 | 93203 | 28 |
| | 15 | 53858 | 57899 | 61917 | 65913 | 69886 | 73837 | 77766 | 81674 | 85559 | 89423 | 93266 | 29 |
| | 30 | 53926 | 57966 | 61984 | 65979 | 69952 | 73903 | 77832 | 81739 | 85624 | 89488 | 93330 | 30 |
| | 45 | 53993 | 58033 | 62051 | 66046 | 70018 | 73969 | 77897 | 81803 | 85688 | 89552 | 93394 | 31 |
| 8 | 0 | 54061 | 58101 | 62118 | 66112 | 70084 | 74034 | 77962 | 81868 | 85753 | 89616 | 93458 | 32 |
| | 15 | 54128 | 58168 | 62184 | 66179 | 70150 | 74100 | 78028 | 81933 | 85818 | 89680 | 93522 | 33 |
| | 30 | 54196 | 58235 | 62251 | 66245 | 70216 | 74166 | 78093 | 81998 | 85882 | 89745 | 93586 | 34 |
| | 45 | 54263 | 58302 | 62318 | 66311 | 70282 | 74231 | 78158 | 82063 | 85947 | 89809 | 93650 | 35 |
| 9 | 0 | 54331 | 58369 | 62385 | 66378 | 70348 | 74297 | 78223 | 82128 | 86011 | 89873 | 93713 | 36 |
| | 15 | 54398 | 58436 | 62452 | 66444 | 70414 | 74362 | 78289 | 82193 | 86076 | 89937 | 93777 | 37 |
| | 30 | 54466 | 58503 | 62518 | 66510 | 70480 | 74428 | 78354 | 82258 | 86140 | 90001 | 93841 | 38 |
| | 45 | 54533 | 58570 | 62585 | 66577 | 70546 | 74494 | 78419 | 82323 | 86205 | 90065 | 93905 | 39 |
| 10 | 0 | 54601 | 58637 | 62652 | 66643 | 70612 | 74559 | 78484 | 82388 | 86269 | 90130 | 93969 | 40 |
| | 15 | 54668 | 58705 | 62718 | 66710 | 70678 | 74625 | 78550 | 82452 | 86334 | 90194 | 94033 | 41 |
| | 30 | 54735 | 58772 | 62785 | 66776 | 70744 | 74691 | 78615 | 82517 | 86398 | 90258 | 94096 | 42 |
| | 45 | 54803 | 58839 | 62852 | 66842 | 70810 | 74756 | 78680 | 82582 | 86463 | 90322 | 94160 | 43 |
| 11 | 0 | 54870 | 58906 | 62918 | 66908 | 70876 | 74822 | 78745 | 82647 | 86527 | 90386 | 94224 | 44 |
| | 15 | 54938 | 58973 | 62985 | 66975 | 70942 | 74887 | 78810 | 82712 | 86592 | 90450 | 94288 | 45 |
| | 30 | 55005 | 59040 | 63052 | 67041 | 71008 | 74953 | 78876 | 82777 | 86656 | 90514 | 94351 | 46 |
| | 45 | 55073 | 59107 | 63118 | 67107 | 71074 | 75018 | 78941 | 82842 | 86721 | 90579 | 94415 | 47 |
| 12 | 0 | 55140 | 59174 | 63185 | 67174 | 71140 | 75084 | 79006 | 82906 | 86785 | 90643 | 94479 | 48 |
| | 15 | 55208 | 59241 | 63252 | 67240 | 71206 | 75149 | 79071 | 82971 | 86850 | 90707 | 94543 | 49 |
| | 30 | 55275 | 59308 | 63318 | 67306 | 71272 | 75215 | 79136 | 83036 | 86914 | 90771 | 94607 | 50 |
| | 45 | 5534[illegible] | 59375 | 63385 | 67373 | 71338 | 75281 | 79202 | 83101 | 86979 | 90835 | 94670 | 51 |
| 13 | 0 | 55410 | 59442 | 63452 | 67439 | 71404 | 75346 | 79267 | 83166 | 87043 | 90899 | 94734 | 52 |
| | 15 | 55477 | 59509 | 63518 | 67505 | 71469 | 75412 | 79332 | 83230 | 87108 | 90963 | 94798 | 53 |
| | 30 | 55545 | 59576 | 63585 | 67571 | 71535 | 75477 | 79397 | 83295 | 87172 | 91027 | 94861 | 54 |
| | 45 | 55612 | 59643 | 63652 | 67638 | 71601 | 75543 | 79462 | 83360 | 87236 | 91091 | 94925 | 55 |
| 14 | 0 | 55679 | 59710 | 63718 | 67704 | 71667 | 75608 | 79527 | 83425 | 87301 | 91155 | 94989 | 56 |
| | 15 | 55747 | 59777 | 63785 | 67770 | 71733 | 75674 | 79593 | 83490 | 87365 | 91219 | 95053 | 57 |
| | 30 | 55814 | 59844 | 63852 | 67836 | 71799 | 75739 | 79658 | 83554 | 87430 | 91284 | 95116 | 58 |
| | 45 | 55881 | 59911 | 63918 | 67902 | 71865 | 75805 | 79723 | 83619 | 87494 | 91348 | 95180 | 59 |

| | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 68. | Parts | 4 | 9 | 13 | 18 | 23 | 27 | 32 | 36 | 41 | 45 | 50 | 54 | 59 | 63 | 68 |
| D. 64. | Parts | 4 | 9 | 13 | 17 | 21 | 26 | 30 | 34 | 38 | 43 | 47 | 51 | 53 | 60 | 64 |

## LOG. SINE SQUARE

| | | 52° | 53° | | | | 54° | | | | 55° | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | |
| | | 3ʰ 31ᵐ | 3ʰ 32ᵐ | 3ʰ 33ᵐ | 3ʰ 34ᵐ | 3ʰ 35ᵐ | 3ʰ 36ᵐ | 3ʰ 37ᵐ | 3ʰ 38ᵐ | 3ʰ 39ᵐ | 3ʰ 40ᵐ | 3ʰ 41ᵐ | s. |
| ′ | ″ | 9·2 | 9· | 9·3 | 9·3 | 9·3 | 9·3 | 9·3 | 9·3 | 9·3 | 9·3 | 9·3 | |
| 0 | 0 | 95244 | 299055 | 02845 | 06615 | 10364 | 14094 | 17803 | 21492 | 25161 | 28811 | 32442 | 0 |
| | 15 | 95307 | 299118 | 02908 | 06678 | 10427 | 14155 | 17864 | 21553 | 25222 | 28872 | 32502 | 1 |
| | 30 | 95371 | 299182 | 02971 | 06740 | 10489 | 14217 | 17926 | 21614 | 25283 | 28933 | 32562 | 2 |
| | 45 | 95435 | 299245 | 03034 | 06803 | 10551 | 14279 | 17988 | 21676 | 25344 | 28993 | 32623 | 3 |
| 1 | 0 | 95498 | 299308 | 03097 | 06866 | 10614 | 14341 | 18049 | 21737 | 25405 | 29054 | 32683 | 4 |
| | 15 | 95562 | 299372 | 03160 | 06928 | 10676 | 14403 | 18111 | 21798 | 25466 | 29114 | 32743 | 5 |
| | 30 | 95626 | 299435 | 03223 | 06991 | 10738 | 14465 | 18172 | 21860 | 25527 | 29175 | 32804 | 6 |
| | 45 | 95689 | 299498 | 03286 | 07053 | 10800 | 14527 | 18234 | 21921 | 25588 | 29236 | 32864 | 7 |
| 2 | 0 | 95753 | 299561 | 03349 | 07116 | 10863 | 14589 | 18296 | 21982 | 25649 | 29296 | 32924 | 8 |
| | 15 | 95817 | 299625 | 03412 | 07179 | 10925 | 14651 | 18357 | 22043 | [illegible] | 29357 | 32985 | 9 |
| | 30 | 95880 | 299688 | 03475 | 07241 | 10987 | 14713 | 18419 | 22105 | 25771 | 29418 | 33045 | 10 |
| | 45 | 95944 | 299751 | 03538 | 07304 | 11050 | 14775 | 18480 | 22166 | 25832 | 29478 | 33105 | 11 |
| 3 | 0 | 96008 | 299815 | 03601 | 07367 | 11112 | 14837 | 18542 | 22227 | 25893 | 29539 | 33166 | 12 |
| | 15 | 96071 | 299878 | 03664 | 07429 | 11174 | 14899 | 18604 | 22289 | 25954 | 29599 | 33226 | 13 |
| | 30 | 96135 | 299941 | 03727 | 07492 | 11236 | 14961 | 18665 | 22350 | 26015 | 29660 | 33286 | 14 |
| | 45 | 96198 | 300004 | 03790 | 07554 | 11299 | 15023 | 18727 | 22411 | 26075 | 29721 | 33346 | 15 |
| 4 | 0 | 96262 | 300068 | 03853 | 07617 | 11361 | 15085 | 18788 | 22472 | 26136 | 29781 | 33407 | 16 |
| | 15 | 96326 | 300131 | 03915 | 07679 | 11423 | 15146 | 18850 | 22533 | 26197 | 29842 | 33467 | 17 |
| | 30 | 96389 | 300194 | 03978 | 07742 | 11485 | 15208 | 18911 | 22595 | 26258 | 29902 | 33527 | 18 |
| | 45 | 96453 | 300257 | 04041 | 07804 | 11547 | 15270 | 18973 | 22656 | 26319 | 29963 | 33587 | 19 |
| 5 | 0 | 96516 | 300321 | 04104 | 07867 | 11610 | 15332 | 19035 | 22717 | 26380 | 30024 | 33648 | 20 |
| | 15 | 96580 | 300384 | 04167 | 07930 | 11672 | 15394 | 19096 | 22778 | 26441 | 30084 | 33708 | 21 |
| | 30 | 96644 | 300447 | 04230 | 07992 | 11734 | 15456 | 19158 | 22840 | 26502 | 30145 | 33768 | 22 |
| | 45 | 96707 | 300510 | 04293 | 08055 | 11796 | 15518 | 19219 | 22901 | 26563 | 30205 | 33828 | 23 |
| 6 | 0 | 96771 | 300574 | 04356 | 08117 | 11858 | 15580 | 19281 | 22962 | 26624 | 30266 | 33889 | 24 |
| | 15 | 96834 | 300637 | 04418 | 08180 | 11920 | 15641 | 19342 | 23023 | 26684 | 30326 | 33949 | 25 |
| | 30 | 96898 | 300700 | 04481 | 08242 | 11983 | 15703 | 19404 | 23084 | 26745 | 30387 | 34009 | 26 |
| | 45 | 96961 | 300763 | 04544 | 08305 | 12045 | 15765 | 19465 | 23146 | 26806 | 30447 | 34069 | 27 |
| 7 | 0 | 97025 | 300826 | 04607 | 08367 | 12107 | 15827 | 19527 | 23207 | 26867 | 30508 | 34129 | 28 |
| | 15 | 97088 | 300889 | 04670 | 08430 | 12169 | 15888 | 19588 | 23268 | 26928 | 30568 | 34190 | 29 |
| | 30 | 97152 | 300953 | 04733 | 08492 | 12231 | 15951 | 19650 | 23329 | 26989 | 30629 | 34250 | 30 |
| | 45 | 97215 | 301016 | 04796 | 08555 | 12294 | 16012 | 19711 | 23390 | 27049 | 30689 | 34310 | 31 |
| 8 | 0 | 97279 | 301079 | 04858 | 08617 | 12356 | 16074 | 19773 | 23451 | 27110 | 30750 | 34370 | 32 |
| | 15 | 97342 | 301142 | 04921 | 08680 | 12418 | 16136 | 19834 | 23512 | 27171 | 30810 | 34430 | 33 |
| | 30 | 97406 | 301205 | 04984 | 08742 | 12480 | 16198 | 19896 | 23574 | 27232 | 30871 | 34490 | 34 |
| | 45 | 97469 | 301268 | 05047 | 08805 | 12542 | 16260 | 19957 | 23635 | 27293 | 30931 | 34551 | 35 |
| 9 | 0 | 97533 | 301332 | 05110 | 08867 | 12604 | 16321 | 20019 | 23696 | 27354 | 30992 | 34611 | 36 |
| | 15 | 97596 | 301395 | 05172 | 08929 | 12666 | 16383 | 20080 | 23757 | 27414 | 31052 | 34671 | 37 |
| | 30 | 97660 | 301458 | 05235 | 08992 | 12729 | 16445 | 20141 | 23818 | 27475 | 31113 | 34731 | 38 |
| | 45 | 97723 | 301521 | 05298 | 09054 | 12791 | 16508 | 20203 | 23879 | 27536 | 31173 | 34791 | 39 |
| 10 | 0 | 97787 | 301584 | 05361 | 09117 | 12853 | 16568 | 20264 | 23940 | 27597 | 31234 | 34851 | 40 |
| | 15 | 97850 | 301647 | 05423 | 09179 | 12915 | 16630 | 20326 | 24001 | 27657 | 31294 | 34912 | 41 |
| | 30 | 97914 | 301710 | 05486 | 09242 | 12977 | 16692 | 20387 | 24062 | 27718 | 31355 | 34972 | 42 |
| | 45 | 97977 | 301773 | 05549 | 09304 | 13039 | 16754 | 20449 | 24124 | 27779 | 31415 | 35032 | 43 |
| 11 | 0 | 98041 | 301836 | 05612 | 09367 | 13101 | 16815 | 20510 | 24185 | 27840 | 31475 | 35092 | 44 |
| | 15 | 98104 | 301900 | 05674 | 09429 | 13163 | 16877 | 20571 | 24246 | 27901 | 31536 | 35152 | 45 |
| | 30 | 98167 | 301963 | 05737 | 09491 | 13225 | 16939 | 20633 | 24307 | 27961 | 31596 | 35212 | 46 |
| | 45 | 98231 | 302026 | 05800 | 09554 | 13287 | 17001 | 20694 | 24368 | 28022 | 31657 | 35272 | 47 |
| 12 | 0 | 98294 | 302089 | 05863 | 09616 | 13349 | 17062 | 20756 | 24429 | 28083 | 31717 | 35332 | 48 |
| | 15 | 98358 | 302152 | 05925 | 09679 | 13411 | 17124 | 20817 | 24490 | 28144 | 31778 | 35392 | 49 |
| | 30 | 98421 | 302215 | 05988 | 09741 | 13473 | 17186 | 20878 | 24551 | 28204 | 31838 | 35452 | 50 |
| | 45 | 98485 | 302278 | 06051 | 09803 | 13535 | 17247 | 20940 | 24612 | 28265 | 31898 | 35513 | 51 |
| 13 | 0 | 98548 | 302341 | 06114 | 09866 | 13597 | 17309 | 21001 | 24673 | 28326 | 31959 | 35573 | 52 |
| | 15 | 98611 | 302404 | 06176 | 09928 | 13659 | 17371 | 21062 | 24734 | 28386 | 32019 | 35633 | 53 |
| | 30 | 98675 | 302467 | 06239 | 09990 | 13722 | 17433 | 21124 | 24795 | 28447 | 32080 | 35693 | 54 |
| | 45 | 98738 | 302530 | 06302 | 10053 | 13784 | 17494 | 21185 | 24856 | 28508 | 32140 | 35753 | 55 |
| 14 | 0 | 98801 | 302593 | 06364 | 10115 | 13846 | 17556 | 21246 | 24917 | 28568 | 32200 | 35813 | 56 |
| | 15 | 98865 | 302656 | 06427 | 10177 | 13908 | 17618 | 21308 | 24978 | 28629 | 32261 | 35873 | 57 |
| | 30 | 98928 | 302719 | 06490 | 10240 | 13970 | 17679 | 21369 | 25039 | 28690 | 32321 | 35933 | 58 |
| | 45 | 98992 | 302782 | 06552 | 10302 | 14032 | 17741 | 21431 | 25100 | 28751 | 32381 | 35993 | 59 |

| | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 63. | Parts | 4 | 9 | 13 | 17 | 21 | 26 | 30 | 34 | 38 | 43 | 47 | 51 | 55 | 60 | 64 |
| D. 60. | Parts | 4 | 8 | 12 | 16 | 20 | 24 | 28 | 32 | 36 | 40 | 44 | 48 | 52 | 56 | 60 |

## LOG. SINE SQUARE

| m s | 55° 30′ 3h 42m | 55° 45′ 3h 43m | 56° 0′ 3h 44m | 56° 15′ 3h 45m | 56° 30′ 3h 46m | 56° 45′ 3h 47m | 57° 0′ 3h 48m | 57° 15′ 3h 49m | 57° 30′ 3h 50m | 57° 45′ 3h 51m | 58° 0′ 3h 52m | s. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ′ ″ | 9·3 | 9·3 | 9·3 | 9·3 | 9·3 | 9·3 | 9·3 | 9·3 | 9·3 | 9·3 | 9·3 | |
| 0 0 | 36053 | 39645 | 43219 | 46773 | 50309 | 53827 | 57326 | 60807 | 64270 | 67715 | 71142 | 0 |
| 15 | 36113 | 39705 | 43278 | 46832 | 50368 | 53885 | 57384 | 60865 | 64327 | 67772 | 71199 | 1 |
| 30 | 36173 | 39765 | 43337 | 46891 | 50427 | 53944 | 57442 | 60923 | 64385 | 67830 | 71256 | 2 |
| 45 | 36233 | 39824 | 43397 | 46950 | 50485 | 54002 | 57500 | 60980 | 64443 | 67887 | 71313 | 3 |
| 1 0 | 36293 | 39884 | 43456 | 47009 | 50544 | 54060 | 57558 | 61038 | 64500 | 67944 | 71370 | 4 |
| 15 | 36353 | 39944 | 43515 | 47069 | 50603 | 54119 | 57617 | 61096 | 64558 | 68001 | 71427 | 5 |
| 30 | 36413 | 40003 | 43575 | 47128 | 50662 | 54177 | 57675 | 61154 | 64615 | 68059 | 71484 | 6 |
| 45 | 36473 | 40063 | 43634 | 47187 | 50720 | 54236 | 57733 | 61212 | 64673 | 68116 | 71541 | 7 |
| 2 0 | 36533 | 40123 | 43694 | 47246 | 50779 | 54294 | 57791 | 61270 | 64730 | 68173 | 71598 | 8 |
| 15 | 36593 | 40182 | 43753 | 47304 | 50838 | 54353 | 57849 | 61327 | 64788 | 68230 | 71655 | 9 |
| 30 | 36653 | 40242 | 43812 | 47364 | 50897 | 54411 | 57907 | 61385 | 64845 | 68287 | 71712 | 10 |
| 45 | 36713 | 40302 | 43872 | 47423 | 50955 | 54469 | 57965 | 61443 | 64903 | 68345 | 71769 | 11 |
| 3 0 | 36773 | 40361 | 43931 | 47482 | 51014 | 54528 | 58023 | 61501 | 64960 | 68402 | 71826 | 12 |
| 15 | 36833 | 40421 | 43990 | 47541 | 51073 | 54586 | 58082 | 61559 | 65018 | 68459 | 71883 | 13 |
| 30 | 36893 | 40481 | 44050 | 47600 | 51131 | 54645 | 58140 | 61616 | 65075 | 68516 | 71940 | 14 |
| 45 | 36953 | 40540 | 44109 | 47659 | 51190 | 54703 | 58198 | 61674 | 65133 | 68574 | 71996 | 15 |
| 4 0 | 37013 | 40600 | 44168 | 47718 | 51249 | 54762 | 58256 | 61732 | 65190 | 68631 | 72053 | 16 |
| 15 | 37073 | 40660 | 44228 | 47777 | 51308 | 54820 | 58314 | 61790 | 65248 | 68688 | 72110 | 17 |
| 30 | 37133 | 40719 | 44287 | 47836 | 51366 | 54878 | 58372 | 61848 | 65305 | 68745 | 72167 | 18 |
| 45 | 37193 | 40779 | 44346 | 47895 | 51425 | 54937 | 58430 | 61905 | 65363 | 68802 | 72224 | 19 |
| 5 0 | 37253 | 40838 | 44406 | 47954 | 51484 | 54995 | 58488 | 61963 | 65420 | 68859 | 72281 | 20 |
| 15 | 37312 | 40898 | 44465 | 48013 | 51542 | 55053 | 58546 | 62021 | 65478 | 68917 | 72338 | 21 |
| 30 | 37372 | 40958 | 44524 | 48072 | 51601 | 55112 | 58604 | 62079 | 65535 | 68974 | 72395 | 22 |
| 45 | 37432 | 41017 | 44583 | 48131 | 51660 | 55170 | 58662 | 62136 | 65593 | 69031 | 72452 | 23 |
| 6 0 | 37492 | 41077 | 44643 | 48190 | 51718 | 55228 | 58720 | 62194 | 65650 | 69088 | 72508 | 24 |
| 15 | 37552 | 41136 | 44702 | 48249 | 51777 | 55287 | 58778 | 62252 | 65707 | 69145 | 72565 | 25 |
| 30 | 37612 | 41196 | 44761 | 48308 | 51836 | 55345 | 58836 | 62310 | 65765 | 69202 | 72622 | 26 |
| 45 | 37672 | 41256 | 44820 | 48367 | 51894 | 55403 | 58894 | 62367 | 65822 | 69260 | 72679 | 27 |
| 7 0 | 37732 | 41315 | 44880 | 48426 | 51953 | 55462 | 58953 | 62425 | 65880 | 69317 | 72736 | 28 |
| 15 | 37792 | 41375 | 44939 | 48485 | 52012 | 55520 | 59011 | 62483 | 65937 | 69374 | 72793 | 29 |
| 30 | 37852 | 41434 | 44998 | 48543 | 52070 | 55578 | 59069 | 62541 | 65995 | 69431 | 72850 | 30 |
| 45 | 37911 | 41494 | 45057 | 48602 | 52129 | 55637 | 59127 | 62598 | 66052 | 69488 | 72906 | 31 |
| 8 0 | 37971 | 41553 | 45117 | 48661 | 52187 | 55695 | 59185 | 62656 | 66110 | 69545 | 72963 | 32 |
| 15 | 38031 | 41613 | 45176 | 48720 | 52246 | 55753 | 59243 | 62714 | 66167 | 69602 | 73020 | 33 |
| 30 | 38091 | 41672 | 45235 | 48779 | 52305 | 55812 | 59301 | 62771 | 66224 | 69659 | 73077 | 34 |
| 45 | 38151 | 41732 | 45294 | 48838 | 52363 | 55870 | 59359 | 62829 | 66282 | 69716 | 73133 | 35 |
| 9 0 | 38211 | 41792 | 45354 | 48897 | 52422 | 55928 | 59417 | 62887 | 66339 | 69774 | 73190 | 36 |
| 15 | 38270 | 41851 | 45413 | 48956 | 52480 | 55987 | 59475 | 62944 | 66396 | 69831 | 73247 | 37 |
| 30 | 38330 | 41911 | 45472 | 49015 | 52539 | 56045 | 59533 | 63002 | 66454 | 69888 | 73304 | 38 |
| 45 | 38390 | 41970 | 45531 | 49074 | 52598 | 56103 | 59591 | 63060 | 66511 | 69945 | 73361 | 39 |
| 10 0 | 38450 | 42030 | 45590 | 49133 | 52656 | 56161 | 59649 | 63118 | 66569 | 70002 | 73418 | 40 |
| 15 | 38510 | 42089 | 45650 | 49191 | 52715 | 56220 | 59706 | 63175 | 66626 | 70059 | 73474 | 41 |
| 30 | 38570 | 42149 | 45709 | 49250 | 52773 | 56278 | 59764 | 63233 | 66683 | 70116 | 73531 | 42 |
| 45 | 38629 | 42208 | 45768 | 49309 | 52832 | 56336 | 59822 | 63291 | 66741 | 70173 | 73588 | 43 |
| 11 0 | 38689 | 42268 | 45827 | 49368 | 52890 | 56394 | 59880 | 63348 | 66798 | 70230 | 73645 | 44 |
| 15 | 38749 | 42327 | 45886 | 49427 | 52949 | 56453 | 59938 | 63406 | 66855 | 70287 | 73701 | 45 |
| 30 | 38809 | 42386 | 45945 | 49486 | 53007 | 56511 | 59996 | 63463 | 66913 | 70344 | 73758 | 46 |
| 45 | 38869 | 42446 | 46005 | 49545 | 53066 | 56569 | 60054 | 63521 | 66970 | 70401 | 73815 | 47 |
| 12 0 | 38928 | 42505 | 46064 | 49603 | 53125 | 56627 | 60112 | 63579 | 67027 | 70458 | 73872 | 48 |
| 15 | 38988 | 42565 | 46123 | 49662 | 53183 | 56685 | 60170 | 63636 | 67085 | 70515 | 73928 | 49 |
| 30 | 39048 | 42624 | 46182 | 49721 | 53242 | 56744 | 60228 | 63694 | 67142 | 70572 | 73985 | 50 |
| 45 | 39108 | 42684 | 46241 | 49780 | 53300 | 56802 | 60286 | 63752 | 67199 | 70629 | 74042 | 51 |
| 13 0 | 39167 | 42743 | 46299 | 49839 | 53359 | 56860 | 60344 | 63809 | 67257 | 70686 | 74099 | 52 |
| 15 | 39227 | 42803 | 46359 | 49898 | 53417 | 56918 | 60402 | 63867 | 67314 | 70743 | 74155 | 53 |
| 30 | 39287 | 42862 | 46419 | 49956 | 53476 | 56977 | 60460 | 63924 | 67371 | 70800 | 74212 | 54 |
| 45 | 39347 | 42921 | 46478 | 50015 | 53534 | 57035 | 60517 | 63982 | 67429 | 70857 | 74269 | 55 |
| 14 0 | 39406 | 42981 | 46537 | 50074 | 53593 | 57093 | 60575 | 64040 | 67486 | 70914 | 74326 | 56 |
| 15 | 39466 | 43040 | 46596 | 50133 | 53651 | 57151 | 60633 | 64097 | 67543 | 70971 | 74382 | 57 |
| 30 | 39526 | 43100 | 46655 | 50192 | 53710 | 57209 | 60691 | 64155 | 67600 | 71028 | 74439 | 58 |
| 45 | 39586 | 43159 | 46714 | 50250 | 53768 | 57268 | 60749 | 64212 | 67658 | 71085 | 74496 | 59 |

| | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 60. | Parts | 4 | 8 | 12 | 16 | 20 | 24 | 28 | 32 | 36 | 40 | 44 | 48 | 52 | 56 | 60 |
| D. 57. | Parts | 4 | 8 | 11 | 15 | 19 | 23 | 27 | 30 | 34 | 38 | 42 | 46 | 49 | 53 | 57 |

## LOG. SINE SQUARE

| | 58° | | | 59° | | | | 60° | | | | 61° | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 43′ | 0′ | |
| | 3h 53m | 3h 54m | 3h 55m | 3h 56m | 3h 57m | 3h 58m | 3h 59m | 4h 0m | 4h 1m | 4h 2m | 4h 3m | 4h 4m | s. |
| ′ ″ | 9·3 | 9·3 | 9·3 | 9·3 | 9·3 | 9·39 | 9·39 | 9· | 9·40 | 9·40 | 9·4 | 9·41 | |
| 0 0 | 74552 | 77945 | 81320 | 84678 | 88018 | 1342 | 4649 | 397940 | 1214 | 4471 | 07713 | 0938 | 0 |
| 15 | 74609 | 78001 | 81376 | 84733 | 88074 | 1398 | 4704 | 397995 | 1268 | 4526 | 07767 | 0991 | 1 |
| 30 | 74666 | 78057 | 81432 | 84789 | 88130 | 1453 | 4759 | 398049 | 1323 | 4580 | 07820 | 1045 | 2 |
| 45 | 74722 | 78114 | 81488 | 84845 | 88185 | 1508 | 4814 | 398104 | 1377 | 4634 | 07874 | 1099 | 3 |
| 1 0 | 74779 | 78170 | 81544 | 84901 | 88241 | 1563 | 4869 | 398159 | 1432 | 4688 | 07928 | 1152 | 4 |
| 15 | 74836 | 78227 | 81600 | 84957 | 88296 | 1619 | 4924 | 398213 | 1486 | 4742 | 07982 | 1206 | 5 |
| 30 | 74892 | 78283 | 81656 | 85012 | 88351 | 1674 | 4979 | 398268 | 1540 | 4796 | 08036 | 1259 | 6 |
| 45 | 74949 | 78339 | 81712 | 85068 | 88407 | 1729 | 5034 | 398323 | 1595 | 4850 | 08090 | 1313 | 7 |
| 2 0 | 75006 | 78396 | 81768 | 85124 | 88463 | 1784 | 5089 | 398377 | 1649 | 4905 | 08144 | 1367 | 8 |
| 15 | 75062 | 78452 | 81825 | 85180 | 88518 | 1839 | 5144 | 398432 | 1704 | 4959 | 08197 | 1420 | 9 |
| 30 | 75119 | 78508 | 81881 | 85236 | 88574 | 1895 | 5199 | 398487 | 1758 | 5013 | 08251 | 1474 | 10 |
| 45 | 75176 | 78565 | 81937 | 85291 | 88629 | 1950 | 5254 | 398541 | 1812 | 5067 | 08305 | 1527 | 11 |
| 3 0 | 75232 | 78621 | 81993 | 85347 | 88685 | 2005 | 5309 | 398596 | 1867 | 5121 | 08359 | 1581 | 12 |
| 15 | 75289 | 78677 | 82049 | 85403 | 88740 | 2060 | 5364 | 398651 | 1921 | 5175 | 08413 | 1634 | 13 |
| 30 | 75345 | 78734 | 82105 | 85459 | 88796 | 2116 | 5419 | 398705 | 1975 | 5229 | 08467 | 1688 | 14 |
| 45 | 75402 | 78790 | 82161 | 85514 | 88851 | 2171 | 5474 | 398760 | 2030 | 5283 | 08520 | 1741 | 15 |
| 4 0 | 75459 | 78846 | 82217 | 85570 | 88906 | 2226 | 5529 | 398814 | 2084 | 5337 | 08574 | 1795 | 16 |
| 15 | 75515 | 78903 | 82273 | 85626 | 88962 | 2281 | 5583 | 398869 | 2139 | 5391 | 08628 | 1849 | 17 |
| 30 | 75572 | 78959 | 82329 | 85681 | 89017 | 2336 | 5638 | 398924 | 2193 | 5446 | 08682 | 1902 | 18 |
| 45 | 75628 | 79015 | 82385 | 85737 | 89073 | 2391 | 5693 | 398979 | 2247 | 5500 | 08736 | 1956 | 19 |
| 5 0 | 75685 | 79072 | 82441 | 85793 | 89128 | 2447 | 5748 | 399033 | 2302 | 5554 | 08789 | 2009 | 20 |
| 15 | 75742 | 79128 | 82497 | 85849 | 89184 | 2502 | 5803 | 399088 | 2356 | 5608 | 08843 | 2063 | 21 |
| 30 | 75798 | 79184 | 82553 | 85905 | 89239 | 2557 | 5858 | 399142 | 2410 | 5662 | 08897 | 2116 | 22 |
| 45 | 75855 | 79240 | 82609 | 85960 | 89295 | 2612 | 5913 | 399197 | 2465 | 5716 | 08951 | 2170 | 23 |
| 6 0 | 75911 | 79297 | 82665 | 86016 | 89350 | 2667 | 5968 | 399252 | 2519 | 5770 | 09005 | 2223 | 24 |
| 15 | 75968 | 79353 | 82721 | 86072 | 89406 | 2722 | 6023 | 399306 | 2573 | 5824 | 09058 | 2277 | 25 |
| 30 | 76024 | 79409 | 82777 | 86127 | 89461 | 2778 | 6077 | 399361 | 2628 | 5878 | 09112 | 2330 | 26 |
| 45 | 76081 | 79466 | 82833 | 86183 | 89516 | 2833 | 6132 | 399415 | 2682 | 5932 | 09166 | 2384 | 27 |
| 7 0 | 76138 | 79522 | 82889 | 86239 | 89572 | 2888 | 6187 | 399470 | 2736 | 5986 | 09220 | 2437 | 28 |
| 15 | 76194 | 79578 | 82945 | 86294 | 89627 | 2943 | 6242 | 399524 | 2790 | 6040 | 09273 | 2491 | 29 |
| 30 | 76251 | 79634 | 83001 | 86350 | 89683 | 2998 | 6297 | 399579 | 2845 | 6094 | 09327 | 2544 | 30 |
| 45 | 76307 | 79691 | 83057 | 86406 | 89738 | 3053 | 6352 | 399633 | 2899 | 6148 | 09381 | 2598 | 31 |
| 8 0 | 76364 | 79747 | 83113 | 86461 | 89793 | 3108 | 6406 | 399688 | 2953 | 6202 | 09435 | 2651 | 32 |
| 15 | 76420 | 79803 | 83169 | 86517 | 89849 | 3163 | 6461 | 399742 | 3008 | 6256 | 09488 | 2705 | 33 |
| 30 | 76477 | 79859 | 83225 | 86573 | 89904 | 3218 | 6516 | 399797 | 3062 | 6310 | 09542 | 2758 | 34 |
| 45 | 76533 | 79916 | 83281 | 86629 | 89959 | 3274 | 6571 | 399852 | 3116 | 6364 | 09596 | 2812 | 35 |
| 9 0 | 76590 | 79972 | 83337 | 86684 | 90015 | 3329 | 6626 | 399906 | 3170 | 6418 | 09650 | 2865 | 36 |
| 15 | 76646 | 80028 | 83392 | 86740 | 90070 | 3384 | 6681 | 399961 | 3225 | 6472 | 09703 | 2919 | 37 |
| 30 | 76703 | 80084 | 83448 | 86795 | 90125 | 3439 | 6735 | 400015 | 3279 | 6526 | 09757 | 2972 | 38 |
| 45 | 76759 | 80140 | 83504 | 86851 | 90181 | 3494 | 6790 | 400070 | 3333 | 6580 | 09811 | 3025 | 39 |
| 10 0 | 76816 | 80197 | 83560 | 86907 | 90236 | 3549 | 6845 | 400124 | 3387 | 6634 | 09864 | 3079 | 40 |
| 15 | 76872 | 80253 | 83616 | 86962 | 90292 | 3604 | 6900 | 400179 | 3442 | 6688 | 09918 | 3132 | 41 |
| 30 | 76929 | 80309 | 83672 | 87018 | 90347 | 3659 | 6955 | 400233 | 3496 | 6742 | 09972 | 3186 | 42 |
| 45 | 76985 | 80365 | 83728 | 87074 | 90402 | 3714 | 7009 | 400288 | 3550 | 6796 | 10026 | 3239 | 43 |
| 11 0 | 77042 | 80421 | 83784 | 87129 | 90458 | 3769 | 7064 | 400342 | 3604 | 6850 | 10079 | 3293 | 44 |
| 15 | 77098 | 80478 | 83840 | 87185 | 90513 | 3824 | 7119 | 400397 | 3659 | 6904 | 10133 | 3346 | 45 |
| 30 | 77155 | 80534 | 83896 | 87240 | 90568 | 3879 | 7174 | 400451 | 3713 | 6958 | 10187 | 3399 | 46 |
| 45 | 77211 | 80590 | 83952 | 87296 | 90624 | 3934 | 7228 | 400506 | 3767 | 7012 | 10240 | 3453 | 47 |
| 12 0 | 77268 | 80646 | 84007 | 87351 | 90679 | 3989 | 7283 | 400560 | 3821 | 7066 | 10294 | 3506 | 48 |
| 15 | 77324 | 80702 | 84063 | 87407 | 90734 | 4045 | 7338 | 400615 | 3875 | 7120 | 10348 | 3560 | 49 |
| 30 | 77380 | 80758 | 84119 | 87463 | 90790 | 4100 | 7393 | 400669 | 3930 | 7174 | 10401 | 3613 | 50 |
| 45 | 77437 | 80815 | 84175 | 87518 | 90845 | 4155 | 7447 | 400724 | 3984 | 7228 | 10455 | 3666 | 51 |
| 13 0 | 77493 | 80871 | 84231 | 87574 | 90900 | 4210 | 7502 | 400778 | 4038 | 7281 | 10509 | 3720 | 52 |
| 15 | 77550 | 80927 | 84287 | 87630 | 90956 | 4265 | 7557 | 400833 | 4092 | 7335 | 10562 | 3773 | 53 |
| 30 | 77606 | 80983 | 84343 | 87685 | 91011 | 4320 | 7612 | 400887 | 4146 | 7389 | 10616 | 3827 | 54 |
| 45 | 77663 | 81039 | 84398 | 87741 | 91066 | 4375 | 7666 | 400942 | 4201 | 7443 | 10670 | 3880 | 55 |
| 14 0 | 77719 | 81095 | 84454 | 87796 | 91121 | 4430 | 7721 | 400996 | 4225 | 7497 | 10723 | 3933 | 56 |
| 15 | 77775 | 81151 | 84510 | 87852 | 91177 | 4485 | 7776 | 401051 | 4309 | 7551 | 10777 | 3987 | 57 |
| 30 | 77832 | 81208 | 84566 | 87907 | 91232 | 4540 | 7831 | 401105 | 4363 | 7605 | 10830 | 4040 | 58 |
| 45 | 77888 | 81264 | 84622 | 87962 | 91287 | 4595 | 7885 | 401159 | 4417 | 7659 | 10884 | 4093 | 59 |

| | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 57. | Parts | 4 | 8 | 11 | 15 | 19 | 23 | 27 | 30 | 34 | 38 | 42 | 46 | 49 | 53 | 57 |
| D. 54. | Parts | 3 | 7 | 10 | 14 | 18 | 21 | 24 | 28 | 32 | 36 | 39 | 42 | 46 | 49 | 54 |

## LOG. SINE SQUARE

| | 61° | | | 62° | | | | 63° | | | | 64° | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | |
| | 4h 5m | 4h 6m | 4h 7m | 4h 8m | 4h 9m | 4h 10m | 4h 11m | 4h 12m | 4h 13m | 4h 14m | 4h 15m | 4h 16m | s. |
| ′ ″ | 9.41 | 9.4 | 9.42 | 9.42 | 9.42 | 9.4 | 9.43 | 9.4 | 9.4 | 9.4 | 9.4 | 9.4 | |
| 0 0 | 4147 | 17340 | 0517 | 3679 | 6825 | 29955 | 3070 | 36170 | 39255 | 42325 | 45379 | 48419 | 0 |
| 15 | 4200 | 17393 | 0570 | 3731 | 6877 | 30007 | 3122 | 36222 | 39306 | 42376 | 45430 | 48470 | 1 |
| 30 | 4253 | 17446 | 0623 | 3784 | 6929 | 30059 | 3174 | 36273 | 39358 | 42427 | 45481 | 48520 | 2 |
| 45 | 4307 | 17499 | 0676 | 3836 | 6982 | 30111 | 3226 | 36325 | 39409 | 42478 | 45532 | 48571 | 3 |
| 1 0 | 4360 | 17552 | 0728 | 3889 | 7034 | 30163 | 3277 | 36376 | 39460 | 42529 | 45583 | 48622 | 4 |
| 15 | 4413 | 17605 | 0781 | 3941 | 7086 | 30215 | 3329 | 36428 | 39511 | 42580 | 45633 | 48672 | 5 |
| 30 | 4467 | 17658 | 0834 | 3994 | 7138 | 30267 | 3381 | 36479 | 39563 | 42631 | 45684 | 48723 | 6 |
| 45 | 4520 | 17711 | 0887 | 4046 | 7191 | 30319 | 3433 | 36531 | 39614 | 42682 | 45735 | 48773 | 7 |
| 2 0 | 4573 | 17764 | 0940 | 4099 | 7243 | 30371 | 3484 | 36582 | 39665 | 42733 | 45786 | 48824 | 8 |
| 15 | 4627 | 17817 | 0992 | 4152 | 7295 | 30423 | 3536 | 36634 | 39716 | 42784 | 45836 | 48874 | 9 |
| 30 | 4680 | 17870 | 1045 | 4204 | 7347 | 30475 | 3588 | 36685 | 39768 | 42835 | 45887 | 48925 | 10 |
| 45 | 4733 | 17924 | 1098 | 4257 | 7400 | 30527 | 3640 | 36737 | 39819 | 42886 | 45938 | 48975 | 11 |
| 3 0 | 4787 | 17977 | 1151 | 4309 | 7452 | 30579 | 3691 | 36788 | 39870 | 42937 | 45989 | 49026 | 12 |
| 15 | 4840 | 18030 | 1203 | 4362 | 7504 | 30631 | 3743 | 36840 | 39921 | 42988 | 46039 | 49076 | 13 |
| 30 | 4893 | 18083 | 1256 | 4414 | 7556 | 30683 | 3795 | 36891 | 39973 | 43039 | 46090 | 49127 | 14 |
| 45 | 4946 | 18136 | 1309 | 4467 | 7609 | 30735 | 3847 | 36943 | 40024 | 43090 | 46141 | 49177 | 15 |
| 4 0 | 5000 | 18189 | 1362 | 4519 | 7661 | 30787 | 3898 | 36994 | 40075 | 43141 | 46192 | 49228 | 16 |
| 15 | 5053 | 18242 | 1414 | 4572 | 7713 | 30839 | 3950 | 37046 | 40126 | 43192 | 46242 | 49278 | 17 |
| 30 | 5106 | 18295 | 1467 | 4624 | 7765 | 30891 | 4002 | 37097 | 40177 | 43243 | 46293 | 49329 | 18 |
| 45 | 5160 | 18348 | 1520 | 4677 | 7817 | 30943 | 4054 | 37149 | 40229 | 43294 | 46344 | 49379 | 19 |
| 5 0 | 5213 | 18401 | 1573 | 4729 | 7870 | 30995 | 4105 | 37200 | 40280 | 43345 | 46394 | 49430 | 20 |
| 15 | 5266 | 18454 | 1625 | 4782 | 7922 | 31047 | 4157 | 37252 | 40331 | 43396 | 46445 | 49480 | 21 |
| 30 | 5319 | 18507 | 1678 | 4834 | 7974 | 31099 | 4209 | 37303 | 40382 | 43446 | 46496 | 49530 | 22 |
| 45 | 5373 | 18560 | 1731 | 4886 | 8026 | 31151 | 4260 | 37354 | 40433 | 43497 | 46546 | 49581 | 23 |
| 6 0 | 5426 | 18613 | 1784 | 4939 | 8079 | 31203 | 4312 | 37406 | 40485 | 43548 | 46597 | 49631 | 24 |
| 15 | 5479 | 18666 | 1836 | 4991 | 8131 | 31255 | 4364 | 37457 | 40536 | 43599 | 46648 | 49682 | 25 |
| 30 | 5532 | 18718 | 1889 | 5044 | 8183 | 31307 | 4415 | 37509 | 40587 | 43650 | 46699 | 49732 | 26 |
| 45 | 5586 | 18771 | 1942 | 5096 | 8235 | 31359 | 4467 | 37560 | 40638 | 43701 | 46749 | 49783 | 27 |
| 7 0 | 5639 | 18824 | 1994 | 5149 | 8287 | 31411 | 4519 | 37611 | 40689 | 43752 | 46800 | 49833 | 28 |
| 15 | 5692 | 18877 | 2047 | 5201 | 8340 | 31463 | 4570 | 37663 | 40741 | 43803 | 46851 | 49883 | 29 |
| 30 | 5745 | 18930 | 2100 | 5254 | 8392 | 31515 | 4622 | 37714 | 40791 | 43854 | 46901 | 49934 | 30 |
| 45 | 5798 | 18983 | 2152 | 5306 | 8444 | 31567 | 4674 | 37766 | 40843 | 43905 | 46952 | 49984 | 31 |
| 8 0 | 5852 | 19036 | 2205 | 5358 | 8496 | 31618 | 4725 | 37817 | 40894 | 43956 | 47003 | 50035 | 32 |
| 15 | 5905 | 19089 | 2258 | 5411 | 8548 | 31670 | 4777 | 37869 | 40945 | 44007 | 47053 | 50085 | 33 |
| 30 | 5958 | 19142 | 2311 | 5463 | 8600 | 31722 | 4829 | 37920 | 40996 | 44057 | 47104 | 50136 | 34 |
| 45 | 6011 | 19195 | 2363 | 5516 | 8653 | 31774 | 4880 | 37971 | 41047 | 44108 | 47155 | 50186 | 35 |
| 9 0 | 6064 | 19248 | 2416 | 5568 | 8705 | 31826 | 4932 | 38023 | 41099 | 44159 | 47205 | 50236 | 36 |
| 15 | 6118 | 19301 | 2469 | 5621 | 8757 | 31878 | 4984 | 38074 | 41150 | 44210 | 47256 | 50287 | 37 |
| 30 | 6171 | 19354 | 2521 | 5673 | 8809 | 31930 | 5035 | 38125 | 41201 | 44261 | 47306 | 50337 | 38 |
| 45 | 6224 | 19407 | 2574 | 5725 | 8861 | 31982 | 5087 | 38177 | 41252 | 44312 | 47357 | 50387 | 39 |
| 10 0 | 6277 | 19460 | 2627 | 5778 | 8913 | 32034 | 5139 | 38228 | 41303 | 44363 | 47408 | 50438 | 40 |
| 15 | 6330 | 19513 | 2679 | 5830 | 8966 | 32085 | 5190 | 38280 | 41354 | 44414 | 47458 | 50488 | 41 |
| 30 | 6384 | 19566 | 2732 | 5882 | 9018 | 32137 | 5242 | 38331 | 41405 | 44465 | 47509 | 50539 | 42 |
| 45 | 6437 | 19618 | 2784 | 5935 | 9070 | 32189 | 5293 | 38382 | 41456 | 44515 | 47560 | 50589 | 43 |
| 11 0 | 6490 | 19671 | 2837 | 5987 | 9122 | 32241 | 5345 | 38434 | 41507 | 44566 | 47610 | 50639 | 44 |
| 15 | 6543 | 19724 | 2890 | 6040 | 9174 | 32293 | 5397 | 38485 | 41559 | 44617 | 47661 | 50690 | 45 |
| 30 | 6596 | 19777 | 2942 | 6092 | 9226 | 32345 | 5448 | 38536 | 41610 | 44668 | 47711 | 50740 | 46 |
| 45 | 6649 | 19830 | 2995 | 6144 | 9278 | 32397 | 5500 | 38588 | 41661 | 44719 | 47762 | 50790 | 47 |
| 12 0 | 6702 | 19883 | 3048 | 6197 | 9330 | 32449 | 5551 | 38639 | 41712 | 44770 | 47813 | 50841 | 48 |
| 15 | 6756 | 19936 | 3100 | 6249 | 9382 | 32500 | 5603 | 38691 | 41763 | 44821 | 47863 | 50891 | 49 |
| 30 | 6809 | 19989 | 3153 | 6301 | 9434 | 32552 | 5655 | 38742 | 41814 | 44871 | 47914 | 50941 | 50 |
| 45 | 6862 | 20042 | 3205 | 6354 | 9487 | 32604 | 5706 | 38793 | 41865 | 44922 | 47964 | 50992 | 51 |
| 13 0 | 6915 | 20094 | 3258 | 6406 | 9539 | 32656 | 5758 | 38844 | 41916 | 44973 | 48015 | 51042 | 52 |
| 15 | 6968 | 20147 | 3311 | 6458 | 9591 | 32708 | 5809 | 38896 | 41967 | 45024 | 48065 | 51092 | 53 |
| 30 | 7021 | 20200 | 3363 | 6511 | 9643 | 32759 | 5861 | 38947 | 42018 | 45075 | 48116 | 51143 | 54 |
| 45 | 7074 | 20253 | 3416 | 6563 | 9695 | 32811 | 5912 | 38998 | 42069 | 45125 | 48167 | 51193 | 55 |
| 14 0 | 7127 | 20306 | 3468 | 6615 | 9747 | 32863 | 5964 | 39050 | 42120 | 45176 | 48217 | 51243 | 56 |
| 15 | 7181 | 20359 | 3521 | 6668 | 9799 | 32915 | 6016 | 39101 | 42172 | 45227 | 48268 | 51294 | 57 |
| 30 | 7234 | 20411 | 3574 | 6720 | 9851 | 32967 | 6067 | 39152 | 42223 | 45278 | 48318 | 51344 | 58 |
| 45 | 7287 | 20464 | 3626 | 6772 | 9903 | 33018 | 6119 | 39204 | 42274 | 45329 | 48369 | 51394 | 59 |

| | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 53. | Parts | 3 | 7 | 11 | 14 | 18 | 21 | 25 | 28 | 32 | 35 | 39 | 42 | 46 | 49 | 53 |
| D. 50. | Parts | 3 | 7 | 10 | 13 | 17 | 20 | 23 | 27 | 30 | 33 | 37 | 40 | 43 | 47 | 50 |

LOG. SINE SQUARE

| | | 64° | | | 65° | | | | 66° | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | |
| | | 4h 17m | 4h 18m | 4h 19m | 4h 20m | 4h 21m | 4h 22m | 4h 23m | 4h 24m | 4h 25m | 4h 26m | 4h 27m | s. |
| ′ | ″ | 9·4 | 9·4 | 9·4 | 9·4 | 9·4 | 9·4 | 9·4 | 9·4 | 9 4 | 9·4 | 9·4 | |
| 0 | 0 | 51445 | 54455 | 57451 | 60433 | 63400 | 66353 | 69293 | 72218 | 75128 | 78026 | 80909 | 0 |
| | 15 | 51495 | 54505 | 57501 | 60483 | 63450 | 66403 | 69341 | 72266 | 75177 | 78074 | 80957 | 1 |
| | 30 | 51546 | 54555 | 57551 | 60532 | 63499 | 66452 | 69390 | 72315 | 75225 | 78122 | 81005 | 2 |
| | 45 | 51596 | 54605 | 57601 | 60582 | 63548 | 66501 | 69439 | 72363 | 75274 | 78170 | 81053 | 3 |
| 1 | 0 | 51646 | 54655 | 57651 | 60631 | 63598 | 66550 | 69488 | 72412 | 75322 | 78218 | 81101 | 4 |
| | 15 | 51696 | 54706 | 57700 | 60681 | 63647 | 66599 | 69537 | 72461 | 75371 | 78267 | 81149 | 5 |
| | 30 | 51746 | 54756 | 57750 | 60730 | 63696 | 66648 | 69586 | 72509 | 75419 | 78315 | 81197 | 6 |
| | 45 | 51797 | 54806 | 57800 | 60780 | 63746 | 66697 | 69635 | 72558 | 75467 | 78363 | 81245 | 7 |
| 2 | 0 | 51847 | 54856 | 57850 | 60829 | 63795 | 66746 | 69683 | 72606 | 75516 | 78411 | 81293 | 8 |
| | 15 | 51897 | 54906 | 57900 | 60879 | 63844 | 66795 | 69732 | 72655 | 75564 | 78459 | 81341 | 9 |
| | 30 | 51947 | 54956 | 57949 | 60929 | 63894 | 66844 | 69781 | 72704 | 75612 | 78507 | 81388 | 10 |
| | 45 | 51998 | 55006 | 57999 | 60978 | 63943 | 66893 | 69830 | 72752 | 75661 | 78555 | 81436 | 11 |
| 3 | 0 | 52048 | 55056 | 58049 | 61028 | 63992 | 66942 | 69879 | 72801 | 75709 | 78604 | 81484 | 12 |
| | 15 | 52098 | 55106 | 58099 | 61077 | 64041 | 66992 | 69927 | 72849 | 75757 | 78652 | 81532 | 13 |
| | 30 | 52148 | 55156 | 58148 | 61127 | 64091 | 67041 | 69976 | 72898 | 75806 | 78700 | 81580 | 14 |
| | 45 | 52199 | 55206 | 58198 | 61176 | 64140 | 67090 | 70025 | 72947 | 75854 | 78748 | 81628 | 15 |
| 4 | 0 | 52249 | 55256 | 58248 | 61226 | 64189 | 67139 | 70074 | 72995 | 75902 | 78796 | 81676 | 16 |
| | 15 | 52299 | 55306 | 58298 | 61275 | 64239 | 67188 | 70123 | 73044 | 75951 | 78844 | 81724 | 17 |
| | 30 | 52349 | 55356 | 58347 | 61325 | 64288 | 67237 | 70171 | 73092 | 75999 | 78892 | 81771 | 18 |
| | 45 | 52400 | 55406 | 58397 | 61374 | 64337 | 67286 | 70220 | 73141 | 76047 | 78940 | 81819 | 19 |
| 5 | 0 | 52450 | 55456 | 58447 | 61424 | 64386 | 67335 | 70269 | 73189 | 76096 | 78988 | 81867 | 20 |
| | 15 | 52500 | 55506 | 58497 | 61473 | 64436 | 67384 | 70318 | 73238 | 76144 | 79036 | 81915 | 21 |
| | 30 | 52550 | 55556 | 58546 | 61523 | 64485 | 67433 | 70366 | 73286 | 76192 | 79085 | 81963 | 22 |
| | 45 | 52600 | 55605 | 58596 | 61572 | 64534 | 67482 | 70415 | 73335 | 76241 | 79133 | 82011 | 23 |
| 6 | 0 | 52651 | 55655 | 58646 | 61622 | 64583 | 67531 | 70464 | 73384 | 76289 | 79181 | 82059 | 24 |
| | 15 | 52701 | 55705 | 58695 | 61671 | 64633 | 67580 | 70513 | 73432 | 76337 | 79229 | 82107 | 25 |
| | 30 | 52751 | 55755 | 58745 | 61721 | 64682 | 67629 | 70562 | 73481 | 76386 | 79277 | 82154 | 26 |
| | 45 | 52801 | 55805 | 58795 | 61770 | 64731 | 67678 | 70610 | 73529 | 76434 | 79325 | 82202 | 27 |
| 7 | 0 | 52851 | 55855 | 58845 | 61820 | 64780 | 67727 | 70659 | 73578 | 76482 | 79373 | 82250 | 28 |
| | 15 | 52902 | 55905 | 58894 | 61869 | 64830 | 67776 | 70708 | 73626 | 76531 | 79421 | 82298 | 29 |
| | 30 | 52952 | 55955 | 58944 | 61918 | 64879 | 67825 | 70757 | 73675 | 76579 | 79469 | 82346 | 30 |
| | 45 | 53002 | 56005 | 58994 | 61968 | 64928 | 67874 | 70806 | 73723 | 76627 | 79517 | 82394 | 31 |
| 8 | 0 | 53052 | 56055 | 59043 | 62017 | 64977 | 67923 | 70854 | 73772 | 76675 | 79565 | 82441 | 32 |
| | 15 | 53102 | 56105 | 59093 | 62067 | 65026 | 67972 | 70903 | 73820 | 76724 | 79613 | 82489 | 33 |
| | 30 | 53152 | 56155 | 59143 | 62116 | 65076 | 68021 | 70952 | 73869 | 76772 | 79661 | 82537 | 34 |
| | 45 | 53203 | 56205 | 59192 | 62166 | 65125 | 68070 | 71000 | 73917 | 76820 | 79709 | 82585 | 35 |
| 9 | 0 | 53253 | 56255 | 59242 | 62215 | 65174 | 68119 | 71049 | 73966 | 76869 | 79758 | 82633 | 36 |
| | 15 | 53303 | 56305 | 59292 | 62265 | 65223 | 68168 | 71098 | 74014 | 76917 | 79806 | 82680 | 37 |
| | 30 | 53353 | 56354 | 59341 | 62314 | 65272 | 68217 | 71147 | 74063 | 76965 | 79854 | 82728 | 38 |
| | 45 | 53403 | 56404 | 59391 | 62363 | 65322 | 68265 | 71195 | 74111 | 77013 | 79902 | 82776 | 39 |
| 10 | 0 | 53453 | 56454 | 59441 | 62413 | 65371 | 68314 | 71244 | 74160 | 77062 | 79950 | 82824 | 40 |
| | 15 | 53503 | 56504 | 59490 | 62462 | 65420 | 68363 | 71293 | 74208 | 77110 | 79998 | 82872 | 41 |
| | 30 | 53554 | 56554 | 59540 | 62512 | 65469 | 68412 | 71342 | 74257 | 77158 | 80046 | 82919 | 42 |
| | 45 | 53604 | 56604 | 59590 | 62561 | 65518 | 68461 | 71390 | 74305 | 77206 | 80094 | 82967 | 43 |
| 11 | 0 | 53654 | 56654 | 59639 | 62610 | 65567 | 68510 | 71439 | 74354 | 77254 | 80142 | 83015 | 44 |
| | 15 | 53704 | 56704 | 59689 | 62660 | 65617 | 68559 | 71488 | 74402 | 77303 | 80190 | 83063 | 45 |
| | 30 | 53754 | 56754 | 59739 | 62709 | 65666 | 68608 | 71536 | 74451 | 77351 | 80238 | 83110 | 46 |
| | 45 | 53804 | 56803 | 59788 | 62759 | 65715 | 68657 | 71585 | 74499 | 77399 | 80286 | 83158 | 47 |
| 12 | 0 | 53854 | 56853 | 59838 | 62808 | 65764 | 68706 | 71634 | 74547 | 77447 | 80334 | 83206 | 48 |
| | 15 | 53904 | 56903 | 59887 | 62857 | 65813 | 68755 | 71682 | 74596 | 77496 | 80382 | 83254 | 49 |
| | 30 | 53954 | 56953 | 59937 | 62907 | 65862 | 68804 | 71731 | 74644 | 77544 | 80430 | 83302 | 50 |
| | 45 | 54005 | 57003 | 59987 | 62956 | 65911 | 68853 | 71780 | 74693 | 77592 | 80478 | 83349 | 51 |
| 13 | 0 | 54055 | 57053 | 60036 | 63006 | 65961 | 68901 | 71828 | 74741 | 77640 | 80526 | 83397 | 52 |
| | 15 | 54105 | 57103 | 60086 | 63055 | 66010 | 68950 | 71877 | 74790 | 77688 | 80573 | 83445 | 53 |
| | 30 | 54155 | 57152 | 60135 | 63104 | 66059 | 68999 | 71926 | 74838 | 77737 | 80621 | 83493 | 54 |
| | 45 | 54205 | 57202 | 60185 | 63154 | 66108 | 69048 | 71974 | 74886 | 77785 | 80669 | 83540 | 55 |
| 14 | 0 | 54255 | 57252 | 60235 | 63203 | 66157 | 69097 | 72023 | 74935 | 77833 | 80717 | 83588 | 56 |
| | 15 | 54305 | 57302 | 60284 | 63252 | 66206 | 69146 | 72072 | 74983 | 77881 | 80765 | 83636 | 57 |
| | 30 | 54355 | 57352 | 60334 | 63302 | 66255 | 69195 | 72120 | 75032 | 77929 | 80813 | 83684 | 58 |
| | 45 | 54405 | 57402 | 60383 | 63351 | 66304 | 69244 | 72169 | 75080 | 77978 | 80861 | 83731 | 59 |

| | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 50. | Parts | 3 | 7 | 10 | 13 | 17 | 20 | 23 | 27 | 30 | 33 | 37 | 40 | 43 | 47 | 50 |
| D. 48. | Parts | 3 | 6 | 10 | 13 | 16 | 19 | 22 | 26 | 29 | 32 | 35 | 38 | 42 | 45 | 48 |

## LOG. SINE SQUARE

| | 67° | | | | 68° | | | | 69° | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0' | 15' | 30' | 45' | 0' | 15' | 30' | 45' | 0' | 15' | 30' | |
| | 4h 28m | 4h 29m | 4h 30m | 4h 31m | 4h 32m | 4h 33m | 4h 34m | 4h 35m | 4h 36m | 4h 37m | 4h 38m | s. |
| ′ ″ | 9·4 | 9·4 | 9·4 | 9·4 | 9·4 | 9· | 9·5 | 9·5 | 9·5 | 9·5 | 9·5 | |
| 0 0 | 83779 | 86635 | 89478 | 92307 | 95123 | 497926 | 00716 | 03492 | 06256 | 09007 | 11745 | 0 |
| 15 | 83827 | 86683 | 89525 | 92354 | 95170 | 497973 | 00762 | 03539 | 06302 | 09053 | 11790 | 1 |
| 30 | 83874 | 86730 | 89572 | 92401 | 95217 | 498019 | 00809 | 03585 | 06348 | 09098 | 11836 | 2 |
| 45 | 83922 | 86778 | 89620 | 92448 | 95264 | 498066 | 00855 | 03631 | 06394 | 09144 | 11881 | 3 |
| 1 0 | 83970 | 86825 | 89667 | 92495 | 95311 | 498112 | 00901 | 03677 | 06440 | 09190 | 11927 | 4 |
| 15 | 84017 | 86873 | 89714 | 92542 | 95357 | 498159 | 00948 | 03723 | 06486 | 09235 | 11972 | 5 |
| 30 | 84065 | 86920 | 89761 | 92589 | 95404 | 498206 | 00994 | 03769 | 06532 | 09281 | 12018 | 6 |
| 45 | 84113 | 86968 | 89809 | 92636 | 95451 | 498252 | 01040 | 03815 | 06578 | 09327 | 12063 | 7 |
| 2 0 | 84161 | 87015 | 89856 | 92683 | 95498 | 498299 | 01087 | 03862 | 06624 | 09373 | 12109 | 8 |
| 15 | 84208 | 87062 | 89903 | 92730 | 95545 | 498345 | 01133 | 03908 | 06669 | 09418 | 12154 | 9 |
| 30 | 84256 | 87110 | 89950 | 92778 | 95591 | 498392 | 01179 | 03954 | 06715 | 09464 | 12200 | 10 |
| 45 | 84304 | 87157 | 89998 | 92825 | 95638 | 498438 | 01226 | 04000 | 06761 | 09510 | 12245 | 11 |
| 3 0 | 84351 | 87205 | 90045 | 92872 | 95685 | 498485 | 01272 | 04046 | 06807 | 09555 | 12291 | 12 |
| 15 | 84399 | 87252 | 90092 | 92919 | 95732 | 498532 | 01318 | 04092 | 06853 | 09601 | 12336 | 13 |
| 30 | 84447 | 87300 | 90139 | 92966 | 95778 | 498578 | 01365 | 04138 | 06899 | 09647 | 12382 | 14 |
| 45 | 84494 | 87347 | 90186 | 93012 | 95825 | 498625 | 01411 | 04184 | 06945 | 09692 | 12427 | 15 |
| 4 0 | 84542 | 87395 | 90234 | 93059 | 95872 | 498671 | 01457 | 04231 | 06991 | 09738 | 12473 | 16 |
| 15 | 84590 | 87442 | 90281 | 93106 | 95919 | 498718 | 01504 | 04277 | 07037 | 09784 | 12518 | 17 |
| 30 | 84637 | 87489 | 90328 | 93153 | 95965 | 498764 | 01550 | 04323 | 07083 | 09830 | 12564 | 18 |
| 45 | 84685 | 87537 | 90375 | 93200 | 96012 | 498811 | 01596 | 04369 | 07128 | 09875 | 12609 | 19 |
| 5 0 | 84733 | 87584 | 90423 | 93247 | 96059 | 498857 | 01643 | 04415 | 07174 | 09921 | 12655 | 20 |
| 15 | 84780 | 87632 | 90470 | 93294 | 96106 | 498904 | 01689 | 04461 | 07220 | 09967 | 12700 | 21 |
| 30 | 84828 | 87679 | 90517 | 93341 | 96152 | 498951 | 01735 | 04507 | 07266 | 10012 | 12745 | 22 |
| 45 | 84875 | 87726 | 90564 | 93388 | 96199 | 498997 | 01782 | 04553 | 07312 | 10058 | 12791 | 23 |
| 6 0 | 84923 | 87774 | 90611 | 93435 | 96246 | 499044 | 01828 | 04599 | 07358 | 10103 | 12836 | 24 |
| 15 | 84971 | 87821 | 90658 | 93482 | 96293 | 499090 | 01874 | 04645 | 07404 | 10149 | 12882 | 25 |
| 30 | 85018 | 87869 | 90706 | 93529 | 96339 | 499137 | 01921 | 04692 | 07450 | 10195 | 12927 | 26 |
| 45 | 85066 | 87916 | 90753 | 93576 | 96386 | 499183 | 01967 | 04738 | 07495 | 10240 | 12973 | 27 |
| 7 0 | 85114 | 87963 | 90800 | 93623 | 96433 | 499230 | 02013 | 04784 | 07541 | 10286 | 13018 | 28 |
| 15 | 85161 | 88011 | 90848 | 93670 | 96480 | 499276 | 02059 | 04830 | 07587 | 10332 | 13064 | 29 |
| 30 | 85209 | 88058 | 90894 | 93717 | 96526 | 499323 | 02106 | 04876 | 07633 | 10377 | 13109 | 30 |
| 45 | 85256 | 88106 | 90941 | 93764 | 96573 | 499369 | 02152 | 04922 | 07679 | 10423 | 13154 | 31 |
| 8 0 | 85304 | 88153 | 90989 | 93811 | 96620 | 499416 | 02198 | 04968 | 07725 | 10469 | 13200 | 32 |
| 15 | 85352 | 88200 | 91036 | 93858 | 96666 | 499462 | 02245 | 05014 | 07771 | 10514 | 13245 | 33 |
| 30 | 85399 | 88248 | 91083 | 93905 | 96713 | 499509 | 02291 | 05060 | 07816 | 10560 | 13291 | 34 |
| 45 | 85447 | 88295 | 91130 | 93952 | 96760 | 499555 | 02337 | 05106 | 07862 | 10606 | 13336 | 35 |
| 9 0 | 85494 | 88342 | 91177 | 93998 | 96807 | 499601 | 02383 | 05152 | 07908 | 10651 | 13381 | 36 |
| 15 | 85542 | 88390 | 91224 | 94045 | 96853 | 499648 | 02430 | 05198 | 07954 | 10697 | 13427 | 37 |
| 30 | 85589 | 88437 | 91271 | 94092 | 96900 | 499694 | 02476 | 05244 | 08000 | 10742 | 13472 | 38 |
| 45 | 85637 | 88485 | 91318 | 94139 | 96947 | 499741 | 02522 | 05290 | 08045 | 10788 | 13518 | 39 |
| 10 0 | 85685 | 88532 | 91366 | 94186 | 96993 | 499787 | 02568 | 05336 | 08091 | 10833 | 13563 | 40 |
| 15 | 85732 | 88579 | 91413 | 94233 | 97040 | 499834 | 02615 | 05382 | 08137 | 10879 | 13608 | 41 |
| 30 | 85780 | 88627 | 91460 | 94280 | 97087 | 499880 | 02661 | 05428 | 08183 | 10925 | 13654 | 42 |
| 45 | 85827 | 88674 | 91507 | 94327 | 97133 | 499927 | 02707 | 05474 | 08229 | 10970 | 13699 | 43 |
| 11 0 | 85875 | 88721 | 91554 | 94374 | 97180 | 499973 | 02753 | 05520 | 08274 | 11016 | 13744 | 44 |
| 15 | 85922 | 88769 | 91601 | 94421 | 97227 | 500020 | 02799 | 05566 | 08320 | 11061 | 13790 | 45 |
| 30 | 85970 | 88816 | 91648 | 94467 | 97273 | 500066 | 02846 | 05612 | 08366 | 11107 | 13835 | 46 |
| 45 | 86017 | 88863 | 91695 | 94514 | 97320 | 500112 | 02892 | 05658 | 08412 | 11153 | 13881 | 47 |
| 12 0 | 86065 | 88910 | 91742 | 94561 | 97367 | 500159 | 02938 | 05704 | 08458 | 11198 | 13926 | 48 |
| 15 | 86113 | 88958 | 91790 | 94608 | 97413 | 500205 | 02984 | 05750 | 08503 | 11244 | 13971 | 49 |
| 30 | 86160 | 89005 | 91837 | 94655 | 97460 | 500252 | 03030 | 05796 | 08549 | 11289 | 14017 | 50 |
| 45 | 86208 | 89052 | 91884 | 94702 | 97507 | 500298 | 03077 | 05842 | 08595 | 11335 | 14062 | 51 |
| 13 0 | 86255 | 89100 | 91931 | 94749 | 97553 | 500345 | 03123 | 05888 | 08641 | 11380 | 14107 | 52 |
| 15 | 86303 | 89147 | 91978 | 94795 | 97600 | 500391 | 03169 | 05934 | 08687 | 11426 | 14153 | 53 |
| 30 | 86350 | 89194 | 92025 | 94842 | 97646 | 500437 | 03215 | 05980 | 08732 | 11471 | 14198 | 54 |
| 45 | 86398 | 89242 | 92072 | 94889 | 97693 | 500484 | 03261 | 06026 | 08778 | 11517 | 14243 | 55 |
| 14 0 | 86445 | 89289 | 92119 | 94936 | 97740 | 500530 | 03308 | 06072 | 08824 | 11563 | 14289 | 56 |
| 15 | 86493 | 89336 | 92166 | 94983 | 97786 | 500577 | 03354 | 06118 | 08870 | 11608 | 14334 | 57 |
| 30 | 86540 | 89383 | 92213 | 95030 | 97833 | 500623 | 03400 | 06164 | 08915 | 11654 | 14379 | 58 |
| 45 | 86588 | 89431 | 92260 | 95077 | 97879 | 500669 | 03446 | 06210 | 08961 | 11699 | 14425 | 59 |

| | Sec. | 1" | 2" | 3" | 4" | 5" | 6" | 7" | 8" | 9" | 10" | 11" | 12" | 13" | 14" | 15" |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 48. | Parts | 3 | 6 | 10 | 13 | 16 | 19 | 22 | 26 | 29 | 32 | 35 | 38 | 42 | 45 | 48 |
| D. 46. | Parts | 3 | 6 | 9 | 12 | 15 | 18 | 21 | 25 | 28 | 31 | 34 | 37 | 40 | 43 | 46 |

## LOG. SINE SQUARE

| m | s | 69° 45′ 4h 39m | 70° 0′ 4h 40m | 70° 15′ 4h 41m | 70° 30′ 4h 42m | 70° 45′ 4h 43m | 71° 0′ 4h 44m | 71° 15′ 4h 45m | 71° 30′ 4h 46m | 71° 45′ 4h 47m | 72° 0′ 4h 48m | 72° 15′ 4h 49m | s. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 9·5 | 9·5 | 9·5 | 9·5 | 9·5 | 9·5 | 9·5 | 9·5 | 9·5 | 9·5 | 9·5 | |
| 0 | 0 | 14470 | 17183 | 19883 | 22570 | 25245 | 27908 | 30559 | 33197 | 35823 | 38437 | 41040 | 0 |
| | 15 | 14515 | 17228 | 19927 | 22615 | 25290 | 27952 | 30603 | 33241 | 35867 | 38481 | 41083 | 1 |
| | 30 | 14561 | 17273 | 19972 | 22659 | 25334 | 27997 | 30647 | 33285 | 35910 | 38524 | 41126 | 2 |
| | 45 | 14606 | 17318 | 20017 | 22704 | 25379 | 28041 | 30691 | 33329 | 35954 | 38568 | 41169 | 3 |
| 1 | 0 | 14651 | 17363 | 20062 | 22749 | 25423 | 28085 | 30735 | 33372 | 35998 | 38611 | 41213 | 4 |
| | 15 | 14696 | 17408 | 20107 | 22794 | 25468 | 28129 | 30779 | 33416 | 36041 | 38655 | 41256 | 5 |
| | 30 | 14742 | 17453 | 20152 | 22838 | 25512 | 28174 | 30823 | 33460 | 36085 | 38698 | 41299 | 6 |
| | 45 | 14787 | 17498 | 20197 | 22883 | 25557 | 28218 | 30867 | 33504 | 36129 | 38742 | 41342 | 7 |
| 2 | 0 | 14832 | 17543 | 20242 | 22928 | 25601 | 28262 | 30911 | 33548 | 36172 | 38785 | 41386 | 8 |
| | 15 | 14878 | 17588 | 20287 | 22972 | 25645 | 28306 | 30955 | 33592 | 36216 | 38828 | 41429 | 9 |
| | 30 | 14923 | 17633 | 20331 | 23017 | 25690 | 28351 | 30999 | 33635 | 36260 | 38872 | 41472 | 10 |
| | 45 | 14968 | 17678 | 20376 | 23062 | 25734 | 28395 | 31043 | 33679 | 36303 | 38915 | 41515 | 11 |
| 3 | 0 | 15014 | 17724 | 20421 | 23106 | 25779 | 28439 | 31087 | 33723 | 36347 | 38959 | 41559 | 12 |
| | 15 | 15059 | 17769 | 20466 | 23151 | 25823 | 28483 | 31131 | 33767 | 36391 | 39002 | 41602 | 13 |
| | 30 | 15104 | 17814 | 20511 | 23195 | 25868 | 28528 | 31175 | 33811 | 36434 | 39046 | 41645 | 14 |
| | 45 | 15149 | 17859 | 20556 | 23240 | 25912 | 28572 | 31219 | 33854 | 36478 | 39089 | 41688 | 15 |
| 4 | 0 | 15195 | 17904 | 20600 | 23285 | 25957 | 28616 | 31263 | 33898 | 36521 | 39132 | 41731 | 16 |
| | 15 | 15240 | 17949 | 20645 | 23329 | 26001 | 28660 | 31307 | 33942 | 36565 | 39176 | 41775 | 17 |
| | 30 | 15285 | 17994 | 20690 | 23374 | 26045 | 28704 | 31351 | 33986 | 36609 | 39219 | 41818 | 18 |
| | 45 | 15330 | 18039 | 20735 | 23419 | 26090 | 28749 | 31395 | 34030 | 36652 | 39263 | 41861 | 19 |
| 5 | 0 | 15376 | 18084 | 20780 | 23463 | 26134 | 28793 | 31439 | 34074 | 36696 | 39306 | 41904 | 20 |
| | 15 | 15421 | 18129 | 20825 | 23508 | 26179 | 28837 | 31483 | 34117 | 36740 | 39349 | 41948 | 21 |
| | 30 | 15466 | 18174 | 20869 | 23552 | 26223 | 28881 | 31527 | 34161 | 36783 | 39393 | 41991 | 22 |
| | 45 | 15511 | 18219 | 20914 | 23597 | 26267 | 28926 | 31571 | 34205 | 36827 | 39436 | 42034 | 23 |
| 6 | 0 | 15557 | 18264 | 20959 | 23642 | 26312 | 28970 | 31615 | 34249 | 36870 | 39480 | 42077 | 24 |
| | 15 | 15602 | 18309 | 21004 | 23686 | 26356 | 29014 | 31659 | 34293 | 36914 | 39523 | 42120 | 25 |
| | 30 | 15647 | 18354 | 21049 | 23731 | 26401 | 29058 | 31703 | 34336 | 36957 | 39566 | 42164 | 26 |
| | 45 | 15692 | 18399 | 21094 | 23775 | 26445 | 29102 | 31747 | 34380 | 37001 | 39610 | 42207 | 27 |
| 7 | 0 | 15737 | 18444 | 21138 | 23820 | 26489 | 29146 | 31791 | 34424 | 37045 | 39653 | 42250 | 28 |
| | 15 | 15783 | 18489 | 21183 | 23865 | 26534 | 29191 | 31835 | 34468 | 37088 | 39697 | 42293 | 29 |
| | 30 | 15828 | 18534 | 21228 | 23909 | 26578 | 29235 | 31879 | 34511 | 37132 | 39740 | 42336 | 30 |
| | 45 | 15873 | 18579 | 21273 | 23954 | 26623 | 29279 | 31923 | 34555 | 37175 | 39783 | 42379 | 31 |
| 8 | 0 | 15918 | 18624 | 21317 | 23998 | 26667 | 29323 | 31967 | 34599 | 37219 | 39827 | 42423 | 32 |
| | 15 | 15963 | 18669 | 21362 | 24043 | 26711 | 29367 | 32011 | 34643 | 37262 | 39870 | 42466 | 33 |
| | 30 | 16009 | 18714 | 21407 | 24087 | 26756 | 29411 | 32055 | 34687 | 37306 | 39913 | 42509 | 34 |
| | 45 | 16054 | 18759 | 21452 | 24132 | 26800 | 29456 | 32099 | 34730 | 37350 | 39957 | 42552 | 35 |
| 9 | 0 | 16099 | 18804 | 21497 | 24177 | 26844 | 29500 | 32143 | 34774 | 37393 | 40000 | 42595 | 36 |
| | 15 | 16144 | 18849 | 21541 | 24221 | 26889 | 29544 | 32187 | 34818 | 37437 | 40043 | 42638 | 37 |
| | 30 | 16189 | 18894 | 21586 | 24266 | 26933 | 29588 | 32231 | 34862 | 37480 | 40087 | 42681 | 38 |
| | 45 | 16235 | 18939 | 21631 | 24310 | 26977 | 29632 | 32275 | 34905 | 37524 | 40130 | 42725 | 39 |
| 10 | 0 | 16280 | 18984 | 21676 | 24355 | 27022 | 29676 | 32319 | 34949 | 37567 | 40173 | 42768 | 40 |
| | 15 | 16325 | 19029 | 21720 | 24400 | 27066 | 29721 | 32363 | 34993 | 37611 | 40217 | 42811 | 41 |
| | 30 | 16370 | 19074 | 21765 | 24444 | 27110 | 29765 | 32407 | 35037 | 37654 | 40260 | 42854 | 42 |
| | 45 | 16415 | 19119 | 21810 | 24489 | 27155 | 29809 | 32451 | 35080 | 37698 | 40304 | 42897 | 43 |
| 11 | 0 | 16460 | 19164 | 21855 | 24533 | 27199 | 29853 | 32495 | 35124 | 37741 | 40347 | 42940 | 44 |
| | 15 | 16506 | 19209 | 21899 | 24578 | 27244 | 29897 | 32538 | 35168 | 37785 | 40390 | 42983 | 45 |
| | 30 | 16551 | 19254 | 21944 | 24622 | 27288 | 29941 | 32582 | 35211 | 37828 | 40434 | 43027 | 46 |
| | 45 | 16596 | 19299 | 21989 | 24667 | 27332 | 29985 | 32626 | 35255 | 37872 | 40477 | 43070 | 47 |
| 12 | 0 | 16641 | 19344 | 22034 | 24711 | 27376 | 30029 | 32670 | 35299 | 37915 | 40520 | 43113 | 48 |
| | 15 | 16686 | 19389 | 22078 | 24756 | 27421 | 30074 | 32714 | 35343 | 37959 | 40563 | 43156 | 49 |
| | 30 | 16731 | 19433 | 22123 | 24800 | 27465 | 30118 | 32758 | 35386 | 38002 | 40607 | 43199 | 50 |
| | 45 | 16777 | 19478 | 22168 | 24845 | 27509 | 30162 | 32802 | 35430 | 38046 | 40650 | 43242 | 51 |
| 13 | 0 | 16822 | 19523 | 22213 | 24889 | 27554 | 30206 | 32846 | 35474 | 38089 | 40693 | 43285 | 52 |
| | 15 | 16867 | 19568 | 22257 | 24934 | 27598 | 30250 | 32890 | 35517 | 38133 | 40737 | 43328 | 53 |
| | 30 | 16912 | 19613 | 22302 | 24978 | 27642 | 30294 | 32934 | 35561 | 38176 | 40780 | 43371 | 54 |
| | 45 | 16957 | 19658 | 22347 | 25023 | 27687 | 30338 | 32978 | 35605 | 38220 | 40823 | 43414 | 55 |
| 14 | 0 | 17002 | 19703 | 22391 | 25067 | 27731 | 30382 | 33021 | 35648 | 38263 | 40866 | 43458 | 56 |
| | 15 | 17047 | 19748 | 22436 | 25112 | 27775 | 30426 | 33065 | 35692 | 38307 | 40910 | 43501 | 57 |
| | 30 | 17092 | 19793 | 22481 | 25156 | 27819 | 30470 | 33109 | 35736 | 38350 | 40953 | 43544 | 58 |
| | 45 | 17137 | 19838 | 22525 | 25201 | 27864 | 30514 | 33153 | 35779 | 38394 | 40996 | 43587 | 59 |

| | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 45. | Parts | 3 | 6 | 9 | 12 | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 |
| D. 43. | Parts | 3 | 6 | 9 | 12 | 14 | 17 | 20 | 23 | 26 | 29 | 32 | 35 | 37 | 40 | 43 |

## LOG. SINE SQUARE

| | | 72° | | 73° | | | | 74° | | | | 75° | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | |
| | | 4h 50m | 4h 51m | 4h 52m | 4h 53m | 4h 54m | 4h 55m | 4h 56m | 4h 57m | 4h 58m | 4h 59m | 5h 0m | s. |
| ′ | ″ | 9·5 | 9·5 | 9·5 | 9·5 | 9·5 | 9·5 | 9·5 | 9·5 | 9·5 | 9·5 | 9·5 | |
| 0 | 0 | 43630 | 46208 | 48775 | 51330 | 53874 | 56406 | 58926 | 61435 | 63933 | 66419 | 68894 | 0 |
| | 15 | 43673 | 46251 | 48818 | 51373 | 53916 | 56448 | 58968 | 61477 | 63974 | 66460 | 68935 | 1 |
| | 30 | 43716 | 46294 | 48861 | 51415 | 53958 | 56490 | 59010 | 61519 | 64016 | 66502 | 68977 | 2 |
| | 45 | 43759 | 46337 | 48903 | 51458 | 54001 | 56532 | 59052 | 61560 | 64057 | 66543 | 69018 | 3 |
| 1 | 0 | 43802 | 46380 | 48946 | 51500 | 54043 | 56574 | 59094 | 61602 | 64099 | 66584 | 69059 | 4 |
| | 15 | 43845 | 46423 | 48989 | 51543 | 54085 | 56616 | 59136 | 61644 | 64140 | 66626 | 69100 | 5 |
| | 30 | 43888 | 46466 | 49031 | 51585 | 54127 | 56658 | 59177 | 6 685 | 64182 | 66667 | 69141 | 6 |
| | 45 | 43931 | 46508 | 49074 | 51628 | 54170 | 56700 | 59219 | 61,27 | 64223 | 66708 | 69182 | 7 |
| 2 | 0 | 43974 | 46551 | 49116 | 51670 | 54212 | 56742 | 59261 | 61769 | 64265 | 66750 | 69223 | 8 |
| | 15 | 44017 | 46594 | 49159 | 51713 | 54254 | 56784 | 59303 | 61810 | 64306 | 66791 | 69265 | 9 |
| | 30 | 44061 | 46637 | 49202 | 51755 | 54296 | 56826 | 59345 | 61852 | 64348 | 66832 | 69306 | 10 |
| | 45 | 44104 | 46680 | 49244 | 51797 | 54339 | 56869 | 59387 | 61894 | 64389 | 66874 | 69347 | 11 |
| 3 | 0 | 44147 | 46723 | 49287 | 51840 | 54381 | 56911 | 59429 | 61935 | 64431 | 66915 | 69388 | 12 |
| | 15 | 44190 | 46766 | 49330 | 51882 | 54423 | 56953 | 59471 | 61977 | 64472 | 66956 | 69429 | 13 |
| | 30 | 44233 | 46808 | 49372 | 51925 | 54465 | 56995 | 59512 | 62019 | 64514 | 66998 | 69470 | 14 |
| | 45 | 44276 | 46851 | 49415 | 51967 | 54508 | 57037 | 59554 | 62060 | 64555 | 67039 | 69511 | 15 |
| 4 | 0 | 44319 | 46894 | 49458 | 52010 | 54550 | 57079 | 59596 | 62102 | 64597 | 67080 | 69552 | 16 |
| | 15 | 44362 | 46937 | 49500 | 52052 | 54592 | 57121 | 59638 | 62144 | 64638 | 67121 | 69593 | 17 |
| | 30 | 44405 | 46980 | 49543 | 52095 | 54634 | 57163 | 59680 | 62186 | 64680 | 67163 | 69635 | 18 |
| | 45 | 44448 | 47022 | 49586 | 52137 | 54677 | 57205 | 59722 | 62227 | 64721 | 67204 | 69676 | 19 |
| 5 | 0 | 44491 | 47065 | 49628 | 52179 | 54719 | 57247 | 59764 | 62269 | 64763 | 67245 | 69717 | 20 |
| | 15 | 44534 | 47108 | 49671 | 52222 | 54761 | 57289 | 59806 | 62311 | 64804 | 67287 | 69758 | 21 |
| | 30 | 44577 | 47151 | 49713 | 52264 | 54803 | 57331 | 59847 | 62352 | 64846 | 67328 | 69799 | 22 |
| | 45 | 44620 | 47194 | 49756 | 52307 | 54846 | 57373 | 59889 | 62394 | 64887 | 67369 | 69840 | 23 |
| 6 | 0 | 44663 | 47237 | 49799 | 52349 | 54888 | 57415 | 59931 | 62435 | 64929 | 67410 | 69881 | 24 |
| | 15 | 44706 | 47279 | 49841 | 52391 | 54930 | 57457 | 59973 | 62477 | 64970 | 67452 | 69922 | 25 |
| | 30 | 44749 | 47322 | 49884 | 52434 | 54972 | 57499 | 60015 | 62519 | 65011 | 67493 | 69963 | 26 |
| | 45 | 44792 | 47365 | 49926 | 52476 | 55014 | 57541 | 60056 | 62560 | 65053 | 67534 | 70004 | 27 |
| 7 | 0 | 44835 | 47408 | 49969 | 52519 | 55057 | 57583 | 60098 | 62602 | 65094 | 67576 | 70045 | 28 |
| | 15 | 44878 | 47451 | 50012 | 52561 | 55099 | 57625 | 60140 | 62644 | 65136 | 67617 | 70087 | 29 |
| | 30 | 44921 | 47493 | 50054 | 52603 | 55141 | 57667 | 60182 | 62685 | 65177 | 67658 | 70128 | 30 |
| | 45 | 44964 | 47536 | 50097 | 52646 | 55183 | 57709 | 60224 | 62727 | 65219 | 67699 | 70169 | 31 |
| 8 | 0 | 45007 | 47579 | 50139 | 52688 | 55225 | 57751 | 60266 | 62769 | 65260 | 67741 | 70210 | 32 |
| | 15 | 45050 | 47622 | 50182 | 52731 | 55268 | 57793 | 60307 | 62810 | 65302 | 67782 | 70251 | 33 |
| | 30 | 45093 | 47664 | 50224 | 52773 | 55310 | 57835 | 60349 | 62852 | 65343 | 67823 | 70292 | 34 |
| | 45 | 45135 | 47707 | 50267 | 52815 | 55352 | 57877 | 60391 | 62893 | 65384 | 67864 | 70333 | 35 |
| 9 | 0 | 45178 | 47750 | 50310 | 52858 | 55394 | 57919 | 60433 | 62935 | 65426 | 67905 | 70374 | 36 |
| | 15 | 45221 | 47793 | 50352 | 52900 | 55436 | 57961 | 60475 | 62977 | 65467 | 67947 | 70415 | 37 |
| | 30 | 45264 | 47835 | 50395 | 52942 | 55479 | 58003 | 60516 | 63018 | 65509 | 67988 | 70456 | 38 |
| | 45 | 45307 | 47878 | 50437 | 52985 | 55521 | 58045 | 60558 | 63060 | 65550 | 68029 | 70497 | 39 |
| 10 | 0 | 45350 | 47921 | 50480 | 53027 | 55563 | 58087 | 60600 | 63101 | 65592 | 68070 | 70538 | 40 |
| | 15 | 45393 | 47964 | 50522 | 53070 | 55605 | 58129 | 60642 | 63143 | 65633 | 68112 | 70579 | 41 |
| | 30 | 45436 | 48006 | 50565 | 53112 | 55647 | 58171 | 60684 | 63185 | 65674 | 68153 | 70620 | 42 |
| | 45 | 45479 | 48049 | 50608 | 53154 | 55689 | 58213 | 60725 | 63226 | 65716 | 68194 | 70661 | 43 |
| 11 | 0 | 45522 | 48092 | 50650 | 53197 | 55732 | 58255 | 60767 | 63268 | 65757 | 68235 | 70702 | 44 |
| | 15 | 45565 | 48135 | 50693 | 53239 | 55774 | 58297 | 60809 | 63309 | 65799 | 68277 | 70743 | 45 |
| | 30 | 45608 | 48177 | 50735 | 53281 | 55816 | 58339 | 60851 | 63351 | 65840 | 68318 | 70784 | 46 |
| | 45 | 45651 | 48220 | 50778 | 53324 | 55858 | 58381 | 60892 | 63393 | 65881 | 68359 | 70825 | 47 |
| 12 | 0 | 45694 | 48263 | 50820 | 53366 | 55900 | 58423 | 60934 | 63434 | 65923 | 68400 | 70866 | 48 |
| | 15 | 45737 | 48305 | 50863 | 53408 | 55942 | 58465 | 60976 | 63476 | 65964 | 68441 | 70907 | 49 |
| | 30 | 45779 | 48348 | 50905 | 53451 | 55984 | 58507 | 61018 | 63517 | 66005 | 68482 | 70948 | 50 |
| | 45 | 45822 | 48391 | 50948 | 53493 | 56027 | 58549 | 61059 | 63559 | 66047 | 68524 | 70989 | 51 |
| 13 | 0 | 45865 | 48434 | 50990 | 53535 | 56069 | 58591 | 61101 | 63600 | 66088 | 68565 | 71030 | 52 |
| | 15 | 45908 | 48476 | 51033 | 53578 | 56111 | 58633 | 61143 | 63642 | 66130 | 68606 | 71071 | 53 |
| | 30 | 45951 | 48519 | 51075 | 53620 | 56153 | 58675 | 61185 | 63683 | 66171 | 68647 | 71112 | 54 |
| | 45 | 45994 | 48562 | 51118 | 53662 | 56195 | 58715 | 61226 | 63725 | 66212 | 68688 | 71153 | 55 |
| 14 | 0 | 46037 | 48604 | 51160 | 53704 | 56237 | 58758 | 61268 | 63767 | 66254 | 68730 | 71194 | 56 |
| | 15 | 46080 | 48647 | 51203 | 53747 | 56279 | 58800 | 61310 | 63808 | 66295 | 68771 | 71235 | 57 |
| | 30 | 46123 | 48690 | 51245 | 53789 | 56321 | 58842 | 61352 | 63850 | 66336 | 68812 | 71276 | 58 |
| | 45 | 46166 | 48732 | 51288 | 53831 | 56363 | 58884 | 61393 | 63891 | 66378 | 68853 | 71317 | 59 |

| | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 43. | Parts | 3 | 6 | 9 | 12 | 14 | 17 | 20 | 23 | 26 | 29 | 32 | 35 | 37 | 40 | 43 |
| D. 41. | Parts | 3 | 5 | 8 | 11 | 14 | 16 | 19 | 22 | 24 | 27 | 30 | 33 | 35 | 38 | 41 |

## LOG. SINE SQUARE

| | 75° | | | 76° | | | | 77° | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | |
| m s | $5^h\,1^m$ | $5^h\,2^m$ | $5^h\,3^m$ | $5^h\,4^m$ | $5^h\,5^m$ | $5^h\,6^m$ | $5^h\,7^m$ | $5^h\,8^m$ | $5^h\,9^m$ | $5^h\,10^m$ | $5^h\,11^m$ | s. |
| ′ ″ | 9·5 | 9·5 | 9·5 | 9·5 | 9·5 | 9·5 | 9·5 | 9·5 | 9·5 | 9·5 | 9·5 | |
| 0 0 | 71358 | 73811 | 76253 | 78684 | 81104 | 83513 | 85911 | 88299 | 90676 | 93042 | 95398 | 0 |
| 15 | 71399 | 73852 | 76294 | 78724 | 81144 | 83553 | 85951 | 88339 | 90716 | 93082 | 95437 | 1 |
| 30 | 71440 | 73893 | 76334 | 78765 | 81185 | 83593 | 85991 | 88379 | 90755 | 93121 | 95477 | 2 |
| 45 | 71481 | 73933 | 76375 | 78805 | 81225 | 83633 | 86031 | 88418 | 90795 | 93161 | 95516 | 3 |
| 1 0 | 71522 | 73974 | 76415 | 78846 | 81265 | 83673 | 86071 | 88458 | 90834 | 93200 | 95555 | 4 |
| 15 | 71563 | 74015 | 76456 | 78886 | 81305 | 83713 | 86111 | 88498 | 90874 | 93239 | 95594 | 5 |
| 30 | 71604 | 74056 | 76497 | 78926 | 81345 | 83753 | 86151 | 88537 | 90913 | 93279 | 95633 | 6 |
| 45 | 71645 | 74097 | 76537 | 78967 | 81386 | 83793 | 86191 | 88577 | 90953 | 93318 | 95672 | 7 |
| 2 0 | 71686 | 74137 | 76578 | 79007 | 81426 | 83834 | 86230 | 88617 | 90992 | 93357 | 95712 | 8 |
| 15 | 71727 | 74178 | 76618 | 79048 | 81466 | 83874 | 86270 | 88656 | 91032 | 93397 | 95751 | 9 |
| 30 | 71768 | 74219 | 76659 | 79088 | 81506 | 83914 | 86310 | 88696 | 91071 | 93436 | 95790 | 10 |
| 45 | 71809 | 74260 | 76700 | 79128 | 81546 | 83954 | 86350 | 88736 | 91111 | 93475 | 95829 | 11 |
| 3 0 | 71850 | 74300 | 76740 | 79169 | 8158- | 83994 | 86390 | 88775 | 91150 | 93514 | 95868 | 12 |
| 15 | 71891 | 74341 | 76781 | 79209 | 81627 | 84034 | 86430 | 88815 | 91190 | 93554 | 95907 | 13 |
| 30 | 71932 | 74382 | 76821 | 79250 | 81667 | 84074 | 86470 | 88855 | 91229 | 93593 | 95946 | 14 |
| 45 | 71973 | 74423 | 76862 | 79290 | 81707 | 84114 | 86509 | 88894 | 91269 | 93632 | 95986 | 15 |
| 4 0 | 72013 | 74463 | 76902 | 79330 | 81747 | 84154 | 86549 | 88934 | 91308 | 93672 | 96025 | 16 |
| 15 | 72054 | 74504 | 76943 | 79371 | 81788 | 84194 | 86589 | 88974 | 91348 | 93711 | 96064 | 17 |
| 30 | 72095 | 74545 | 76983 | 79411 | 81828 | 84234 | 86629 | 89013 | 91387 | 93750 | 96103 | 18 |
| 45 | 72136 | 74586 | 77024 | 79451 | 81868 | 84274 | 86669 | 89053 | 91427 | 93790 | 96142 | 19 |
| 5 0 | 72177 | 74626 | 77065 | 79492 | 81908 | 84314 | 86709 | 89093 | 91466 | 93829 | 96181 | 20 |
| 15 | 72218 | 74667 | 77105 | 79532 | 81948 | 84354 | 86748 | 89132 | 91506 | 93868 | 96220 | 21 |
| 30 | 72259 | 74708 | 77146 | 79573 | 81989 | 84394 | 86788 | 89172 | 91545 | 93907 | 96259 | 22 |
| 45 | 72300 | 74748 | 77186 | 79613 | 82029 | 84434 | 86828 | 89212 | 91584 | 93947 | 96299 | 23 |
| 6 0 | 72341 | 74789 | 77227 | 79653 | 82069 | 84474 | 86868 | 89251 | 91624 | 93986 | 96338 | 24 |
| 15 | 72382 | 74830 | 77267 | 79694 | 82109 | 84514 | 86908 | 89291 | 91663 | 94025 | 96377 | 25 |
| 30 | 72423 | 74871 | 77308 | 79734 | 82149 | 84554 | 86947 | 89330 | 91703 | 94065 | 96416 | 26 |
| 45 | 72463 | 74911 | 77348 | 79774 | 82189 | 84594 | 86987 | 89370 | 91742 | 94104 | 96455 | 27 |
| 7 0 | 72504 | 74952 | 77389 | 79815 | 82230 | 84634 | 87027 | 89410 | 91782 | 94143 | 96494 | 28 |
| 15 | 72545 | 74993 | 77429 | 79855 | 82270 | 84674 | 87067 | 89449 | 91821 | 94182 | 96533 | 29 |
| 30 | 72586 | 75033 | 77470 | 79895 | 82310 | 84714 | 87107 | 89489 | 91861 | 94222 | 96572 | 30 |
| 45 | 72627 | 75074 | 77510 | 79936 | 82350 | 84754 | 87146 | 89529 | 91900 | 94261 | 96611 | 31 |
| 8 0 | 72668 | 75115 | 77551 | 79976 | 82390 | 84794 | 87186 | 89568 | 91939 | 94300 | 96650 | 32 |
| 15 | 72709 | 75156 | 77591 | 80016 | 82430 | 84834 | 87226 | 89608 | 91979 | 94339 | 96689 | 33 |
| 30 | 72750 | 75196 | 77632 | 80057 | 82470 | 84874 | 87266 | 89647 | 92018 | 94379 | 96729 | 34 |
| 45 | 72791 | 75237 | 77672 | 80097 | 82511 | 84913 | 87306 | 89687 | 92058 | 94418 | 96768 | 35 |
| 9 0 | 72831 | 75278 | 77713 | 80137 | 82551 | 84953 | 87345 | 89727 | 92097 | 94457 | 96807 | 36 |
| 15 | 72872 | 75318 | 77754 | 80178 | 82591 | 84993 | 87385 | 89766 | 92137 | 94496 | 96846 | 37 |
| 30 | 72913 | 75359 | 77794 | 80218 | 82631 | 85033 | 87425 | 89806 | 92176 | 94536 | 96885 | 38 |
| 45 | 72954 | 75400 | 77834 | 80258 | 82671 | 85073 | 87465 | 89845 | 92215 | 94575 | 96924 | 39 |
| 10 0 | 72995 | 75440 | 77875 | 80298 | 82711 | 85113 | 87504 | 89885 | 92255 | 94614 | 96963 | 40 |
| 15 | 73036 | 75481 | 77915 | 80339 | 82751 | 85153 | 87544 | 89925 | 92294 | 94653 | 97002 | 41 |
| 30 | 73076 | 75522 | 77956 | 80379 | 82791 | 85193 | 87584 | 89964 | 92334 | 94693 | 97041 | 42 |
| 45 | 73117 | 75562 | 77996 | 80419 | 82832 | 85233 | 87624 | 90004 | 92373 | 94732 | 97080 | 43 |
| 11 0 | 73158 | 75603 | 78037 | 80460 | 82872 | 85273 | 87663 | 90043 | 92412 | 94771 | 97119 | 44 |
| 15 | 73199 | 75644 | 78077 | 80500 | 82912 | 85313 | 87703 | 90083 | 92452 | 94810 | 97158 | 45 |
| 30 | 73240 | 75684 | 78118 | 80540 | 82952 | 85353 | 87743 | 90122 | 92491 | 94850 | 97197 | 46 |
| 45 | 73281 | 75725 | 78158 | 80581 | 82992 | 85393 | 87783 | 90162 | 92531 | 94889 | 97236 | 47 |
| 12 0 | 73321 | 75766 | 78199 | 80621 | 83032 | 85433 | 87822 | 90202 | 92570 | 94928 | 97275 | 48 |
| 15 | 73362 | 75806 | 78239 | 80661 | 83072 | 85473 | 87862 | 90241 | 92609 | 94967 | 97314 | 49 |
| 30 | 73403 | 75847 | 78279 | 80701 | 83112 | 85513 | 87902 | 90281 | 92649 | 95006 | 97353 | 50 |
| 45 | 73444 | 75887 | 78320 | 80742 | 83152 | 85552 | 87942 | 90320 | 92688 | 95046 | 97392 | 51 |
| 13 0 | 73485 | 75928 | 78360 | 80782 | 83193 | 85592 | 87981 | 90360 | 92728 | 95085 | 97432 | 52 |
| 15 | 73526 | 75969 | 78401 | 80822 | 83233 | 85632 | 88021 | 90399 | 92767 | 95124 | 97471 | 53 |
| 30 | 73566 | 76009 | 78441 | 80862 | 83273 | 85672 | 88061 | 90439 | 92806 | 95163 | 97510 | 54 |
| 45 | 73607 | 76050 | 78482 | 80903 | 83313 | 85712 | 88101 | 90478 | 92846 | 95202 | 97549 | 55 |
| 14 0 | 73648 | 76091 | 78522 | 80943 | 83353 | 85752 | 88140 | 90518 | 92885 | 95242 | 97588 | 56 |
| 15 | 73689 | 76131 | 78563 | 80983 | 83393 | 85792 | 88180 | 90558 | 92924 | 95281 | 97627 | 57 |
| 30 | 73730 | 76172 | 78603 | 81023 | 83433 | 85832 | 88220 | 90597 | 92964 | 95320 | 97666 | 58 |
| 45 | 73770 | 76212 | 78644 | 81064 | 83473 | 85872 | 88259 | 90637 | 93003 | 95359 | 97705 | 59 |

| | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 41. | Parts | 3 | 5 | 8 | 11 | 14 | 16 | 19 | 22 | 24 | 27 | 30 | 33 | 35 | 38 | 41 |
| D. 39. | Parts | 3 | 5 | 8 | 10 | 13 | 15 | 18 | 21 | 23 | 26 | 29 | 31 | 33 | 36 | 39 |

## LOG. SINE SQUARE

| | 78° | | | | 79° | | | | 80° | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | |
| | 5ʰ 12ᵐ | 5ʰ 13ᵐ | 5ʰ 14ᵐ | 5ʰ 15ᵐ | 5ʰ 16ᵐ | 5ʰ 17ᵐ | 5ʰ 18ᵐ | 5ʰ 19ᵐ | 5ʰ 20ᵐ | 5ʰ 21ᵐ | 5ʰ 22ᵐ | s. |
| ′ ″ | 9· | 9·6 | 9·6 | 9·6 | 9·6 | 9·6 | 9·6 | 9·6 | 9·6 | 9·6 | 9·6 | |
| 0 0 | 597744 | 00078 | 02403 | 04717 | 07021 | 09315 | 11598 | 13872 | 16135 | 18388 | 20632 | 0 |
| 15 | 597783 | 00117 | 02442 | 04756 | 07059 | 09353 | 11636 | 13909 | 16173 | 18426 | 20669 | 1 |
| 30 | 597822 | 00156 | 02480 | 04794 | 07098 | 09391 | 11674 | 13947 | 16210 | 18463 | 20706 | 2 |
| 45 | 597861 | 00195 | 02519 | 04833 | 07136 | 09429 | 11712 | 13985 | 16248 | 18501 | 20744 | 3 |
| 1 0 | 597900 | 00234 | 02558 | 04871 | 07174 | 09467 | 11750 | 14023 | 16285 | 18538 | 20781 | 4 |
| 15 | 597939 | 00273 | 02596 | 04910 | 07213 | 09505 | 11788 | 14061 | 16323 | 18576 | 20818 | 5 |
| 30 | 597978 | 00311 | 02635 | 04948 | 07251 | 09544 | 11826 | 14098 | 16361 | 18613 | 20855 | 6 |
| 45 | 598017 | 00350 | 02674 | 04986 | 07289 | 09582 | 11864 | 14136 | 16398 | 18651 | 20893 | 7 |
| 2 0 | 598056 | 00389 | 02712 | 05025 | 07327 | 09620 | 11902 | 14174 | 16436 | 18688 | 20930 | 8 |
| 15 | 598095 | 00428 | 02751 | 05063 | 07366 | 09658 | 11940 | 14212 | 16474 | 18725 | 20967 | 9 |
| 30 | 598133 | 00467 | 02789 | 05102 | 07404 | 09696 | 11978 | 14250 | 16511 | 18763 | 21005 | 10 |
| 45 | 598172 | 00505 | 02828 | 05140 | 07442 | 09734 | 12016 | 14287 | 16549 | 18800 | 21042 | 11 |
| 3 0 | 598211 | 00544 | 02867 | 05179 | 07481 | 09772 | 12054 | 14325 | 16586 | 18838 | 21079 | 12 |
| 15 | 598250 | 00583 | 02905 | 05217 | 07519 | 09810 | 12092 | 14363 | 16624 | 18875 | 21116 | 13 |
| 30 | 598289 | 00622 | 02944 | 05256 | 07557 | 09848 | 12130 | 14401 | 16662 | 18913 | 21154 | 14 |
| 45 | 598328 | 00661 | 02982 | 05294 | 07595 | 09886 | 12168 | 14438 | 16699 | 18950 | 21191 | 15 |
| 4 0 | 598367 | 00699 | 03021 | 05332 | 07634 | 09925 | 12205 | 14476 | 16737 | 18987 | 21228 | 16 |
| 15 | 598406 | 00738 | 03060 | 05371 | 07672 | 09963 | 12243 | 14514 | 16774 | 19025 | 21266 | 17 |
| 30 | 598445 | 00777 | 03098 | 05409 | 07710 | 10001 | 12281 | 14552 | 16812 | 19062 | 21303 | 18 |
| 45 | 598484 | 00816 | 03137 | 05448 | 07748 | 10039 | 12319 | 14589 | 16850 | 19100 | 21340 | 19 |
| 5 0 | 598523 | 00854 | 03175 | 05486 | 07787 | 10077 | 12357 | 14627 | 16887 | 19137 | 21377 | 20 |
| 15 | 598562 | 00893 | 03214 | 05525 | 07825 | 10115 | 12395 | 14665 | 16925 | 19175 | 21415 | 21 |
| 30 | 598601 | 00932 | 03253 | 05563 | 07863 | 10153 | 12433 | 14703 | 16962 | 19212 | 21452 | 22 |
| 45 | 598640 | 00971 | 03291 | 05601 | 07901 | 10191 | 12471 | 14740 | 17000 | 19249 | 21489 | 23 |
| 6 0 | 598679 | 01009 | 03330 | 05640 | 07940 | 10229 | 12509 | 14778 | 17037 | 19287 | 21526 | 24 |
| 15 | 598718 | 01048 | 03368 | 05678 | 07978 | 10267 | 12547 | 14816 | 17075 | 19324 | 21564 | 25 |
| 30 | 598757 | 01087 | 03407 | 05717 | 08016 | 10305 | 12585 | 14854 | 17113 | 19362 | 21601 | 26 |
| 45 | 598796 | 01126 | 03446 | 05755 | 08054 | 10343 | 12622 | 14891 | 17150 | 19399 | 21638 | 27 |
| 7 0 | 598834 | 01164 | 03484 | 05794 | 08093 | 10381 | 12660 | 14929 | 17188 | 19436 | 21675 | 28 |
| 15 | 598873 | 01203 | 03523 | 05832 | 08131 | 10420 | 12698 | 14967 | 17225 | 19474 | 21712 | 29 |
| 30 | 598912 | 01242 | 03561 | 05870 | 08169 | 10458 | 12736 | 15005 | 17263 | 19511 | 21749 | 30 |
| 45 | 598951 | 01281 | 03600 | 05909 | 08207 | 10496 | 12774 | 15042 | 17300 | 19549 | 21787 | 31 |
| 8 0 | 598990 | 01319 | 03638 | 05947 | 08246 | 10534 | 12812 | 15080 | 17338 | 19586 | 21824 | 32 |
| 15 | 599029 | 01358 | 03677 | 05986 | 08284 | 10572 | 12850 | 15118 | 17376 | 19623 | 21861 | 33 |
| 30 | 599068 | 01397 | 03716 | 06024 | 08322 | 10610 | 12888 | 15155 | 17413 | 19661 | 21899 | 34 |
| 45 | 599107 | 01436 | 03754 | 06062 | 08360 | 10648 | 12926 | 15193 | 17451 | 19698 | 21936 | 35 |
| 9 0 | 599146 | 01474 | 03793 | 06101 | 08398 | 10686 | 12963 | 15231 | 17488 | 19736 | 21973 | 36 |
| 15 | 599185 | 01513 | 03831 | 06139 | 08437 | 10724 | 13001 | 15269 | 17526 | 19773 | 22010 | 37 |
| 30 | 599224 | 01552 | 03870 | 06177 | 08475 | 10762 | 13039 | 15306 | 17563 | 19810 | 22047 | 38 |
| 45 | 599262 | 01591 | 03908 | 06216 | 08513 | 10800 | 13077 | 15344 | 17601 | 19848 | 22085 | 39 |
| 10 0 | 599301 | 01629 | 03947 | 06254 | 08551 | 10838 | 13115 | 15383 | 17638 | 19885 | 22122 | 40 |
| 15 | 599340 | 01668 | 03986 | 06293 | 08589 | 10876 | 13153 | 15419 | 17676 | 19922 | 22159 | 41 |
| 30 | 599379 | 01707 | 04024 | 06331 | 08628 | 10914 | 13191 | 15457 | 17713 | 19960 | 22196 | 42 |
| 45 | 599418 | 01745 | 04063 | 06369 | 08666 | 10952 | 13229 | 15495 | 17751 | 19997 | 22233 | 43 |
| 1 0 | 599457 | 01784 | 04101 | 06408 | 08704 | 10990 | 13266 | 15532 | 17788 | 20034 | 22271 | 44 |
| 15 | 599496 | 01823 | 04140 | 06446 | 08742 | 11028 | 13304 | 15570 | 17826 | 20072 | 22308 | 45 |
| 30 | 599535 | 01861 | 04178 | 06484 | 08780 | 11066 | 13342 | 5608 | 17863 | 20109 | 22345 | 46 |
| 45 | 599574 | 01900 | 04217 | 06523 | 08819 | 11104 | 13380 | 15645 | 17901 | 20146 | 22382 | 47 |
| 12 0 | 599612 | 01939 | 04255 | 06561 | 08857 | 11142 | 13418 | 15683 | 17938 | 20184 | 22419 | 48 |
| 15 | 599651 | 01978 | 04294 | 06599 | 08895 | 11180 | 13456 | 15721 | 17976 | 20221 | 22456 | 49 |
| 30 | 599690 | 02016 | 04332 | 06638 | 08933 | 11218 | 13493 | 15758 | 18013 | 20258 | 22494 | 50 |
| 45 | 599729 | 02055 | 04371 | 06676 | 08971 | 11256 | 13531 | 15796 | 18051 | 20296 | 22531 | 51 |
| 13 0 | 599768 | 02094 | 04409 | 06714 | 09009 | 11294 | 13569 | 15834 | 18088 | 20333 | 22568 | 52 |
| 15 | 599807 | 02132 | 04448 | 06753 | 09048 | 11332 | 13607 | 15871 | 18126 | 20371 | 22605 | 53 |
| 30 | 599845 | 02171 | 04486 | 06791 | 09086 | 11370 | 13645 | 15909 | 18163 | 20408 | 22642 | 54 |
| 45 | 599884 | 02210 | 04525 | 06829 | 09124 | 11408 | 13683 | 15947 | 18201 | 20445 | 22679 | 55 |
| 14 0 | 599923 | 02248 | 04563 | 06868 | 09162 | 11446 | 13720 | 15984 | 18238 | 20482 | 22717 | 56 |
| 15 | 599962 | 02287 | 04602 | 06906 | 09200 | 11484 | 13758 | 16022 | 18276 | 20520 | 22754 | 57 |
| 30 | 600001 | 02326 | 04640 | 06944 | 09238 | 11522 | 13796 | 16060 | 18313 | 20557 | 22791 | 58 |
| 45 | 600040 | 02364 | 04679 | 06983 | 09277 | 11560 | 13834 | 16097 | 18351 | 20594 | 22828 | 59 |

| | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 39. | Parts | 3 | 5 | 8 | 10 | 13 | 15 | 18 | 21 | 23 | 26 | 29 | 31 | 33 | 36 | 39 |
| D. 37. | Parts | 2 | 5 | 7 | 10 | 12 | 15 | 17 | 20 | 22 | 25 | 27 | 29 | 32 | 34 | 37 |

## LOG. SINE SQUARE

| | 80° | 81° | | | | 82° | | | | 83° | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | |
| | 5h 23m | 5h 24m | 5h 25m | 5h 26m | 5h 27m | 5h 28m | 5h 29m | 5h 30m | 5h 31m | 5h 32m | 5h 33m | s. |
| ′ ″ | 9·6 | 9·6 | 9·6 | 9·6 | 9·6 | 9·6 | 9·6 | 9·6 | 9·6 | 9·6 | 9·6 | |
| 0 0 | 22865 | 25089 | 27303 | 29507 | 31701 | 33886 | 36061 | 38226 | 40383 | 42529 | 44666 | 0 |
| 15 | 22902 | 25126 | 27339 | 29543 | 31738 | 33922 | 36097 | 38263 | 40418 | 42565 | 44702 | 1 |
| 30 | 22939 | 25163 | 27376 | 29580 | 31774 | 33958 | 36133 | 38299 | 40454 | 42601 | 44737 | 2 |
| 45 | 22977 | 25200 | 27413 | 29617 | 31811 | 33995 | 36169 | 38335 | 40490 | 42636 | 44773 | 3 |
| 1 0 | 23014 | 25237 | 27450 | 29653 | 31847 | 34031 | 36206 | 38371 | 40526 | 42672 | 44808 | 4 |
| 15 | 23051 | 25274 | 27487 | 29690 | 31884 | 34067 | 36242 | 38407 | 40562 | 42708 | 44844 | 5 |
| 30 | 23088 | 25311 | 27524 | 29727 | 31920 | 34104 | 36278 | 38443 | 40598 | 42743 | 44880 | 6 |
| 45 | 23125 | 25348 | 27560 | 29763 | 31956 | 34140 | 36314 | 38479 | 40633 | 42779 | 44915 | 7 |
| 2 0 | 23162 | 25385 | 27597 | 29800 | 31993 | 34176 | 36350 | 38515 | 40669 | 42815 | 44951 | 8 |
| 15 | 23199 | 25422 | 27634 | 29837 | 32029 | 34213 | 36386 | 38551 | 40705 | 42850 | 44986 | 9 |
| 30 | 23237 | 25459 | 27671 | 29873 | 32066 | 34249 | 36422 | 38587 | 40741 | 42886 | 45022 | 10 |
| 45 | 23274 | 25495 | 27707 | 29910 | 32102 | 34285 | 36459 | 38622 | 40777 | 42922 | 45057 | 11 |
| 3 0 | 23311 | 25532 | 27744 | 29946 | 32139 | 34322 | 36495 | 38658 | 40813 | 42957 | 45093 | 12 |
| 15 | 23348 | 25569 | 27781 | 29983 | 32175 | 34358 | 36531 | 38694 | 40848 | 42993 | 45128 | 13 |
| 30 | 23385 | 25606 | 27818 | 30020 | 32212 | 34394 | 36567 | 38730 | 40884 | 43029 | 45164 | 14 |
| 45 | 23422 | 25643 | 27855 | 30056 | 32248 | 34430 | 36603 | 38766 | 40920 | 43064 | 45199 | 15 |
| 4 0 | 23459 | 25680 | 27891 | 30093 | 32285 | 34467 | 36639 | 38802 | 40956 | 43100 | 45235 | 16 |
| 15 | 23496 | 25717 | 27928 | 30129 | 32321 | 34503 | 36676 | 38838 | 40992 | 43136 | 45270 | 17 |
| 30 | 23533 | 25754 | 27965 | 30166 | 32357 | 34539 | 36712 | 38874 | 41027 | 43171 | 45306 | 18 |
| 45 | 23570 | 25791 | 28002 | 30203 | 32394 | 34576 | 36748 | 38910 | 41063 | 43207 | 45341 | 19 |
| 5 0 | 23607 | 25828 | 28038 | 30239 | 32430 | 34612 | 36784 | 38946 | 41099 | 43243 | 45377 | 20 |
| 15 | 23645 | 25865 | 28075 | 30276 | 32467 | 34648 | 36820 | 38982 | 41135 | 43278 | 45412 | 21 |
| 30 | 23682 | 25902 | 28112 | 30312 | 32503 | 34684 | 36856 | 39018 | 41171 | 43314 | 45448 | 22 |
| 45 | 23719 | 25939 | 28149 | 30349 | 32540 | 34721 | 36892 | 39054 | 41206 | 43349 | 45483 | 23 |
| 6 0 | 23756 | 25975 | 28185 | 30386 | 32576 | 34757 | 36928 | 39090 | 41242 | 43385 | 45519 | 24 |
| 15 | 23793 | 26012 | 28222 | 30422 | 32613 | 34793 | 36964 | 39126 | 41278 | 43421 | 45554 | 25 |
| 30 | 23830 | 26049 | 28259 | 30459 | 32649 | 34829 | 37000 | 39162 | 41314 | 43456 | 45590 | 26 |
| 45 | 23867 | 26086 | 28296 | 30495 | 32685 | 34866 | 37037 | 39198 | 41350 | 43492 | 45625 | 27 |
| 7 0 | 23904 | 26123 | 28332 | 30532 | 32722 | 34902 | 37073 | 39234 | 41385 | 43528 | 45660 | 28 |
| 15 | 23941 | 26160 | 28369 | 30569 | 32758 | 34938 | 37109 | 39270 | 41421 | 43563 | 45696 | 29 |
| 30 | 23978 | 26197 | 28406 | 30605 | 32795 | 34975 | 37145 | 39306 | 41457 | 43599 | 45731 | 30 |
| 45 | 24015 | 26234 | 28443 | 30642 | 32831 | 35011 | 37181 | 39342 | 41493 | 43635 | 45767 | 31 |
| 8 0 | 24052 | 26271 | 28479 | 30678 | 32867 | 35047 | 37217 | 39378 | 41529 | 43670 | 45802 | 32 |
| 15 | 24089 | 26308 | 28516 | 30715 | 32904 | 35083 | 37253 | 39414 | 41564 | 43706 | 45838 | 33 |
| 30 | 24126 | 26345 | 28553 | 30751 | 32940 | 35120 | 37289 | 39449 | 41600 | 43741 | 45873 | 34 |
| 45 | 24164 | 26381 | 28590 | 30788 | 32977 | 35156 | 37325 | 39485 | 41636 | 43777 | 45909 | 35 |
| 9 0 | 24201 | 26418 | 28626 | 30824 | 33013 | 35192 | 37361 | 39521 | 41672 | 43813 | 45944 | 36 |
| 15 | 24238 | 26455 | 28663 | 30861 | 33049 | 35228 | 37397 | 39557 | 41707 | 43848 | 45980 | 37 |
| 30 | 24275 | 26492 | 28700 | 30898 | 33086 | 35265 | 37434 | 39593 | 41743 | 43884 | 46015 | 38 |
| 45 | 24312 | 26529 | 28736 | 30934 | 33122 | 35301 | 37470 | 39629 | 41779 | 43919 | 46050 | 39 |
| 10 0 | 24349 | 26566 | 28773 | 30971 | 33159 | 35337 | 37506 | 39665 | 41815 | 43955 | 46086 | 40 |
| 15 | 24386 | 26603 | 28810 | 31007 | 33195 | 35373 | 37542 | 39701 | 41850 | 43991 | 46121 | 41 |
| 30 | 24423 | 26639 | 28846 | 31044 | 33231 | 35409 | 37578 | 39737 | 41886 | 44026 | 46157 | 42 |
| 45 | 24460 | 26676 | 28883 | 31080 | 33268 | 35446 | 37614 | 39773 | 41922 | 44062 | 46192 | 43 |
| 11 0 | 24497 | 26713 | 28920 | 31117 | 33304 | 35482 | 37650 | 39808 | 41958 | 44097 | 46228 | 44 |
| 15 | 24534 | 26750 | 28957 | 31153 | 33341 | 35518 | 37686 | 39844 | 41993 | 44133 | 46263 | 45 |
| 30 | 24571 | 26787 | 28993 | 31190 | 33377 | 35554 | 37722 | 39880 | 42029 | 44169 | 46298 | 46 |
| 45 | 24608 | 26824 | 29030 | 31226 | 33413 | 35590 | 37758 | 39916 | 42065 | 44204 | 46334 | 47 |
| 12 0 | 24645 | 26861 | 29067 | 31263 | 33450 | 35627 | 37794 | 39952 | 42101 | 44240 | 46369 | 48 |
| 15 | 24682 | 26898 | 29103 | 31300 | 33486 | 35663 | 37830 | 39988 | 42136 | 44275 | 46405 | 49 |
| 30 | 24719 | 26934 | 29140 | 31336 | 33522 | 35699 | 37866 | 40024 | 42172 | 44311 | 46440 | 50 |
| 45 | 24756 | 26971 | 29177 | 31373 | 33559 | 35735 | 37902 | 40060 | 42208 | 44346 | 46476 | 51 |
| 13 0 | 24793 | 27008 | 29213 | 31409 | 33595 | 35771 | 37938 | 40096 | 42243 | 44382 | 46511 | 52 |
| 15 | 24830 | 27045 | 29250 | 31446 | 33631 | 35808 | 37974 | 40131 | 42279 | 44417 | 46546 | 53 |
| 30 | 24867 | 27082 | 29287 | 31482 | 33668 | 35844 | 38010 | 40167 | 42315 | 44453 | 46582 | 54 |
| 45 | 24904 | 27119 | 29323 | 31519 | 33704 | 35880 | 38046 | 40203 | 42351 | 44489 | 46617 | 55 |
| 14 0 | 24941 | 27155 | 29360 | 31555 | 33740 | 35916 | 38082 | 40239 | 42386 | 44524 | 46653 | 56 |
| 15 | 24978 | 27192 | 29397 | 31592 | 33777 | 35952 | 38118 | 40275 | 42422 | 44560 | 46688 | 57 |
| 30 | 25015 | 27229 | 29433 | 31628 | 33813 | 35988 | 38154 | 40311 | 42458 | 44595 | 46723 | 58 |
| 45 | 25052 | 27266 | 29470 | 31665 | 33849 | 36025 | 38190 | 40347 | 42493 | 44631 | 46759 | 59 |

| | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 37. | Parts | 2 | 5 | 7 | 10 | 12 | 15 | 17 | 20 | 22 | 25 | 27 | 29 | 32 | 34 | 37 |
| D. 35. | Parts | 2 | 5 | 7 | 9 | 12 | 14 | 16 | 19 | 21 | 23 | 26 | 28 | 30 | 33 | 35 |

## LOG. SINE SQUARE

| | 83° 30′ | 83° 45′ | 84° 0′ | 84° 15′ | 84° 30′ | 84° 45′ | 85° 0′ | 85° 15′ | 85° 30′ | 85° 45′ | 86° 0′ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5h 34m | 5h 35m | 5h 36m | 5h 37m | 5h 38m | 5h 39m | 5h 40m | 5h 41m | 5h 42m | 5h 43m | 5h 44m | s. |
| ′ ″ | 9·6 | 9·6 | 9·6 | 9·6 | 9·6 | 9·6 | 9·6 | 9·6 | 9·6 | 9·6 | 9·6 | |
| 0 0 | 46794 | 48913 | 51022 | 53122 | 55212 | 57294 | 59367 | 61430 | 63485 | 65530 | 67567 | 0 |
| 15 | 46829 | 48948 | 51057 | 53157 | 55247 | 57329 | 59401 | 61464 | 63519 | 65564 | 67601 | 1 |
| 30 | 46865 | 48983 | 51092 | 53192 | 55282 | 57363 | 59436 | 61499 | 63553 | 65598 | 67634 | 2 |
| 45 | 46900 | 49018 | 51127 | 53226 | 55317 | 57398 | 59470 | 61533 | 63587 | 65632 | 67668 | 3 |
| 1 0 | 46936 | 49053 | 51162 | 53261 | 55352 | 57433 | 59504 | 61567 | 63621 | 65666 | 67702 | 4 |
| 15 | 46971 | 49089 | 51197 | 53296 | 55386 | 57467 | 59539 | 61602 | 63655 | 65700 | 67736 | 5 |
| 30 | 47006 | 49124 | 51232 | 53331 | 55421 | 57502 | 59573 | 61636 | 63690 | 65734 | 67770 | 6 |
| 45 | 47042 | 49159 | 51267 | 53366 | 55456 | 57536 | 59608 | 61670 | 63724 | 65768 | 67804 | 7 |
| 2 0 | 47077 | 49194 | 51302 | 53401 | 55491 | 57571 | 59642 | 61705 | 63758 | 65802 | 67837 | 8 |
| 15 | 47113 | 49230 | 51337 | 53436 | 55525 | 57606 | 59677 | 61739 | 63792 | 65836 | 67871 | 9 |
| 30 | 47148 | 49265 | 51372 | 53471 | 55560 | 57640 | 59711 | 61773 | 63826 | 65870 | 67905 | 10 |
| 45 | 47183 | 49300 | 51407 | 53506 | 55595 | 57675 | 59746 | 61807 | 63860 | 65904 | 67939 | 11 |
| 3 0 | 47219 | 49335 | 51442 | 53541 | 55630 | 57709 | 59780 | 61842 | 63894 | 65938 | 67973 | 12 |
| 15 | 47254 | 49370 | 51478 | 53575 | 55664 | 57744 | 59815 | 61876 | 63929 | 65972 | 68007 | 13 |
| 30 | 47289 | 49406 | 51513 | 53610 | 55699 | 57779 | 59849 | 61910 | 63963 | 66006 | 68041 | 14 |
| 45 | 47325 | 49441 | 51548 | 53645 | 55734 | 57813 | 59883 | 61945 | 63997 | 66040 | 68074 | 15 |
| 4 0 | 47360 | 49476 | 51583 | 53680 | 55768 | 57848 | 59918 | 61979 | 64031 | 66074 | 68108 | 16 |
| 15 | 47395 | 49511 | 51618 | 53715 | 55803 | 57882 | 59952 | 62013 | 64065 | 66108 | 68142 | 17 |
| 30 | 47431 | 49546 | 51653 | 53750 | 55838 | 57917 | 59987 | 62047 | 64099 | 66142 | 68176 | 18 |
| 45 | 47466 | 49582 | 51688 | 53785 | 55873 | 57951 | 60021 | 62082 | 64133 | 66176 | 68210 | 19 |
| 5 0 | 47501 | 49617 | 51723 | 53820 | 55907 | 57986 | 60055 | 62116 | 64167 | 66210 | 68243 | 20 |
| 15 | 47537 | 49652 | 51758 | 53855 | 55942 | 58021 | 60090 | 62150 | 64201 | 66244 | 68277 | 21 |
| 30 | 47572 | 49687 | 51793 | 53889 | 55977 | 58055 | 60124 | 62184 | 64236 | 66278 | 68311 | 22 |
| 45 | 47607 | 49722 | 51828 | 53924 | 56012 | 58090 | 60159 | 62219 | 64270 | 66312 | 68345 | 23 |
| 6 0 | 47643 | 49757 | 51863 | 53959 | 56046 | 58124 | 60193 | 62253 | 64304 | 66346 | 68379 | 24 |
| 15 | 47678 | 49793 | 51898 | 53994 | 56081 | 58159 | 60228 | 62287 | 64338 | 66380 | 68413 | 25 |
| 30 | 47713 | 49828 | 51933 | 54029 | 56116 | 58193 | 60262 | 62321 | 64372 | 66414 | 68446 | 26 |
| 45 | 47749 | 49863 | 51968 | 54064 | 56150 | 58228 | 60296 | 62356 | 64406 | 66448 | 68480 | 27 |
| 7 0 | 47784 | 49898 | 52003 | 54099 | 56185 | 58262 | 60331 | 62390 | 64440 | 66482 | 68514 | 28 |
| 15 | 47819 | 49933 | 52038 | 54133 | 56220 | 58297 | 60365 | 62424 | 64474 | 66516 | 68548 | 29 |
| 30 | 47854 | 49968 | 52073 | 54168 | 56254 | 58332 | 60400 | 62458 | 64508 | 66550 | 68582 | 30 |
| 45 | 47890 | 50003 | 52108 | 54203 | 56289 | 58366 | 60434 | 62493 | 64543 | 66584 | 68615 | 31 |
| 8 0 | 47925 | 50039 | 52143 | 54238 | 56324 | 58401 | 60468 | 62527 | 64577 | 66617 | 68649 | 32 |
| 15 | 47960 | 50074 | 52178 | 54273 | 56359 | 58435 | 60503 | 62561 | 64611 | 66651 | 68683 | 33 |
| 30 | 47996 | 50109 | 52213 | 54308 | 56393 | 58470 | 60537 | 62595 | 64645 | 66685 | 68717 | 34 |
| 45 | 48031 | 50144 | 52248 | 54343 | 56428 | 58504 | 60571 | 62630 | 64679 | 66719 | 68751 | 35 |
| 9 0 | 48066 | 50179 | 52283 | 54377 | 56463 | 58539 | 60606 | 62664 | 64713 | 66753 | 68784 | 36 |
| 15 | 48102 | 50214 | 52318 | 54412 | 56497 | 58573 | 60640 | 62698 | 64747 | 66787 | 68818 | 37 |
| 30 | 48137 | 50249 | 52353 | 54447 | 56532 | 58608 | 60675 | 62732 | 64781 | 66821 | 68852 | 38 |
| 45 | 48172 | 50285 | 52388 | 54482 | 56567 | 58642 | 60709 | 62767 | 64815 | 66855 | 68886 | 39 |
| 10 0 | 48207 | 50320 | 52423 | 54517 | 56601 | 58677 | 60743 | 62801 | 64849 | 66889 | 68919 | 40 |
| 15 | 48243 | 50355 | 52458 | 54551 | 56636 | 58711 | 60778 | 62835 | 64883 | 66923 | 68953 | 41 |
| 30 | 48278 | 50390 | 52493 | 54586 | 56671 | 58746 | 60812 | 62869 | 64917 | 66957 | 68987 | 42 |
| 45 | 48313 | 50425 | 52528 | 54621 | 56705 | 58780 | 60846 | 62903 | 64951 | 66991 | 69021 | 43 |
| 11 0 | 48349 | 50460 | 52563 | 54656 | 56740 | 58815 | 60881 | 62938 | 64985 | 67024 | 69054 | 44 |
| 15 | 48384 | 50495 | 52598 | 54691 | 56775 | 58849 | 60915 | 62972 | 65020 | 67058 | 69088 | 45 |
| 30 | 48419 | 50530 | 52633 | 54725 | 56809 | 58884 | 60949 | 63006 | 65054 | 67092 | 69122 | 46 |
| 45 | 48454 | 50566 | 52668 | 54760 | 56844 | 58918 | 60984 | 63040 | 65088 | 67126 | 69156 | 47 |
| 12 0 | 48490 | 50601 | 52702 | 54795 | 56879 | 58953 | 61018 | 63074 | 65122 | 67160 | 69189 | 48 |
| 15 | 48525 | 50636 | 52737 | 54830 | 56913 | 58987 | 61053 | 63109 | 65156 | 67194 | 69223 | 49 |
| 30 | 48560 | 50671 | 52772 | 54865 | 56948 | 59022 | 61087 | 63143 | 65190 | 67228 | 69257 | 50 |
| 45 | 48595 | 50706 | 52807 | 54900 | 56982 | 59056 | 61121 | 63177 | 65224 | 67262 | 69291 | 51 |
| 13 0 | 48631 | 50741 | 52842 | 54934 | 57017 | 59091 | 61156 | 63211 | 65258 | 67296 | 69324 | 52 |
| 15 | 48666 | 50776 | 52877 | 54969 | 57052 | 59125 | 61190 | 63245 | 65292 | 67329 | 69358 | 53 |
| 30 | 48701 | 50811 | 52912 | 55004 | 57086 | 59160 | 61224 | 63280 | 65326 | 67363 | 69392 | 54 |
| 45 | 48736 | 50846 | 52947 | 55039 | 57121 | 59194 | 61259 | 63314 | 65360 | 67397 | 69426 | 55 |
| 14 0 | 48772 | 50881 | 52982 | 55073 | 57156 | 59229 | 61293 | 63348 | 65394 | 67431 | 69459 | 56 |
| 15 | 48807 | 50917 | 53017 | 55108 | 57190 | 59263 | 61327 | 63382 | 65428 | 67465 | 69493 | 57 |
| 30 | 48842 | 50952 | 53052 | 55143 | 57225 | 59298 | 61362 | 63416 | 65462 | 67499 | 69527 | 58 |
| 45 | 48877 | 50987 | 53087 | 55178 | 57260 | 59332 | 61396 | 63450 | 65496 | 67533 | 69561 | 59 |

| | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 35. | Parts | 2 | 5 | 7 | 9 | 12 | 14 | 16 | 19 | 21 | 23 | 26 | 28 | 30 | 33 | 35 |

## LOG. SINE SQUARE

| | 86° | | | 87° | | | | 88° | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | |
| ′ ″ | 5h 45m | 5h 46m | 5h 47m | 5h 48m | 5h 49m | 5h 50m | 5h 51m | 5h 52m | 5h 53m | 5h 54m | 5h 55m | s. |
| | 9·6 | 9·6 | 9·6 | 9·6 | 9·6 | 9·6 | 9·6 | 9·6 | 9·6 | 9·6 | 9·6 | |
| 0 0 | 69594 | 71613 | 73623 | 75624 | 77617 | 79601 | 81576 | 83543 | 85501 | 87450 | 89391 | 0 |
| 15 | 69628 | 71647 | 73657 | 75658 | 77650 | 79634 | 81609 | 83575 | 85533 | 87482 | 89423 | 1 |
| 30 | 69662 | 71680 | 73690 | 75691 | 77683 | 79667 | 81642 | 83608 | 85566 | 87515 | 89456 | 2 |
| 45 | 69695 | 71714 | 73723 | 75724 | 77716 | 79700 | 81674 | 83641 | 85598 | 87547 | 89488 | 3 |
| 1 0 | 69729 | 71747 | 73757 | 75757 | 77749 | 79733 | 81707 | 83673 | 85631 | 87580 | 89520 | 4 |
| 15 | 69763 | 71781 | 73790 | 75791 | 77783 | 79766 | 81740 | 83706 | 85663 | 87612 | 89552 | 5 |
| 30 | 69797 | 71815 | 73824 | 75824 | 77816 | 79799 | 81773 | 83739 | 85696 | 87644 | 89585 | 6 |
| 45 | 69830 | 71848 | 73857 | 75857 | 77849 | 79832 | 81806 | 83771 | 85728 | 87677 | 89617 | 7 |
| 2 0 | 69864 | 71882 | 73890 | 75891 | 77882 | 79865 | 81839 | 83804 | 85761 | 87709 | 89649 | 8 |
| 15 | 69898 | 71915 | 73924 | 75924 | 77915 | 79898 | 81872 | 83837 | 85794 | 87742 | 89681 | 9 |
| 30 | 69931 | 71949 | 73957 | 75957 | 77948 | 79930 | 81904 | 83869 | 85826 | 87774 | 89714 | 10 |
| 45 | 69965 | 71982 | 73991 | 75990 | 77981 | 79963 | 81937 | 83902 | 85859 | 87806 | 89746 | 11 |
| 3 0 | 69999 | 72016 | 74024 | 76024 | 78014 | 79996 | 81970 | 83935 | 85891 | 87839 | 89778 | 12 |
| 15 | 70032 | 72049 | 74058 | 76057 | 78047 | 80029 | 82003 | 83967 | 85924 | 87871 | 89811 | 13 |
| 30 | 70066 | 72083 | 74091 | 76090 | 78081 | 80062 | 82036 | 84000 | 85956 | 87904 | 89843 | 14 |
| 45 | 70100 | 72116 | 74124 | 76123 | 78114 | 80095 | 82068 | 84033 | 85989 | 87936 | 89875 | 15 |
| 4 0 | 70133 | 72150 | 74158 | 76157 | 78147 | 80128 | 82101 | 84065 | 86021 | 87968 | 89907 | 16 |
| 15 | 70167 | 72184 | 74191 | 76190 | 78180 | 80161 | 82134 | 84098 | 86054 | 88001 | 89939 | 17 |
| 30 | 70201 | 72217 | 74224 | 76223 | 78213 | 80194 | 82167 | 84131 | 86086 | 88033 | 89972 | 18 |
| 45 | 70234 | 72251 | 74258 | 76256 | 78246 | 80227 | 82200 | 84163 | 86119 | 88066 | 90004 | 19 |
| 5 0 | 70268 | 72284 | 74291 | 76290 | 78279 | 80260 | 82232 | 84196 | 86151 | 88098 | 90036 | 20 |
| 15 | 70302 | 72318 | 74325 | 76323 | 78312 | 80293 | 82265 | 84229 | 86184 | 88130 | 90068 | 21 |
| 30 | 70336 | 72351 | 74358 | 76356 | 78345 | 80326 | 82298 | 84261 | 86216 | 88163 | 90101 | 22 |
| 45 | 70369 | 72385 | 74391 | 76389 | 78378 | 80359 | 82331 | 84294 | 86249 | 88195 | 90133 | 23 |
| 6 0 | 70403 | 72418 | 74425 | 76422 | 78411 | 80392 | 82364 | 84327 | 86281 | 88227 | 90165 | 24 |
| 15 | 70437 | 72452 | 74458 | 76456 | 78445 | 80425 | 82396 | 84359 | 86314 | 88260 | 90197 | 25 |
| 30 | 70470 | 72485 | 74491 | 76489 | 78478 | 80458 | 82429 | 84392 | 86346 | 88292 | 90230 | 26 |
| 45 | 70504 | 72519 | 74525 | 76522 | 78511 | 80491 | 82462 | 84425 | 86379 | 88325 | 90262 | 27 |
| 7 0 | 70538 | 72552 | 74558 | 76555 | 78544 | 80524 | 82495 | 84457 | 86411 | 88357 | 90294 | 28 |
| 15 | 70571 | 72586 | 74592 | 76589 | 78577 | 80557 | 82528 | 84490 | 86444 | 88389 | 90326 | 29 |
| 30 | 70605 | 72619 | 74625 | 76622 | 78610 | 80589 | 82560 | 84523 | 86476 | 88422 | 90358 | 30 |
| 45 | 70638 | 72653 | 74658 | 76655 | 78643 | 80622 | 82593 | 84555 | 86509 | 88454 | 90391 | 31 |
| 8 0 | 70672 | 72686 | 74692 | 76688 | 78676 | 80655 | 82626 | 84588 | 86541 | 88486 | 90423 | 32 |
| 15 | 70706 | 72720 | 74725 | 76721 | 78709 | 80688 | 82659 | 84620 | 86574 | 88519 | 90455 | 33 |
| 30 | 70739 | 72753 | 74758 | 76755 | 78742 | 80721 | 82691 | 84653 | 86606 | 88551 | 90487 | 34 |
| 45 | 70773 | 72787 | 74792 | 76788 | 78775 | 80754 | 82724 | 84686 | 86639 | 88583 | 90519 | 35 |
| 9 0 | 70807 | 72820 | 74825 | 76821 | 78808 | 80787 | 82757 | 84718 | 86671 | 88616 | 90552 | 36 |
| 15 | 70840 | 72854 | 74858 | 76854 | 78841 | 80820 | 82790 | 84751 | 86704 | 88648 | 90584 | 37 |
| 30 | 70874 | 72887 | 74892 | 76887 | 78874 | 80853 | 82822 | 84784 | 86736 | 88680 | 90616 | 38 |
| 45 | 70908 | 72921 | 74925 | 76920 | 78907 | 80886 | 82855 | 84816 | 86769 | 88713 | 90648 | 39 |
| 10 0 | 70941 | 72954 | 74958 | 76954 | 78940 | 80919 | 82888 | 84849 | 86801 | 88745 | 90680 | 40 |
| 15 | 70975 | 72988 | 74992 | 76987 | 78974 | 80951 | 82921 | 84881 | 86834 | 88777 | 90713 | 41 |
| 30 | 71008 | 73021 | 75025 | 77020 | 79007 | 80984 | 82953 | 84914 | 86866 | 88810 | 90745 | 42 |
| 45 | 71042 | 73054 | 75058 | 77053 | 79040 | 81017 | 82986 | 84947 | 86899 | 88842 | 90777 | 43 |
| 11 0 | 71076 | 73088 | 75092 | 77086 | 79073 | 81050 | 83019 | 84979 | 86931 | 88874 | 90809 | 44 |
| 15 | 71109 | 73121 | 75125 | 77120 | 79106 | 81083 | 83052 | 85012 | 86963 | 88907 | 90841 | 45 |
| 30 | 71143 | 73155 | 75158 | 77153 | 79139 | 81116 | 83084 | 85044 | 86996 | 88939 | 90873 | 46 |
| 45 | 71176 | 73188 | 75192 | 77186 | 79172 | 81149 | 83117 | 85077 | 87028 | 88971 | 90905 | 47 |
| 12 0 | 71210 | 73222 | 75225 | 77219 | 79205 | 81182 | 83150 | 85110 | 87061 | 89003 | 90938 | 48 |
| 15 | 71244 | 73255 | 75258 | 77252 | 79238 | 81214 | 83183 | 85142 | 87093 | 89036 | 90970 | 49 |
| 30 | 71277 | 73289 | 75291 | 77285 | 79271 | 81247 | 83215 | 85175 | 87126 | 89068 | 91002 | 50 |
| 45 | 71311 | 73322 | 75325 | 77319 | 79304 | 81280 | 83248 | 85207 | 87158 | 89100 | 91034 | 51 |
| 13 0 | 71344 | 73356 | 75358 | 77352 | 79337 | 81313 | 83281 | 85240 | 87191 | 89133 | 91066 | 52 |
| 15 | 71378 | 73389 | 75391 | 77385 | 79370 | 81346 | 83313 | 85273 | 87223 | 89165 | 91099 | 53 |
| 30 | 71412 | 73423 | 75425 | 77418 | 79403 | 81379 | 83346 | 85305 | 87255 | 89197 | 91131 | 54 |
| 45 | 71445 | 73456 | 75458 | 77451 | 79436 | 81412 | 83379 | 85338 | 87288 | 89230 | 91163 | 55 |
| 14 0 | 71479 | 73489 | 75491 | 77484 | 79469 | 81445 | 83412 | 85370 | 87320 | 89262 | 91195 | 56 |
| 15 | 71512 | 73523 | 75525 | 77518 | 79502 | 81477 | 83444 | 85403 | 87353 | 89294 | 91227 | 57 |
| 30 | 71546 | 73556 | 75558 | 77551 | 79535 | 81510 | 83477 | 85435 | 87385 | 89326 | 91259 | 58 |
| 45 | 71580 | 73590 | 75591 | 77584 | 79568 | 81543 | 83510 | 85468 | 87417 | 89359 | 91291 | 59 |

Sec. 1″ 2″ 3″ 4″ 5″ 6″ 7″ 8″ 9″ 10″ 11″ 12″ 13″ 14″ 15″

D. 33. Parts 2 4 7 9 11 13 15 18 20 22 24 26 29 31 33

## LOG. SINE SQUARE.

| | 89° | | | | 90° | | | | 91° | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | |
| | 5h 56m | 5h 57m | 5h 58m | 5h 59m | 6h 0m | 6h 1m | 6h 2m | 6h 3m | 6h 4m | 6h 5m | 6h 6m | s. |
| ′ ″ | 9·6 | 9·6 | 9·6 | 9·6 | 9· | 9·7 | 9·7 | 9·7 | 9·7 | 9·7 | 9·7 | |
| 0 0 | 91324 | 93248 | 95163 | 97071 | 698970 | 00861 | 02743 | 04618 | 06484 | 08342 | 10192 | 0 |
| 15 | 91356 | 93280 | 95195 | 97103 | 699002 | 00892 | 02775 | 04649 | 06515 | 08373 | 10223 | 1 |
| 30 | 91388 | 93312 | 95227 | 97134 | 699033 | 00924 | 02806 | 04680 | 06546 | 08404 | 10254 | 2 |
| 45 | 91420 | 93344 | 95259 | 97166 | 699065 | 00955 | 02837 | 04711 | 06577 | 08435 | 10285 | 3 |
| 1 0 | 91452 | 93376 | 95291 | 97198 | 699096 | 00987 | 02869 | 04742 | 06608 | 08466 | 10315 | 4 |
| 15 | 91484 | 93408 | 95323 | 97229 | 699128 | 01018 | 02900 | 04774 | 06639 | 08497 | 10346 | 5 |
| 30 | 91516 | 93440 | 95355 | 97261 | 699159 | 01049 | 02931 | 04805 | 06670 | 08528 | 10377 | 6 |
| 45 | 91548 | 93472 | 95386 | 97293 | 699191 | 01081 | 02963 | 04836 | 06701 | 08558 | 10408 | 7 |
| 2 0 | 91581 | 93504 | 95418 | 97325 | 699223 | 01112 | 02994 | 04867 | 06732 | 08589 | 10438 | 8 |
| 15 | 91613 | 93536 | 95450 | 97356 | 699254 | 01144 | 03025 | 04898 | 06763 | 08620 | 10469 | 9 |
| 30 | 91645 | 93568 | 95482 | 97388 | 699286 | 01175 | 03056 | 04929 | 06794 | 08651 | 10500 | 10 |
| 45 | 91677 | 93600 | 95514 | 97420 | 699317 | 01207 | 03088 | 04961 | 06825 | 08682 | 10531 | 11 |
| 3 0 | 91709 | 93632 | 95546 | 97451 | 699349 | 01238 | 03119 | 04992 | 06856 | 08713 | 10561 | 12 |
| 15 | 91741 | 93664 | 95577 | 97483 | 699380 | 01269 | 03150 | 05023 | 06887 | 08744 | 10592 | 13 |
| 30 | 91773 | 93695 | 95609 | 97515 | 699412 | 01301 | 03182 | 05054 | 06918 | 08775 | 10623 | 14 |
| 45 | 91805 | 93727 | 95641 | 97546 | 699443 | 01332 | 03213 | 05085 | 06949 | 08805 | 10653 | 15 |
| 4 0 | 91838 | 93759 | 95673 | 97578 | 699475 | 01364 | 03244 | 05116 | 06980 | 08836 | 10684 | 16 |
| 15 | 91870 | 93791 | 95705 | 97610 | 699506 | 01395 | 03275 | 05147 | 07011 | 08867 | 10715 | 17 |
| 30 | 91902 | 93823 | 95737 | 97641 | 699538 | 01426 | 03307 | 05179 | 07042 | 08898 | 10746 | 18 |
| 45 | 91933 | 93855 | 95768 | 97673 | 699570 | 01458 | 03338 | 05210 | 07073 | 08929 | 10776 | 19 |
| 5 0 | 91966 | 93887 | 95800 | 97705 | 699601 | 01489 | 03369 | 05241 | 07104 | 08960 | 10807 | 20 |
| 15 | 91998 | 93919 | 95832 | 97737 | 699633 | 01521 | 03400 | 05272 | 07135 | 08991 | 10838 | 21 |
| 30 | 92030 | 93951 | 95864 | 97768 | 699664 | 01552 | 03432 | 05303 | 07166 | 09021 | 10869 | 22 |
| 45 | 92062 | 93983 | 95896 | 97800 | 699696 | 01583 | 03463 | 05334 | 07197 | 09052 | 10899 | 23 |
| 6 0 | 92094 | 94015 | 95927 | 97831 | 699727 | 01615 | 03494 | 05365 | 07228 | 09083 | 10930 | 24 |
| 15 | 92126 | 94047 | 95959 | 97863 | 699759 | 01646 | 03525 | 05396 | 07259 | 09114 | 10961 | 25 |
| 30 | 92158 | 94079 | 95991 | 97895 | 699790 | 01678 | 03557 | 05428 | 07290 | 09145 | 10991 | 26 |
| 45 | 92190 | 94111 | 96023 | 97926 | 699822 | 01709 | 03588 | 05459 | 07321 | 09176 | 11022 | 27 |
| 7 0 | 92223 | 94143 | 96055 | 97958 | 699853 | 01740 | 03619 | 05490 | 07352 | 09207 | 11053 | 28 |
| 15 | 92255 | 94175 | 96086 | 97990 | 699885 | 01772 | 03650 | 05521 | 07383 | 09237 | 11083 | 29 |
| 30 | 92287 | 94207 | 96118 | 98021 | 699916 | 01803 | 03682 | 05552 | 07414 | 09268 | 11114 | 30 |
| 45 | 92319 | 94239 | 96150 | 98053 | 699948 | 01834 | 03713 | 05583 | 07445 | 09299 | 11145 | 31 |
| 8 0 | 92351 | 94270 | 96182 | 98085 | 699979 | 01866 | 03744 | 05614 | 07476 | 09330 | 11176 | 32 |
| 15 | 92383 | 94302 | 96214 | 98116 | 700011 | 01897 | 03775 | 05645 | 07507 | 09361 | 11206 | 33 |
| 30 | 92415 | 94334 | 96245 | 98148 | 700042 | 01929 | 03807 | 05676 | 07538 | 09392 | 11237 | 34 |
| 45 | 92447 | 94366 | 96277 | 98180 | 700074 | 01960 | 03838 | 05707 | 07569 | 09422 | 11268 | 35 |
| 9 0 | 92479 | 94398 | 96309 | 98211 | 700105 | 01991 | 03869 | 05739 | 07600 | 09453 | 11298 | 36 |
| 15 | 92511 | 94430 | 96341 | 98243 | 700137 | 02023 | 03900 | 05770 | 07631 | 09484 | 11329 | 37 |
| 30 | 92543 | 94462 | 96372 | 98275 | 700168 | 02054 | 03932 | 05801 | 07662 | 09515 | 11360 | 38 |
| 45 | 92575 | 94494 | 96404 | 98306 | 700200 | 02085 | 03963 | 05832 | 07693 | 09546 | 11390 | 39 |
| 10 0 | 92607 | 94526 | 96436 | 98338 | 700231 | 02117 | 03994 | 05863 | 07724 | 09576 | 11421 | 40 |
| 15 | 92639 | 94558 | 96468 | 98370 | 700263 | 02148 | 04025 | 05894 | 07755 | 09607 | 11452 | 41 |
| 30 | 92671 | 94590 | 96499 | 98401 | 700294 | 02179 | 04056 | 05925 | 07786 | 09638 | 11482 | 42 |
| 45 | 92703 | 94621 | 96531 | 98433 | 700326 | 02211 | 04088 | 05956 | 07817 | 09669 | 11513 | 43 |
| 11 0 | 92735 | 94653 | 96563 | 98464 | 700357 | 02242 | 04119 | 05987 | 07847 | 09700 | 11544 | 44 |
| 15 | 92767 | 94685 | 96595 | 98496 | 700389 | 02274 | 04150 | 06018 | 07878 | 09730 | 11574 | 45 |
| 30 | 92800 | 94717 | 96627 | 98528 | 700420 | 02305 | 04181 | 06049 | 07909 | 09761 | 11605 | 46 |
| 45 | 92832 | 94749 | 96658 | 98559 | 700452 | 02336 | 04212 | 06080 | 07940 | 09792 | 11636 | 47 |
| 12 0 | 92864 | 94781 | 96690 | 98591 | 700483 | 02368 | 04244 | 06112 | 07971 | 09823 | 11666 | 48 |
| 15 | 92896 | 94813 | 96722 | 98622 | 700515 | 02399 | 04275 | 06143 | 08002 | 09854 | 11697 | 49 |
| 30 | 92928 | 94845 | 96754 | 98654 | 700546 | 02430 | 04306 | 06174 | 08033 | 09884 | 11728 | 50 |
| 45 | 92960 | 94877 | 96785 | 98686 | 700578 | 02462 | 04337 | 06205 | 08064 | 09915 | 11758 | 51 |
| 13 0 | 92992 | 94909 | 96817 | 98717 | 700609 | 02493 | 04368 | 06236 | 08095 | 09946 | 11789 | 52 |
| 15 | 93024 | 94940 | 96849 | 98749 | 700641 | 02524 | 04400 | 06267 | 08126 | 09977 | 11820 | 53 |
| 30 | 93056 | 94972 | 96881 | 98780 | 700672 | 02556 | 04431 | 06298 | 08157 | 10008 | 11850 | 54 |
| 45 | 93088 | 95004 | 96912 | 98812 | 700702 | 02587 | 04462 | 06329 | 08188 | 10038 | 11881 | 55 |
| 14 0 | 93120 | 95036 | 96944 | 98844 | 700735 | 02618 | 04493 | 06360 | 08219 | 10069 | 11912 | 56 |
| 15 | 93152 | 95068 | 96976 | 98875 | 700766 | 02649 | 04524 | 06391 | 08249 | 10100 | 11942 | 57 |
| 30 | 93184 | 95100 | 97007 | 98907 | 700798 | 02681 | 04556 | 06422 | 08280 | 10131 | 11973 | 58 |
| 45 | 93216 | 95132 | 97039 | 98938 | 700829 | 02712 | 04587 | 06453 | 08311 | 10161 | 12004 | 59 |

| | Sec. | 1″ | 2″ | 3″ | 4 | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 32. | Parts | 2 | 4 | 6 | 9 | 11 | 13 | 15 | 17 | 19 | 21 | 23 | 26 | 28 | 30 | 32 |

## LOG. SINE SQUARE

| | 91° | 92° | | | | 93° | | | | 94° | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | |
| | 6h 7m | 6h 8m | 6h 9m | 6h 10m | 6h 11m | 6h 12m | 6h 13m | 6h 14m | 6h 15m | 6h 16m | 6h 17m | s. |
| ′ ″ | 9·7 | 9·7 | 9·7 | 9·7 | 9·7 | 9·7 | 9·7 | 9·7 | 9·7 | 9·7 | 9·7 | |
| 0 0 | 12034 | 13868 | 15694 | 17512 | 19322 | 21124 | 22919 | 24705 | 26484 | 28255 | 30018 | 0 |
| 15 | 12065 | 13899 | 15725 | 17542 | 19352 | 21154 | 22949 | 24735 | 26514 | 28284 | 30047 | 1 |
| 30 | 12095 | 13929 | 15755 | 17573 | 19382 | 21184 | 22978 | 24765 | 26543 | 28314 | 30077 | 2 |
| 45 | 12126 | 13960 | 15785 | 17603 | 19412 | 21214 | 23008 | 24794 | 26573 | 28343 | 30106 | 3 |
| 1 0 | 12157 | 13990 | 15816 | 17633 | 19443 | 21244 | 23038 | 24824 | 26602 | 28373 | 30135 | 4 |
| 15 | 12187 | 14021 | 15846 | 17663 | 19473 | 21274 | 23068 | 24854 | 26632 | 28402 | 30165 | 5 |
| 30 | 12218 | 14051 | 15876 | 17693 | 19503 | 21304 | 23098 | 24883 | 26661 | 28432 | 30194 | 6 |
| 45 | 12249 | 14082 | 15907 | 17724 | 19533 | 21334 | 23128 | 24913 | 26691 | 28461 | 30223 | 7 |
| 2 0 | 12279 | 14112 | 15937 | 17754 | 19563 | 21364 | 23157 | 24943 | 26721 | 28490 | 30253 | 8 |
| 15 | 12310 | 14142 | 15967 | 17784 | 19593 | 21394 | 23187 | 24973 | 26750 | 28520 | 30282 | 9 |
| 30 | 12340 | 14173 | 15998 | 17814 | 19623 | 21424 | 23217 | 25002 | 26780 | 28549 | 30311 | 10 |
| 45 | 12371 | 14203 | 16028 | 17845 | 19653 | 21454 | 23247 | 25032 | 26809 | 28579 | 30341 | 11 |
| 3 0 | 12402 | 14234 | 16058 | 17875 | 19683 | 21484 | 23277 | 25062 | 26839 | 28608 | 30370 | 12 |
| 15 | 12432 | 14264 | 16089 | 17905 | 19713 | 21514 | 23306 | 25091 | 26868 | 28638 | 30399 | 13 |
| 30 | 12463 | 14295 | 16119 | 17935 | 19743 | 21544 | 23336 | 25121 | 26898 | 28667 | 30428 | 14 |
| 45 | 12493 | 14325 | 16149 | 17965 | 19773 | 21574 | 23366 | 25151 | 26927 | 28696 | 30458 | 15 |
| 4 0 | 12524 | 14356 | 16180 | 17996 | 19804 | 21604 | 23396 | 25180 | 26957 | 28726 | 30487 | 16 |
| 15 | 12555 | 14386 | 16210 | 18026 | 19834 | 21634 | 23426 | 25210 | 26987 | 28755 | 30516 | 17 |
| 30 | 12585 | 14417 | 16240 | 18056 | 19864 | 21664 | 23455 | 25240 | 27016 | 28785 | 30546 | 18 |
| 45 | 12616 | 14447 | 16271 | 18086 | 19894 | 21693 | 23485 | 25270 | 27046 | 28814 | 30575 | 19 |
| 5 0 | 12646 | 14478 | 16301 | 18116 | 19924 | 21723 | 23515 | 25299 | 27075 | 28843 | 30604 | 20 |
| 15 | 12677 | 14508 | 16331 | 18147 | 19954 | 21753 | 23545 | 25329 | 27105 | 28873 | 30633 | 21 |
| 30 | 12708 | 14539 | 16362 | 18177 | 19984 | 21783 | 23575 | 25358 | 27134 | 28902 | 30663 | 22 |
| 45 | 12738 | 14569 | 16392 | 18207 | 20014 | 21813 | 23604 | 25388 | 27164 | 28932 | 30692 | 23 |
| 6 0 | 12769 | 14599 | 16422 | 18237 | 20044 | 21843 | 23634 | 25418 | 27193 | 28961 | 30721 | 24 |
| 15 | 12799 | 14630 | 16453 | 18267 | 20074 | 21873 | 23664 | 25447 | 27223 | 28990 | 30751 | 25 |
| 30 | 12830 | 14660 | 16483 | 18297 | 20104 | 21903 | 23694 | 25477 | 27252 | 29020 | 30780 | 26 |
| 45 | 12860 | 14691 | 16513 | 18328 | 20134 | 21933 | 23724 | 25507 | 27282 | 29049 | 30809 | 27 |
| 7 0 | 12891 | 14721 | 16544 | 18358 | 20164 | 21963 | 23753 | 25536 | 27311 | 29079 | 30838 | 28 |
| 15 | 12922 | 14752 | 16574 | 18388 | 20194 | 21993 | 23783 | 25566 | 27341 | 29108 | 30868 | 29 |
| 30 | 12952 | 14782 | 16604 | 18418 | 20224 | 22023 | 23813 | 25596 | 27370 | 29137 | 30897 | 30 |
| 45 | 12983 | 14813 | 16634 | 18448 | 20254 | 22052 | 23843 | 25625 | 27400 | 29167 | 30926 | 31 |
| 8 0 | 13013 | 14843 | 16665 | 18479 | 20284 | 22082 | 23872 | 25655 | 27429 | 29196 | 30955 | 32 |
| 15 | 13044 | 14873 | 16695 | 18509 | 20314 | 22112 | 23902 | 25685 | 27459 | 29226 | 30985 | 33 |
| 30 | 13074 | 14904 | 16725 | 18539 | 20344 | 22142 | 23932 | 25714 | 27488 | 29255 | 31014 | 34 |
| 45 | 13105 | 14934 | 16756 | 18569 | 20374 | 22172 | 23962 | 25744 | 27518 | 29284 | 31043 | 35 |
| 9 0 | 13136 | 14965 | 16786 | 18599 | 20405 | 22202 | 23992 | 25773 | 27547 | 29314 | 31072 | 36 |
| 15 | 13166 | 14995 | 16816 | 18629 | 20435 | 22232 | 24021 | 25803 | 27577 | 29343 | 31102 | 37 |
| 30 | 13197 | 15026 | 16846 | 18659 | 20465 | 22262 | 24051 | 25833 | 27606 | 29373 | 31131 | 38 |
| 45 | 13227 | 15056 | 16877 | 18690 | 20495 | 22292 | 24081 | 25862 | 27636 | 29402 | 31160 | 39 |
| 10 0 | 13258 | 15086 | 16907 | 18720 | 20525 | 22322 | 24111 | 25892 | 27665 | 29431 | 31189 | 40 |
| 15 | 13288 | 15117 | 16937 | 18750 | 20555 | 22351 | 24140 | 25922 | 27695 | 29461 | 31219 | 41 |
| 30 | 13319 | 15147 | 16967 | 18780 | 20585 | 22381 | 24170 | 25951 | 27724 | 29490 | 31248 | 42 |
| 45 | 13349 | 15178 | 16998 | 18810 | 20615 | 22411 | 24200 | 25981 | 27754 | 29519 | 31277 | 43 |
| 11 0 | 13380 | 15208 | 17028 | 18840 | 20645 | 22441 | 24230 | 26010 | 27783 | 29549 | 31306 | 44 |
| 15 | 13411 | 15238 | 17058 | 18870 | 20675 | 22471 | 24259 | 26040 | 27813 | 29578 | 31335 | 45 |
| 30 | 13441 | 15269 | 17089 | 18901 | 20705 | 22501 | 24289 | 26070 | 27842 | 29607 | 31365 | 46 |
| 45 | 13472 | 15299 | 11719 | 18931 | 20735 | 22531 | 24319 | 26099 | 27872 | 29637 | 31394 | 47 |
| 12 0 | 13502 | 15330 | 17149 | 18961 | 20765 | 22560 | 24349 | 26129 | 27901 | 29666 | 31423 | 48 |
| 15 | 13533 | 15360 | 17179 | 18991 | 20795 | 22590 | 24378 | 26158 | 27931 | 29695 | 31452 | 49 |
| 30 | 13563 | 15390 | 17210 | 19021 | 20825 | 22620 | 24408 | 26188 | 27960 | 29725 | 31482 | 50 |
| 45 | 13594 | 15421 | 17240 | 19051 | 20855 | 22650 | 24438 | 26218 | 27990 | 29754 | 31511 | 51 |
| 13 0 | 13624 | 15451 | 17270 | 19081 | 20885 | 22680 | 24468 | 26247 | 28019 | 29783 | 31540 | 52 |
| 15 | 13655 | 15481 | 17300 | 19111 | 20915 | 22710 | 24497 | 26277 | 28049 | 29813 | 31569 | 53 |
| 30 | 13685 | 15512 | 17331 | 19141 | 20945 | 22740 | 24527 | 26306 | 28078 | 29842 | 31598 | 54 |
| 45 | 13716 | 15542 | 17361 | 19172 | 20975 | 22769 | 24557 | 26336 | 28108 | 29871 | 31628 | 55 |
| 14 0 | 13746 | 15573 | 17391 | 19202 | 21004 | 22799 | 24586 | 26366 | 28137 | 29901 | 31657 | 56 |
| 15 | 13777 | 15603 | 17421 | 19232 | 21034 | 22829 | 24616 | 26395 | 28166 | 29930 | 31686 | 57 |
| 30 | 13807 | 15633 | 17452 | 19262 | 21064 | 22859 | 24646 | 26425 | 28196 | 29959 | 31715 | 58 |
| 45 | 13833 | 15664 | 17482 | 19292 | 21094 | 22889 | 24676 | 26454 | 28225 | 29989 | 31744 | 59 |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
| D 30. | Parts | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 26 | 28 | 30 |

## LOG. SINE SQUARE

| m s | 94° 30′ 6h 18m | 94° 45′ 6h 19m | 95° 0′ 6h 20m | 95° 15′ 6h 21m | 95° 30′ 6h 22m | 95° 45′ 6h 23m | 96° 0′ 6h 24m | 96° 15′ 6h 25m | 96° 30′ 6h 26m | 96° 45′ 6h 27m | 97° 0′ 6h 28m | s. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ′ ″ | 9·7 | 9·7 | 9·7 | 9·7 | 9·7 | 9·7 | 9·7 | 9·7 | 9·7 | 9·7 | 9·7 | |
| 0 0 | 31774 | 33521 | 35262 | 36994 | 38719 | 40437 | 42147 | 43849 | 45544 | 47232 | 48912 | 0 |
| 15 | 31803 | 33551 | 35291 | 37023 | 38748 | 40465 | 42175 | 43878 | 45573 | 47260 | 48940 | 1 |
| 30 | 31832 | 33580 | 35320 | 37052 | 38777 | 40494 | 42204 | 43906 | 45601 | 47288 | 48968 | 2 |
| 45 | 31861 | 33609 | 35349 | 37081 | 38805 | 40523 | 42232 | 43934 | 45629 | 47316 | 48996 | 3 |
| 1 0 | 31890 | 33638 | 35377 | 37110 | 38834 | 40551 | 42261 | 43963 | 45657 | 47344 | 49024 | 4 |
| 15 | 31920 | 33667 | 35406 | 37138 | 38863 | 40580 | 42289 | 43991 | 45685 | 47372 | 49052 | 5 |
| 30 | 31949 | 33696 | 35435 | 37167 | 38892 | 40608 | 42317 | 44019 | 45713 | 47400 | 49080 | 6 |
| 45 | 31978 | 33725 | 35464 | 37196 | 38920 | 40637 | 42346 | 44048 | 45742 | 47428 | 49108 | 7 |
| 2 0 | 32007 | 33754 | 35493 | 37225 | 38949 | 40665 | 42374 | 44076 | 45770 | 47456 | 49136 | 8 |
| 15 | 32036 | 33783 | 35522 | 37254 | 38978 | 40694 | 42403 | 44104 | 45798 | 47485 | 49164 | 9 |
| 30 | 32066 | 33812 | 35551 | 37282 | 39006 | 40722 | 42431 | 44132 | 45826 | 47513 | 49192 | 10 |
| 45 | 32095 | 33841 | 35580 | 37311 | 39035 | 40751 | 42460 | 44161 | 45854 | 47541 | 49219 | 11 |
| 3 0 | 32124 | 33870 | 35609 | 37340 | 39063 | 40780 | 42488 | 44189 | 45883 | 47569 | 49247 | 12 |
| 15 | 32153 | 33899 | 35638 | 37369 | 39092 | 40808 | 42516 | 44217 | 45911 | 47597 | 49275 | 13 |
| 30 | 32182 | 33928 | 35667 | 37397 | 39121 | 40837 | 42545 | 44246 | 45939 | 47625 | 49303 | 14 |
| 45 | 32211 | 33957 | 35696 | 37426 | 39149 | 40865 | 42573 | 44274 | 45967 | 47653 | 49331 | 15 |
| 4 0 | 32241 | 33986 | 35724 | 37455 | 39178 | 40894 | 42602 | 44302 | 45995 | 47681 | 49359 | 16 |
| 15 | 32270 | 34015 | 35753 | 37484 | 39207 | 40922 | 42630 | 44330 | 46023 | 47709 | 49387 | 17 |
| 30 | 32299 | 34044 | 35782 | 37513 | 39235 | 40951 | 42658 | 44359 | 46051 | 47737 | 49415 | 18 |
| 45 | 32328 | 34073 | 35811 | 37541 | 39264 | 40979 | 42687 | 44387 | 46080 | 47765 | 49443 | 19 |
| 5 0 | 32357 | 34102 | 35840 | 37570 | 39293 | 41008 | 42715 | 44415 | 46108 | 47793 | 49471 | 20 |
| 15 | 32386 | 34131 | 35869 | 37599 | 39321 | 41036 | 42744 | 44443 | 46136 | 47821 | 49499 | 21 |
| 30 | 32415 | 34160 | 35898 | 37628 | 39350 | 41065 | 42772 | 44472 | 46164 | 47849 | 49526 | 22 |
| 45 | 32445 | 34189 | 35927 | 37656 | 39379 | 41093 | 42800 | 44500 | 46192 | 47877 | 49554 | 23 |
| 6 0 | 32474 | 34218 | 35956 | 37685 | 39407 | 41122 | 42829 | 44528 | 46220 | 47905 | 49582 | 24 |
| 15 | 32503 | 34248 | 35985 | 37714 | 39436 | 41150 | 42857 | 44557 | 46249 | 47933 | 49610 | 25 |
| 30 | 32532 | 34277 | 36013 | 37743 | 39465 | 41179 | 42885 | 44585 | 46277 | 47961 | 49638 | 26 |
| 45 | 32561 | 34306 | 36042 | 37772 | 39493 | 41207 | 42914 | 44613 | 46305 | 47989 | 49666 | 27 |
| 7 0 | 32590 | 34335 | 36071 | 37800 | 39522 | 41236 | 42942 | 44641 | 46333 | 48017 | 49694 | 28 |
| 15 | 32619 | 34364 | 36100 | 37829 | 39551 | 41264 | 42971 | 44670 | 46361 | 48045 | 49722 | 29 |
| 30 | 32649 | 34394 | 36129 | 37858 | 39579 | 41293 | 42999 | 44698 | 46389 | 48073 | 49750 | 30 |
| 45 | 32678 | 34422 | 36158 | 37887 | 39608 | 41321 | 43027 | 44726 | 46417 | 48101 | 49778 | 31 |
| 8 0 | 32707 | 34451 | 36187 | 37915 | 39636 | 41350 | 43056 | 44754 | 46445 | 48129 | 49805 | 32 |
| 15 | 32736 | 34479 | 36216 | 37944 | 39665 | 41378 | 43084 | 44783 | 46473 | 48157 | 49833 | 33 |
| 30 | 32765 | 34509 | 36244 | 37973 | 39694 | 41407 | 43112 | 44811 | 46502 | 48185 | 49861 | 34 |
| 45 | 32794 | 34537 | 36273 | 38002 | 39722 | 41435 | 43141 | 44839 | 46530 | 48213 | 49889 | 35 |
| 9 0 | 32823 | 34567 | 36302 | 38030 | 39751 | 41464 | 43169 | 44867 | 46558 | 48241 | 49917 | 36 |
| 15 | 32852 | 34590 | 36331 | 38059 | 39779 | 41492 | 43198 | 44896 | 46586 | 48269 | 49945 | 37 |
| 30 | 32882 | 34625 | 36360 | 38088 | 39808 | 41521 | 43226 | 44924 | 46614 | 48297 | 49973 | 38 |
| 45 | 32911 | 34654 | 36389 | 38117 | 39837 | 41549 | 43254 | 44952 | 46642 | 48325 | 50000 | 39 |
| 10 0 | 32940 | 34682 | 36418 | 38145 | 39865 | 41578 | 43283 | 44980 | 46670 | 48353 | 50028 | 40 |
| 15 | 32969 | 34711 | 36447 | 38174 | 39894 | 41606 | 43311 | 45009 | 46698 | 48381 | 50056 | 41 |
| 30 | 32998 | 34740 | 36475 | 38203 | 39922 | 41635 | 43339 | 45037 | 46727 | 48409 | 50084 | 42 |
| 45 | 33027 | 34769 | 36504 | 38231 | 39951 | 41663 | 43368 | 45065 | 46755 | 48437 | 50112 | 43 |
| 11 0 | 33056 | 34798 | 36533 | 38260 | 39980 | 41692 | 43396 | 45093 | 46783 | 48465 | 50140 | 44 |
| 15 | 33085 | 34827 | 36562 | 38289 | 40008 | 41720 | 43424 | 45121 | 46811 | 48493 | 50168 | 45 |
| 30 | 33114 | 34856 | 36591 | 38318 | 40037 | 41749 | 43453 | 45150 | 46839 | 48521 | 50195 | 46 |
| 45 | 33143 | 34885 | 36620 | 38346 | 40065 | 41777 | 43481 | 45178 | 46867 | 48549 | 50223 | 47 |
| 12 0 | 33173 | 34914 | 36648 | 38375 | 40094 | 41805 | 43509 | 45206 | 46895 | 48577 | 50251 | 48 |
| 15 | 33202 | 34943 | 36677 | 38404 | 40123 | 41834 | 43538 | 45234 | 46923 | 48605 | 50279 | 49 |
| 30 | 33231 | 34972 | 36706 | 38432 | 40151 | 41862 | 43566 | 45262 | 46951 | 48633 | 50307 | 50 |
| 45 | 33260 | 35001 | 36735 | 38461 | 40180 | 41891 | 43594 | 45291 | 46979 | 48661 | 50335 | 51 |
| 13 0 | 33289 | 35030 | 36764 | 38490 | 40208 | 41919 | 43623 | 45319 | 47007 | 48689 | 50362 | 52 |
| 15 | 33318 | 35059 | 36793 | 38519 | 40237 | 41948 | 43651 | 45347 | 47036 | 48717 | 50390 | 53 |
| 30 | 33347 | 35088 | 36821 | 38547 | 40266 | 41976 | 43679 | 45375 | 47064 | 48745 | 50418 | 54 |
| 45 | 33376 | 35117 | 36850 | 38576 | 40294 | 42005 | 43708 | 45403 | 47093 | 48773 | 50446 | 55 |
| 14 0 | 33405 | 35146 | 36879 | 38605 | 40323 | 42033 | 43736 | 45432 | 47120 | 48800 | 50474 | 56 |
| 15 | 33434 | 35175 | 36908 | 38633 | 40351 | 42062 | 43764 | 45460 | 47148 | 48828 | 50502 | 57 |
| 30 | 33463 | 35204 | 36937 | 38662 | 40380 | 42090 | 43793 | 45488 | 47176 | 48856 | 50529 | 58 |
| 45 | 33492 | 35233 | 36966 | 38691 | 40408 | 42118 | 43821 | 45516 | 47204 | 48884 | 50557 | 59 |

| | Sec. | 1′ | 2′ | 3′ | 4′ | 5′ | 6′ | 7′ | 8′ | 9′ | 10′ | 11′ | 12′ | 13′ | 14′ | 15′ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 28. | Parts | 2 | 4 | 6 | 7 | 9 | 11 | 13 | 15 | 17 | 19 | 20 | 22 | 24 | 26 | 28 |

## LOG. SINE SQUARE

| | 97° | | | 98° | | | | 99° | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | |
| | 6ʰ 29ᵐ | 6ʰ 30ᵐ | 6ʰ 31ᵐ | 6ʰ 32ᵐ | 6ʰ 33ᵐ | 6ʰ 34ᵐ | 6ʰ 35ᵐ | 6ʰ 36ᵐ | 6ʰ 37ᵐ | 6ʰ 38ᵐ | 6ʰ 39ᵐ | s. |
| ′ ″ | 9·7 | 9·7 | 9·7 | 9·7 | 9·7 | 9·7 | 9·7 | 9·7 | 9·7 | 9·7 | 9·7 | |
| 0 0 | 50585 | 52251 | 53909 | 55560 | 57203 | 58840 | 60469 | 62091 | 63706 | 65314 | 66914 | 0 |
| 15 | 50613 | 52278 | 53936 | 55587 | 57231 | 58867 | 60496 | 62118 | 63733 | 65340 | 66941 | 1 |
| 30 | 50641 | 52306 | 53964 | 55615 | 57258 | 58894 | 60523 | 62145 | 63760 | 65367 | 66968 | 2 |
| 45 | 50669 | 52334 | 53991 | 55642 | 57285 | 58921 | 60550 | 62172 | 63786 | 65394 | 66994 | 3 |
| 1 0 | 50696 | 52361 | 54019 | 55670 | 57313 | 58949 | 60577 | 62199 | 63813 | 65421 | 67021 | 4 |
| 15 | 50724 | 52389 | 54047 | 55697 | 57340 | 58976 | 60604 | 62226 | 63840 | 65447 | 67047 | 5 |
| 30 | 50752 | 52417 | 54074 | 55724 | 57367 | 59003 | 60631 | 62253 | 63867 | 65474 | 67074 | 6 |
| 45 | 50780 | 52444 | 54102 | 55752 | 57395 | 59030 | 60659 | 62280 | 63894 | 65501 | 67101 | 7 |
| 2 0 | 50808 | 52472 | 54129 | 55779 | 57422 | 59057 | 60686 | 62307 | 63921 | 65527 | 67127 | 8 |
| 15 | 50835 | 52500 | 54157 | 55807 | 57449 | 59085 | 60713 | 62334 | 63948 | 65554 | 67154 | 9 |
| 30 | 50863 | 52527 | 54184 | 55834 | 57477 | 59112 | 60740 | 62361 | 63974 | 65581 | 67180 | 10 |
| 45 | 50891 | 52555 | 54212 | 55862 | 57504 | 59139 | 60767 | 62388 | 64001 | 65608 | 67207 | 11 |
| 3 0 | 50919 | 52583 | 54240 | 55889 | 57531 | 59166 | 60794 | 62415 | 64028 | 65634 | 67234 | 12 |
| 15 | 50947 | 52611 | 54267 | 55916 | 57558 | 59193 | 60821 | 62442 | 64055 | 65661 | 67260 | 13 |
| 30 | 50974 | 52638 | 54295 | 55944 | 57586 | 59221 | 60848 | 62468 | 64082 | 65688 | 67287 | 14 |
| 45 | 51002 | 52666 | 54322 | 55971 | 57613 | 59248 | 60875 | 62495 | 64108 | 65714 | 67313 | 15 |
| 4 0 | 51030 | 52694 | 54350 | 55999 | 57640 | 59275 | 60902 | 62522 | 64135 | 65741 | 67340 | 16 |
| 15 | 51058 | 52721 | 54377 | 56026 | 57668 | 59302 | 60929 | 62549 | 64162 | 65768 | 67367 | 17 |
| 30 | 51085 | 52749 | 54405 | 56054 | 57695 | 59329 | 60956 | 62576 | 64189 | 65795 | 67393 | 18 |
| 45 | 51113 | 52776 | 54432 | 56081 | 57722 | 59356 | 60983 | 62603 | 64216 | 65821 | 67420 | 19 |
| 5 0 | 51141 | 52804 | 54460 | 56108 | 57750 | 59384 | 61010 | 62630 | 64243 | 65848 | 67446 | 20 |
| 15 | 51169 | 52832 | 54487 | 56136 | 57777 | 59411 | 61038 | 62657 | 64269 | 65875 | 67473 | 21 |
| 30 | 51197 | 52859 | 54515 | 56163 | 57804 | 59438 | 61065 | 62684 | 64296 | 65901 | 67499 | 22 |
| 45 | 51224 | 52887 | 54543 | 56191 | 57831 | 59465 | 61092 | 62711 | 64323 | 65928 | 67526 | 23 |
| 6 0 | 51252 | 52915 | 54570 | 56218 | 57859 | 59492 | 61119 | 62738 | 64350 | 65955 | 67553 | 24 |
| 15 | 51280 | 52942 | 54598 | 56245 | 57886 | 59519 | 61146 | 62765 | 64377 | 65981 | 67579 | 25 |
| 30 | 51308 | 52970 | 54625 | 56273 | 57913 | 59547 | 61173 | 62792 | 64403 | 66008 | 67606 | 26 |
| 45 | 51335 | 52998 | 54653 | 56300 | 57941 | 59574 | 61200 | 62819 | 64430 | 66035 | 67632 | 27 |
| 7 0 | 51363 | 53025 | 54680 | 56328 | 57968 | 59601 | 61227 | 62845 | 64457 | 66061 | 67659 | 28 |
| 15 | 51391 | 53053 | 54708 | 56355 | 57995 | 59628 | 61254 | 62872 | 64484 | 66088 | 67685 | 29 |
| 30 | 51419 | 53081 | 54735 | 56382 | 58022 | 59655 | 61281 | 62899 | 64511 | 66115 | 67712 | 30 |
| 45 | 51447 | 53108 | 54763 | 56410 | 58050 | 59682 | 61308 | 62926 | 64537 | 66141 | 67739 | 31 |
| 8 0 | 51474 | 53136 | 54790 | 56437 | 58077 | 59710 | 61335 | 62953 | 64564 | 66168 | 67765 | 32 |
| 15 | 51502 | 53164 | 54818 | 56465 | 58104 | 59737 | 61362 | 62980 | 64591 | 66195 | 67792 | 33 |
| 30 | 51530 | 53191 | 54845 | 56492 | 58131 | 59764 | 61389 | 63007 | 64618 | 66221 | 67818 | 34 |
| 45 | 51558 | 53219 | 54873 | 56519 | 58159 | 59791 | 61416 | 63034 | 64645 | 66248 | 67845 | 35 |
| 9 0 | 51585 | 53246 | 54900 | 56547 | 58186 | 59818 | 61443 | 63061 | 64671 | 66275 | 67871 | 36 |
| 15 | 51613 | 53274 | 54928 | 56574 | 58213 | 59845 | 61470 | 63088 | 64698 | 66302 | 67898 | 37 |
| 30 | 51641 | 53302 | 54955 | 56602 | 58241 | 59872 | 61497 | 63115 | 64725 | 66328 | 67924 | 38 |
| 45 | 51669 | 53329 | 54983 | 56629 | 58268 | 59900 | 61524 | 63141 | 64752 | 66355 | 67951 | 39 |
| 10 0 | 51696 | 53357 | 55010 | 56656 | 58295 | 59927 | 61551 | 63168 | 64778 | 66382 | 67977 | 40 |
| 15 | 51724 | 53385 | 55038 | 56684 | 58322 | 59954 | 61578 | 63195 | 64805 | 66408 | 68004 | 41 |
| 30 | 51752 | 53412 | 55065 | 56711 | 58350 | 59981 | 61605 | 63222 | 64832 | 66435 | 68031 | 42 |
| 45 | 51779 | 53440 | 55093 | 56738 | 58377 | 60008 | 61632 | 63249 | 64859 | 66462 | 68057 | 43 |
| 11 0 | 51807 | 53467 | 55120 | 56766 | 58404 | 60035 | 61659 | 63276 | 64886 | 66488 | 68084 | 44 |
| 15 | 51835 | 53495 | 55148 | 56793 | 58431 | 60062 | 61686 | 63303 | 64912 | 66515 | 68110 | 45 |
| 30 | 51863 | 53523 | 55175 | 56820 | 58459 | 60089 | 61713 | 63330 | 64939 | 66541 | 68137 | 46 |
| 45 | 51890 | 53550 | 55203 | 56848 | 58486 | 60117 | 61740 | 63357 | 64966 | 66568 | 68163 | 47 |
| 12 0 | 51918 | 53578 | 55230 | 56875 | 58513 | 60144 | 61767 | 63384 | 64993 | 66595 | 68190 | 48 |
| 15 | 51946 | 53605 | 55258 | 56903 | 58540 | 60171 | 61794 | 63410 | 65019 | 66621 | 68216 | 49 |
| 30 | 51974 | 53633 | 55285 | 56930 | 58568 | 60198 | 61821 | 63437 | 65046 | 66648 | 68243 | 50 |
| 45 | 52001 | 53661 | 55312 | 56957 | 58595 | 60225 | 61848 | 63464 | 65073 | 66675 | 68269 | 51 |
| 13 0 | 52029 | 53688 | 55340 | 56985 | 58622 | 60252 | 61875 | 63491 | 65100 | 66701 | 68296 | 52 |
| 15 | 52057 | 53716 | 55367 | 57012 | 58649 | 60279 | 61902 | 63518 | 65126 | 66728 | 68322 | 53 |
| 30 | 52084 | 53743 | 55395 | 57039 | 58676 | 60306 | 61929 | 63545 | 65153 | 66755 | 68349 | 54 |
| 45 | 52112 | 53771 | 55422 | 57067 | 58704 | 60333 | 61956 | 63572 | 65180 | 66781 | 68375 | 55 |
| 14 0 | 52140 | 53799 | 55450 | 57094 | 58731 | 60361 | 61983 | 63598 | 65207 | 66808 | 68402 | 56 |
| 15 | 52167 | 53826 | 55477 | 57121 | 58758 | 60388 | 62010 | 63625 | 65233 | 66834 | 68428 | 57 |
| 30 | 52195 | 53854 | 55505 | 57149 | 58785 | 60415 | 62037 | 63652 | 65260 | 66861 | 68455 | 58 |
| 45 | 52223 | 53881 | 55532 | 57176 | 58813 | 60442 | 62064 | 63679 | 65287 | 66888 | 68481 | 59 |

| | Sec. | 1′ | 2′ | 3′ | 4′ | 5′ | 6′ | 7′ | 8′ | 9′ | 10′ | 11′ | 12′ | 13′ | 14′ | 15′ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 27. | Parts | 2 | 4 | 5 | 7 | 9 | 11 | 13 | 14 | 16 | 18 | 20 | 22 | 23 | 25 | 27 |

## LOG. SINE SQUARE

| | 100° 0′ | 100° 15′ | 100° 30′ | 100° 45′ | 101° 0′ | 101° 15′ | 101° 30′ | 101° 45′ | 102° 0′ | 102° 15′ | 102° 30′ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6h 40m | 6h 41m | 6h 42m | 6h 43m | 6h 44m | 6h 45m | 6h 46m | 6h 47m | 6h 48m | 6h 49m | 6h 50m | s. |
| ′ ″ | 9·7 | 9·7 | 9·7 | 9·7 | 9·7 | 9·7 | 9·7 | 9·7 | 9·7 | 9·7 | 9·7 | |
| 0 0 | 68508 | 70094 | 71674 | 73246 | 74812 | 76371 | 77922 | 79467 | 81005 | 82536 | 84061 | 0 |
| 15 | 68534 | 70121 | 71700 | 73273 | 74838 | 76397 | 77948 | 79493 | 81031 | 82562 | 84086 | 1 |
| 30 | 68561 | 70147 | 71726 | 73299 | 74864 | 76423 | 77974 | 79519 | 81056 | 82587 | 84111 | 2 |
| 45 | 68587 | 70174 | 71753 | 73325 | 74890 | 76448 | 78000 | 79544 | 81082 | 82613 | 84137 | 3 |
| 1 0 | 68614 | 70200 | 71779 | 73351 | 74916 | 76474 | 78026 | 79570 | 81107 | 82638 | 84162 | 4 |
| 15 | 68640 | 70226 | 71805 | 73377 | 74942 | 76500 | 78051 | 79596 | 81133 | 82664 | 84187 | 5 |
| 30 | 68667 | 70253 | 71832 | 73403 | 74968 | 76526 | 78077 | 79621 | 81159 | 82689 | 84212 | 6 |
| 45 | 68693 | 70279 | 71858 | 73430 | 74994 | 76552 | 78103 | 79647 | 81184 | 82714 | 84238 | 7 |
| 2 0 | 68720 | 70305 | 71884 | 73456 | 75020 | 76578 | 78129 | 79673 | 81210 | 82740 | 84263 | 8 |
| 15 | 68746 | 70332 | 71910 | 73482 | 75046 | 76604 | 78155 | 79698 | 81235 | 82765 | 84289 | 9 |
| 30 | 68773 | 70358 | 71936 | 73508 | 75072 | 76630 | 78180 | 79724 | 81261 | 82791 | 84314 | 10 |
| 45 | 68799 | 70385 | 71963 | 73534 | 75098 | 76656 | 78206 | 79750 | 81286 | 82816 | 84339 | 11 |
| 3 0 | 68826 | 70411 | 71989 | 73560 | 75124 | 76682 | 78232 | 79775 | 81312 | 82842 | 84365 | 12 |
| 15 | 68852 | 70437 | 72015 | 73586 | 75150 | 76707 | 78258 | 79801 | 81338 | 82867 | 84390 | 13 |
| 30 | 68879 | 70464 | 72042 | 73612 | 75176 | 76733 | 78284 | 79827 | 81363 | 82893 | 84415 | 14 |
| 45 | 68905 | 70490 | 72068 | 73639 | 75202 | 76759 | 78309 | 79852 | 81389 | 82918 | 84441 | 15 |
| 4 0 | 68932 | 70516 | 72094 | 73665 | 75228 | 76785 | 78335 | 79878 | 81414 | 82943 | 84466 | 16 |
| 15 | 68958 | 70543 | 72120 | 73691 | 75254 | 76811 | 78361 | 79904 | 81440 | 82969 | 84491 | 17 |
| 30 | 68985 | 70569 | 72146 | 73717 | 75280 | 76837 | 78387 | 79929 | 81465 | 82994 | 84516 | 18 |
| 45 | 69011 | 70595 | 72173 | 73743 | 75306 | 76863 | 78412 | 79955 | 81491 | 83020 | 84542 | 19 |
| 5 0 | 69038 | 70622 | 72199 | 73769 | 75332 | 76889 | 78438 | 79981 | 81516 | 83045 | 84567 | 20 |
| 15 | 69064 | 70648 | 72225 | 73795 | 75358 | 76915 | 78464 | 80006 | 81542 | 83071 | 84592 | 21 |
| 30 | 69090 | 70674 | 72251 | 73821 | 75384 | 76940 | 78490 | 80032 | 81567 | 83096 | 84618 | 22 |
| 45 | 69117 | 70701 | 72278 | 73847 | 75410 | 76966 | 78515 | 80058 | 81593 | 83121 | 84643 | 23 |
| 6 0 | 69143 | 70727 | 72304 | 73874 | 75436 | 76992 | 78541 | 80083 | 81618 | 83147 | 84668 | 24 |
| 15 | 69170 | 70753 | 72330 | 73900 | 75462 | 77018 | 78567 | 80109 | 81644 | 83172 | 84694 | 25 |
| 30 | 69196 | 70780 | 72356 | 73926 | 75488 | 77044 | 78593 | 80134 | 81669 | 83198 | 84719 | 26 |
| 45 | 69223 | 70806 | 72382 | 73952 | 75514 | 77070 | 78618 | 80160 | 81695 | 83223 | 84744 | 27 |
| 7 0 | 69249 | 70832 | 72409 | 73978 | 75540 | 77096 | 78644 | 80186 | 81721 | 83248 | 84770 | 28 |
| 15 | 69276 | 70859 | 72435 | 74004 | 75566 | 77122 | 78670 | 80211 | 81746 | 83274 | 84795 | 29 |
| 30 | 69302 | 70885 | 72461 | 74030 | 75592 | 77147 | 78696 | 80237 | 81772 | 83299 | 84820 | 30 |
| 45 | 69329 | 70911 | 72487 | 74056 | 75618 | 77173 | 78721 | 80263 | 81797 | 83325 | 84845 | 31 |
| 8 0 | 69355 | 70938 | 72514 | 74082 | 75644 | 77199 | 78747 | 80288 | 81823 | 83350 | 84871 | 32 |
| 15 | 69381 | 70964 | 72540 | 74108 | 75670 | 77225 | 78773 | 80314 | 81848 | 83375 | 84896 | 33 |
| 30 | 69408 | 70990 | 72566 | 74135 | 75696 | 77251 | 78799 | 80340 | 81874 | 83401 | 84921 | 34 |
| 45 | 69434 | 71017 | 72592 | 74161 | 75722 | 77277 | 78824 | 80365 | 81899 | 83426 | 84947 | 35 |
| 9 0 | 69461 | 71043 | 72618 | 74187 | 75748 | 77303 | 78850 | 80391 | 81925 | 83452 | 84972 | 36 |
| 15 | 69487 | 71069 | 72645 | 74213 | 75774 | 77328 | 78876 | 80416 | 81950 | 83477 | 84997 | 37 |
| 30 | 69514 | 71096 | 72671 | 74239 | 75800 | 77354 | 78902 | 80442 | 81976 | 83502 | 85022 | 38 |
| 45 | 69540 | 71122 | 72697 | 74265 | 75826 | 77380 | 78927 | 80468 | 82001 | 83528 | 85048 | 39 |
| 10 0 | 69566 | 71148 | 72723 | 74291 | 75852 | 77406 | 78953 | 80493 | 82027 | 83553 | 85073 | 40 |
| 15 | 69593 | 71175 | 72749 | 74317 | 75878 | 77432 | 78979 | 80519 | 82052 | 83579 | 85098 | 41 |
| 30 | 69619 | 71201 | 72775 | 74343 | 75904 | 77458 | 79005 | 80544 | 82078 | 83604 | 85123 | 42 |
| 45 | 69646 | 71227 | 72802 | 74369 | 75930 | 77483 | 79030 | 80570 | 82103 | 83629 | 85149 | 43 |
| 11 0 | 69672 | 71253 | 72828 | 74395 | 75956 | 77509 | 79056 | 80596 | 82129 | 83655 | 85174 | 44 |
| 15 | 69698 | 71280 | 72854 | 74421 | 75982 | 77535 | 79082 | 80621 | 82154 | 83680 | 85199 | 45 |
| 30 | 69725 | 71306 | 72880 | 74447 | 76008 | 77561 | 79107 | 80647 | 82180 | 83705 | 85224 | 46 |
| 45 | 69751 | 71332 | 72906 | 74473 | 76034 | 77587 | 79133 | 80672 | 82205 | 83731 | 85250 | 47 |
| 12 0 | 69778 | 71359 | 72933 | 74500 | 76060 | 77613 | 79159 | 80698 | 82231 | 83756 | 85275 | 48 |
| 15 | 69804 | 71385 | 72959 | 74526 | 76085 | 77638 | 79184 | 80724 | 82256 | 83782 | 85300 | 49 |
| 30 | 69831 | 71411 | 72985 | 74552 | 76111 | 77664 | 79210 | 80749 | 82282 | 83807 | 85326 | 50 |
| 45 | 69857 | 71437 | 73011 | 74578 | 76137 | 77690 | 79236 | 80775 | 82307 | 83832 | 85351 | 51 |
| 13 0 | 69883 | 71464 | 73037 | 74604 | 76163 | 77716 | 79262 | 80799 | 82333 | 83858 | 85376 | 52 |
| 15 | 69910 | 71490 | 73063 | 74630 | 76189 | 77742 | 79287 | 80826 | 82358 | 83883 | 85401 | 53 |
| 30 | 69936 | 71516 | 73090 | 74656 | 76215 | 77768 | 79313 | 80852 | 82384 | 83908 | 85427 | 54 |
| 45 | 69962 | 71543 | 73116 | 74682 | 76241 | 77793 | 79339 | 80877 | 82409 | 83934 | 85452 | 55 |
| 14 0 | 69989 | 71569 | 73142 | 74708 | 76267 | 77819 | 79364 | 80903 | 82434 | 83959 | 85477 | 56 |
| 15 | 70015 | 71595 | 73168 | 74734 | 76293 | 77845 | 79390 | 80928 | 82460 | 83985 | 85502 | 57 |
| 30 | 70042 | 71621 | 73194 | 74760 | 76319 | 77871 | 79416 | 80954 | 82485 | 84010 | 85528 | 58 |
| 45 | 70068 | 71648 | 73220 | 74786 | 76345 | 77897 | 79442 | 80980 | 82511 | 84035 | 85553 | 59 |

| | Sec. | 1′ | 2′ | 3′ | 4′ | 5′ | 6′ | 7′ | 8′ | 9′ | 10′ | 11′ | 12′ | 13′ | 14′ | 15′ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 26. | Parts | 2 | 3 | 5 | 7 | 9 | 10 | 12 | 14 | 15 | 17 | 19 | 21 | 22 | 24 | 26 |

## LOG. SINE SQUARE

| | 102° | 103° | | | | 104° | | | | 105° | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | |
| | 6h 51m | 6h 52m | 6h 53m | 6h 54m | 6h 55m | 6h 56m | 6h 57m | 6h 58m | 6h 59m | 7h 0m | 7h 1m | s. |
| ′ ″ | 9·7 | 9·7 | 9·7 | 9·7 | 9·7 | 9·7 | 9·7 | 9·7 | 9·7 | 9· | 9·8 | |
| 0 0 | 85578 | 87089 | 88593 | 90090 | 91580 | 93064 | 94541 | 96012 | 97476 | 798933 | 00384 | 0 |
| 15 | 85603 | 87114 | 88618 | 90115 | 91605 | 93089 | 94566 | 96036 | 97500 | 798958 | 00408 | 1 |
| 30 | 85628 | 87139 | 88643 | 90140 | 91630 | 93114 | 94591 | 96061 | 97525 | 798982 | 00432 | 2 |
| 45 | 85654 | 87164 | 88668 | 90165 | 91655 | 93138 | 94615 | 96085 | 97549 | 799006 | 00456 | 3 |
| 1 0 | 85679 | 87189 | 88693 | 90189 | 91680 | 93163 | 94640 | 96110 | 97573 | 799030 | 00481 | 4 |
| 15 | 85704 | 87214 | 88718 | 90214 | 91704 | 93188 | 94664 | 96134 | 97598 | 799054 | 00505 | 5 |
| 30 | 85729 | 87239 | 88743 | 90239 | 91729 | 93212 | 94689 | 96159 | 97622 | 799079 | 00529 | 6 |
| 45 | 85755 | 87265 | 88768 | 90264 | 91754 | 93237 | 94713 | 96183 | 97646 | 799103 | 00553 | 7 |
| 2 0 | 85780 | 87290 | 88793 | 90289 | 91779 | 93262 | 94738 | 96208 | 97671 | 799127 | 00577 | 8 |
| 15 | 85805 | 87315 | 88818 | 90314 | 91803 | 93286 | 94762 | 96232 | 97695 | 799151 | 00601 | 9 |
| 30 | 85830 | 87340 | 88843 | 90339 | 91828 | 93311 | 94787 | 96256 | 97719 | 799176 | 00625 | 10 |
| 45 | 85855 | 87365 | 88868 | 90364 | 91853 | 93336 | 94812 | 96281 | 97744 | 799200 | 00649 | 11 |
| 3 0 | 85881 | 87390 | 88893 | 90389 | 91878 | 93360 | 94836 | 96305 | 97768 | 799224 | 00673 | 12 |
| 15 | 85906 | 87415 | 88918 | 90413 | 91902 | 93385 | 94861 | 96330 | 97792 | 799248 | 00698 | 13 |
| 30 | 85931 | 87440 | 88943 | 90438 | 91927 | 93410 | 94885 | 96354 | 97817 | 799272 | 00722 | 14 |
| 45 | 85956 | 87465 | 88968 | 90463 | 91952 | 93434 | 94910 | 96379 | 97841 | 799297 | 00746 | 15 |
| 4 0 | 85982 | 87490 | 88993 | 90488 | 91977 | 93459 | 94934 | 96403 | 97865 | 799321 | 00770 | 16 |
| 15 | 86007 | 87516 | 89018 | 90513 | 92002 | 93483 | 94959 | 96427 | 97889 | 799345 | 00794 | 17 |
| 30 | 86032 | 87541 | 89043 | 90538 | 92026 | 93508 | 94983 | 96452 | 97914 | 799369 | 00818 | 18 |
| 45 | 86057 | 87566 | 89068 | 90563 | 92051 | 93533 | 95008 | 96476 | 97938 | 799393 | 00842 | 19 |
| 5 0 | 86082 | 87591 | 89093 | 90587 | 92076 | 93557 | 95032 | 96501 | 97962 | 799418 | 00866 | 20 |
| 15 | 86108 | 87616 | 89117 | 90612 | 92101 | 93582 | 95057 | 96525 | 97987 | 799442 | 00890 | 21 |
| 30 | 86133 | 87641 | 89142 | 90637 | 92125 | 93607 | 95081 | 96549 | 98011 | 799466 | 00914 | 22 |
| 45 | 86158 | 87666 | 89167 | 90662 | 92150 | 93631 | 95106 | 96574 | 98035 | 799490 | 00938 | 23 |
| 6 0 | 86183 | 87691 | 89192 | 90687 | 92175 | 93656 | 95130 | 96598 | 98060 | 799514 | 00963 | 24 |
| 15 | 86208 | 87716 | 89217 | 90712 | 92200 | 93681 | 95155 | 96623 | 98084 | 799539 | 00987 | 25 |
| 30 | 86233 | 87741 | 89242 | 90737 | 92224 | 93705 | 95180 | 96647 | 98108 | 799563 | 01011 | 26 |
| 45 | 86259 | 87766 | 89267 | 90761 | 92249 | 93730 | 95204 | 96672 | 98133 | 799587 | 01035 | 27 |
| 7 0 | 86284 | 87791 | 89292 | 90786 | 92274 | 93754 | 95229 | 96696 | 98157 | 799611 | 01059 | 28 |
| 15 | 86309 | 87816 | 89317 | 90811 | 92299 | 93779 | 95253 | 96720 | 98181 | 799635 | 01083 | 29 |
| 30 | 86334 | 87842 | 89342 | 90836 | 92323 | 93804 | 95278 | 96745 | 98205 | 799660 | 01107 | 30 |
| 45 | 86359 | 87866 | 89367 | 90861 | 92348 | 93828 | 95302 | 96769 | 98230 | 799684 | 01131 | 31 |
| 8 0 | 86385 | 87892 | 89392 | 90886 | 92373 | 93853 | 95327 | 96794 | 98254 | 799708 | 01155 | 32 |
| 15 | 86410 | 87917 | 89417 | 90911 | 92397 | 93878 | 95351 | 96818 | 98278 | 799732 | 01179 | 33 |
| 30 | 86435 | 87942 | 89442 | 90935 | 92422 | 93902 | 95376 | 96842 | 98303 | 799756 | 01203 | 34 |
| 45 | 86460 | 87967 | 89467 | 90960 | 92447 | 93927 | 95400 | 96867 | 98327 | 799780 | 01227 | 35 |
| 9 0 | 86485 | 87992 | 89491 | 90985 | 92472 | 93951 | 95425 | 96891 | 98351 | 799805 | 01251 | 36 |
| 15 | 86510 | 88017 | 89517 | 91010 | 92496 | 93976 | 95449 | 96916 | 98375 | 799829 | 01275 | 37 |
| 30 | 86536 | 88042 | 89542 | 91035 | 92521 | 94001 | 95474 | 96940 | 98400 | 799853 | 01299 | 38 |
| 45 | 86561 | 88067 | 89567 | 91060 | 92546 | 94025 | 95498 | 96964 | 98424 | 799877 | 01324 | 39 |
| 10 0 | 86586 | 88092 | 89592 | 91084 | 92570 | 94050 | 95523 | 96989 | 98448 | 799901 | 01348 | 40 |
| 15 | 86611 | 88117 | 89617 | 91109 | 92595 | 94074 | 95547 | 97013 | 98473 | 799925 | 01372 | 41 |
| 30 | 86636 | 88142 | 89642 | 91134 | 92620 | 94099 | 95572 | 97038 | 98497 | 799949 | 01396 | 42 |
| 45 | 86661 | 88167 | 89666 | 91159 | 92644 | 94124 | 95596 | 97062 | 98521 | 799974 | 01420 | 43 |
| 11 0 | 86687 | 88192 | 89691 | 91184 | 92669 | 94148 | 95620 | 97086 | 98545 | 799998 | 01444 | 44 |
| 15 | 86712 | 88217 | 89716 | 91208 | 92694 | 94173 | 95645 | 97111 | 98570 | 800022 | 01468 | 45 |
| 30 | 86737 | 88242 | 89741 | 91233 | 92719 | 94197 | 95669 | 97135 | 98594 | 800046 | 01492 | 46 |
| 45 | 86762 | 88267 | 89766 | 91258 | 92743 | 94222 | 95694 | 97159 | 98618 | 800070 | 01516 | 47 |
| 12 0 | 86787 | 88292 | 89791 | 91283 | 92768 | 94247 | 95718 | 97184 | 98642 | 800094 | 01540 | 48 |
| 15 | 86812 | 88317 | 89816 | 91308 | 92793 | 94271 | 95743 | 97208 | 98667 | 800119 | 01564 | 49 |
| 30 | 86837 | 88342 | 89841 | 91333 | 92817 | 94296 | 95767 | 97232 | 98691 | 800143 | 01588 | 50 |
| 45 | 86863 | 88368 | 89866 | 91357 | 92842 | 94320 | 95792 | 97257 | 98715 | 800167 | 01612 | 51 |
| 13 0 | 86888 | 88393 | 89891 | 91382 | 92867 | 94345 | 95816 | 97281 | 98739 | 800191 | 01636 | 52 |
| 15 | 86913 | 88418 | 89916 | 91407 | 92891 | 94369 | 95841 | 97306 | 98764 | 800215 | 01660 | 53 |
| 30 | 86938 | 88443 | 89940 | 91432 | 92916 | 94394 | 95865 | 97330 | 98788 | 800239 | 01684 | 54 |
| 45 | 86963 | 88468 | 89965 | 91457 | 92941 | 94419 | 95890 | 97354 | 98812 | 800264 | 01708 | 55 |
| 14 0 | 86988 | 88493 | 89990 | 91481 | 92966 | 94443 | 95914 | 97379 | 98836 | 800288 | 01732 | 56 |
| 15 | 87013 | 88518 | 90015 | 91506 | 92990 | 94468 | 95939 | 97403 | 98861 | 800312 | 01756 | 57 |
| 30 | 87038 | 88543 | 90040 | 91531 | 93015 | 94492 | 95963 | 97427 | 98885 | 800336 | 01780 | 58 |
| 45 | 87064 | 88568 | 90065 | 91556 | 93040 | 94517 | 95988 | 97452 | 98909 | 800360 | 01804 | 59 |

| | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 25. | Parts | 2 | 3 | 5 | 7 | 8 | 10 | 12 | 13 | 15 | 17 | 18 | 20 | 22 | 23 | 25 |

## LOG. SINE SQUARE

| | 105° | | 106° | | | | 107° | | | | 108° | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | |
| | 7ʰ 2ᵐ | 7ʰ 3ᵐ | 7ʰ 4ᵐ | 7ʰ 5ᵐ | 7ʰ 6ᵐ | 7ʰ 7ᵐ | 7ʰ 8ᵐ | 7ʰ 9ᵐ | 7ʰ 10ᵐ | 7ʰ 11ᵐ | 7ʰ 12ᵐ | 7ʰ 13ᵐ | s. |
| ′ ″ | 9·80 | 9·80 | 9·80 | 9·80 | 9·80 | 9·8 | 9·8 | 9·8 | 9·8 | 9·8 | 9·8 | 9·8 | |
| 0 0 | 1828 | 3266 | 4697 | 6122 | 7540 | 08952 | 10357 | 11756 | 13149 | 14535 | 15915 | 17289 | 0 |
| 15 | 1852 | 3290 | 4721 | 6146 | 7564 | 08975 | 10381 | 11780 | 13172 | 14558 | 15938 | 17312 | 1 |
| 30 | 1876 | 3314 | 4745 | 6169 | 7587 | 08999 | 10404 | 11803 | 13195 | 14581 | 15961 | 17335 | 2 |
| 45 | 1900 | 3338 | 4769 | 6193 | 7611 | 09022 | 10427 | 11826 | 13219 | 14604 | 15984 | 17357 | 3 |
| 1 0 | 1924 | 3362 | 4792 | 6217 | 7634 | 09046 | 10451 | 11849 | 13242 | 14628 | 16007 | 17380 | 4 |
| 15 | 1948 | 3385 | 4816 | 6240 | 7658 | 09069 | 10474 | 11873 | 13265 | 14651 | 16030 | 17403 | 5 |
| 30 | 1972 | 3409 | 4840 | 6264 | 7682 | 09093 | 10498 | 11896 | 13288 | 14674 | 16054 | 17426 | 6 |
| 45 | 1996 | 3433 | 4864 | 6288 | 7705 | 09116 | 10521 | 11919 | 13311 | 14697 | 16077 | 17449 | 7 |
| 2 0 | 2020 | 3457 | 4887 | 6311 | 7729 | 09140 | 10544 | 11942 | 13334 | 14720 | 16100 | 17472 | 8 |
| 15 | 2044 | 3481 | 4911 | 6335 | 7752 | 09163 | 10568 | 11966 | 13357 | 14743 | 16123 | 17494 | 9 |
| 30 | 2068 | 3505 | 4935 | 6359 | 7776 | 09187 | 10591 | 11989 | 13381 | 14766 | 16146 | 17517 | 10 |
| 45 | 2092 | 3529 | 4959 | 6383 | 7800 | 09210 | 10614 | 12012 | 13404 | 14789 | 16169 | 17540 | 11 |
| 3 0 | 2116 | 3553 | 4983 | 6406 | 7823 | 09234 | 10638 | 12035 | 13427 | 14812 | 16191 | 17563 | 12 |
| 15 | 2140 | 3577 | 5006 | 6430 | 7847 | 09257 | 10661 | 12059 | 13450 | 14835 | 16214 | 17586 | 13 |
| 30 | 2164 | 3601 | 5030 | 6453 | 7870 | 09281 | 10684 | 12082 | 13473 | 14858 | 16237 | 17608 | 14 |
| 45 | 2188 | 3624 | 5054 | 6477 | 7894 | 09304 | 10708 | 12105 | 13496 | 14881 | 16260 | 17631 | 15 |
| 4 0 | 2212 | 3648 | 5078 | 6501 | 7917 | 09327 | 10731 | 12128 | 13519 | 14904 | 16283 | 17654 | 16 |
| 15 | 2236 | 3672 | 5102 | 6524 | 7941 | 09351 | 10754 | 12152 | 13543 | 14927 | 16306 | 17677 | 17 |
| 30 | 2260 | 3696 | 5125 | 6548 | 7964 | 09374 | 10778 | 12175 | 13566 | 14950 | 16329 | 17700 | 18 |
| 45 | 2284 | 3720 | 5149 | 6572 | 7988 | 09398 | 10801 | 12198 | 13589 | 14973 | 16352 | 17722 | 19 |
| 5 0 | 2308 | 3744 | 5173 | 6595 | 8012 | 09421 | 10824 | 12221 | 13612 | 14996 | 16375 | 17745 | 20 |
| 15 | 2332 | 3768 | 5197 | 6619 | 8035 | 09445 | 10848 | 12245 | 13635 | 15019 | 16398 | 17768 | 21 |
| 30 | 2356 | 3792 | 5220 | 6643 | 8059 | 09468 | 10871 | 12268 | 13658 | 15042 | 16420 | 17791 | 22 |
| 45 | 2380 | 3815 | 5244 | 6666 | 8082 | 09492 | 10894 | 12291 | 13681 | 15065 | 16443 | 17814 | 23 |
| 6 0 | 2404 | 3839 | 5268 | 6690 | 8106 | 09515 | 10918 | 12314 | 13704 | 15088 | 16466 | 17837 | 24 |
| 15 | 2428 | 3863 | 5292 | 6714 | 8129 | 09538 | 10941 | 12337 | 13727 | 15111 | 16489 | 17859 | 25 |
| 30 | 2452 | 3887 | 5315 | 6737 | 8153 | 09562 | 10964 | 12361 | 13751 | 15134 | 16512 | 17882 | 26 |
| 45 | 2476 | 3911 | 5339 | 6761 | 8176 | 09585 | 10988 | 12384 | 13774 | 15157 | 16534 | 17905 | 27 |
| 7 0 | 2500 | 3935 | 5363 | 6785 | 8200 | 09609 | 11011 | 12407 | 13797 | 15180 | 16557 | 17928 | 28 |
| 15 | 2524 | 3959 | 5387 | 6808 | 8223 | 09632 | 11034 | 12430 | 13820 | 15203 | 16580 | 17951 | 29 |
| 30 | 2548 | 3982 | 5410 | 6832 | 8247 | 09656 | 11058 | 12453 | 13843 | 15226 | 16603 | 17973 | 30 |
| 45 | 2572 | 4006 | 5434 | 6856 | 8270 | 09679 | 11081 | 12477 | 13866 | 15249 | 16626 | 17996 | 31 |
| 8 0 | 2596 | 4030 | 5458 | 6879 | 8294 | 09702 | 11104 | 12500 | 13889 | 15272 | 16649 | 18019 | 32 |
| 15 | 2620 | 4054 | 5482 | 6903 | 8318 | 09726 | 11127 | 12523 | 13912 | 15295 | 16671 | 18042 | 33 |
| 30 | 2644 | 4078 | 5505 | 6926 | 8341 | 09749 | 11151 | 12546 | 13935 | 15318 | 16694 | 18064 | 34 |
| 45 | 2668 | 4102 | 5529 | 6950 | 8365 | 09773 | 11174 | 12570 | 13958 | 15341 | 16717 | 18087 | 35 |
| 9 0 | 2692 | 4125 | 5553 | 6974 | 8388 | 09796 | 11198 | 12593 | 13982 | 15364 | 16740 | 18110 | 36 |
| 15 | 2716 | 4149 | 5577 | 6997 | 8412 | 09819 | 11221 | 12616 | 14005 | 15387 | 16763 | 18133 | 37 |
| 30 | 2740 | 4173 | 5600 | 7021 | 8435 | 09843 | 11244 | 12639 | 14028 | 15410 | 16786 | 18156 | 38 |
| 45 | 2764 | 4197 | 5624 | 7045 | 8459 | 09866 | 11267 | 12662 | 14051 | 15433 | 16809 | 18178 | 39 |
| 10 0 | 2787 | 4221 | 5648 | 7068 | 8482 | 09890 | 11291 | 12686 | 14074 | 15456 | 16832 | 18201 | 40 |
| 15 | 2811 | 4245 | 5672 | 7092 | 8506 | 09913 | 11314 | 12709 | 14097 | 15479 | 16854 | 18224 | 41 |
| 30 | 2835 | 4269 | 5695 | 7115 | 8529 | 09936 | 11337 | 12732 | 14120 | 15502 | 16877 | 18247 | 42 |
| 45 | 2859 | 4292 | 5719 | 7139 | 8553 | 09960 | 11361 | 12755 | 14143 | 15525 | 16900 | 18269 | 43 |
| 11 0 | 2883 | 4316 | 5743 | 7163 | 8576 | 09983 | 11384 | 12778 | 14166 | 15548 | 16923 | 18292 | 44 |
| 15 | 2907 | 4340 | 5766 | 7186 | 8600 | 10007 | 11407 | 12801 | 14189 | 15571 | 16946 | 18315 | 45 |
| 30 | 2931 | 4364 | 5790 | 7210 | 8623 | 10030 | 11431 | 12825 | 14212 | 15594 | 16969 | 18338 | 46 |
| 45 | 2955 | 4388 | 5814 | 7233 | 8647 | 10053 | 11454 | 12848 | 14235 | 15617 | 16992 | 18360 | 47 |
| 12 0 | 2979 | 4411 | 5837 | 7257 | 8670 | 10077 | 11477 | 12871 | 14259 | 15640 | 17015 | 18383 | 48 |
| 15 | 3003 | 4435 | 5861 | 7281 | 8694 | 10100 | 11500 | 12894 | 14282 | 15663 | 17037 | 18406 | 49 |
| 30 | 3027 | 4459 | 5885 | 7304 | 8717 | 10124 | 11524 | 12917 | 14305 | 15686 | 17060 | 18429 | 50 |
| 45 | 3051 | 4483 | 5909 | 7328 | 8741 | 10147 | 11547 | 12941 | 14328 | 15709 | 17083 | 18452 | 51 |
| 13 0 | 3075 | 4507 | 5932 | 7351 | 8764 | 10170 | 11570 | 12964 | 14351 | 15732 | 17106 | 18474 | 52 |
| 15 | 3099 | 4531 | 5956 | 7375 | 8788 | 10194 | 11594 | 12987 | 14374 | 15755 | 17129 | 18497 | 53 |
| 30 | 3123 | 4554 | 5980 | 7399 | 8811 | 10217 | 11617 | 13010 | 14397 | 15778 | 17152 | 18520 | 54 |
| 45 | 3146 | 4578 | 6003 | 7422 | 8835 | 10241 | 11640 | 13033 | 14420 | 15801 | 17175 | 18543 | 55 |
| 14 0 | 3170 | 4602 | 6027 | 7446 | 8858 | 10264 | 11663 | 13056 | 14443 | 15823 | 17198 | 18565 | 56 |
| 15 | 3194 | 4626 | 6051 | 7469 | 8882 | 10287 | 11687 | 13080 | 14466 | 15846 | 17220 | 18588 | 57 |
| 30 | 3218 | 4650 | 6075 | 7493 | 8905 | 10311 | 11710 | 13103 | 14489 | 15869 | 17243 | 18611 | 58 |
| 45 | 3242 | 4673 | 6098 | 7517 | 8929 | 10334 | 11733 | 13126 | 14512 | 15892 | 17266 | 18633 | 59 |

| | Sec. | 1′ | 2′ | 3′ | 4′ | 5′ | 6′ | 7′ | 8′ | 9′ | 10′ | 11′ | 12′ | 13′ | 14′ | 15′ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 24. | Parts | 2 | 3 | 5 | 6 | 8 | 10 | 11 | 13 | 14 | 16 | 18 | 19 | 21 | 22 | 24 |

## LOG. SINE SQUARE

| | 108° | | 109° | | | | 110° | | | | 111° | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | |
| | 7h 14m | 7h 15m | 7h 16m | 7h 17m | 7h 18m | 7h 19m | 7h 20m | 7h 21m | 7h 22m | 7h 23m | 7h 24m | s. |
| ′ ″ | 9·8 | 9·8 | 9·8 | 9·8 | 9·8 | 9·8 | 9·8 | 9·8 | 9·8 | 9·8 | 9·8 | |
| 0 0 | 18656 | 20017 | 21372 | 22721 | 24063 | 25399 | 26729 | 28053 | 29370 | 30682 | 31987 | 0 |
| 15 | 18679 | 20040 | 21395 | 22743 | 24085 | 25421 | 26751 | 28075 | 29392 | 30704 | 32009 | 1 |
| 30 | 18702 | 20063 | 21417 | 22765 | 24108 | 25444 | 26773 | 28097 | 29414 | 30726 | 32031 | 2 |
| 45 | 18724 | 20085 | 21440 | 22788 | 24130 | 25466 | 26795 | 28119 | 29436 | 30747 | 32052 | 3 |
| 1 0 | 18747 | 20108 | 21462 | 22810 | 24152 | 25488 | 26817 | 28141 | 29458 | 30769 | 32074 | 4 |
| 15 | 18770 | 20130 | 21485 | 22833 | 24174 | 25510 | 26840 | 28163 | 29480 | 30791 | 32096 | 5 |
| 30 | 18793 | 20153 | 21507 | 22855 | 24197 | 25532 | 26862 | 28185 | 29502 | 30813 | 32118 | 6 |
| 45 | 18815 | 20176 | 21530 | 22878 | 24219 | 25555 | 26884 | 28207 | 29524 | 30835 | 32139 | 7 |
| 2 0 | 18838 | 20198 | 21552 | 22900 | 24241 | 25577 | 26906 | 28229 | 29546 | 30856 | 32161 | 8 |
| 15 | 18861 | 20221 | 21575 | 22922 | 24264 | 25599 | 26928 | 28251 | 29568 | 30878 | 32183 | 9 |
| 30 | 18883 | 20244 | 21597 | 22945 | 24286 | 25621 | 26950 | 28273 | 29589 | 30900 | 32204 | 10 |
| 45 | 18906 | 20266 | 21620 | 22967 | 24308 | 25643 | 26972 | 28295 | 29611 | 30922 | 32226 | 11 |
| 3 0 | 18929 | 20289 | 21642 | 22990 | 24331 | 25666 | 26994 | 28317 | 29633 | 30944 | 32248 | 12 |
| 15 | 18952 | 20311 | 21665 | 23012 | 24353 | 25688 | 27016 | 28339 | 29655 | 30965 | 32269 | 13 |
| 30 | 18974 | 20334 | 21687 | 23034 | 24375 | 25710 | 27038 | 28361 | 29677 | 30987 | 32291 | 14 |
| 45 | 18997 | 20357 | 21710 | 23057 | 24398 | 25732 | 27061 | 28383 | 29699 | 31009 | 32313 | 15 |
| 4 0 | 19020 | 20379 | 21732 | 23079 | 24420 | 25754 | 27083 | 28405 | 29721 | 31031 | 32335 | 16 |
| 15 | 19042 | 20402 | 21755 | 23102 | 24442 | 25776 | 27105 | 28427 | 29743 | 31052 | 32356 | 17 |
| 30 | 19065 | 20424 | 21777 | 23124 | 24464 | 25799 | 27127 | 28449 | 29765 | 31074 | 32378 | 18 |
| 45 | 19088 | 20447 | 21800 | 23146 | 24487 | 25821 | 27149 | 28471 | 29786 | 31096 | 32400 | 19 |
| 5 0 | 19111 | 20470 | 21822 | 23169 | 24509 | 25843 | 27171 | 28493 | 29808 | 31118 | 32421 | 20 |
| 15 | 19133 | 20492 | 21845 | 23191 | 24531 | 25865 | 27193 | 28515 | 29830 | 31140 | 32443 | 21 |
| 30 | 19156 | 20515 | 21867 | 23214 | 24554 | 25887 | 27215 | 28537 | 29852 | 31161 | 32465 | 22 |
| 45 | 19179 | 20537 | 21890 | 23236 | 24576 | 25910 | 27237 | 28559 | 29874 | 31183 | 32486 | 23 |
| 6 0 | 19201 | 20560 | 21912 | 23258 | 24598 | 25932 | 27259 | 28581 | 29896 | 31205 | 32508 | 24 |
| 15 | 19224 | 20582 | 21935 | 23281 | 24620 | 25954 | 27281 | 28603 | 29918 | 31227 | 32530 | 25 |
| 30 | 19247 | 20605 | 21957 | 23303 | 24643 | 25976 | 27303 | 28625 | 29940 | 31248 | 32551 | 26 |
| 45 | 19269 | 20628 | 21980 | 23325 | 24665 | 25998 | 27325 | 28646 | 29961 | 31270 | 32573 | 27 |
| 7 0 | 19292 | 20650 | 22002 | 23348 | 24687 | 26020 | 27348 | 28668 | 29983 | 31292 | 32595 | 28 |
| 15 | 19315 | 20673 | 22025 | 23370 | 24710 | 26043 | 27370 | 28690 | 30005 | 31314 | 32616 | 29 |
| 30 | 19338 | 20695 | 22047 | 23392 | 24732 | 26065 | 27392 | 28712 | 30027 | 31335 | 32638 | 30 |
| 45 | 19360 | 20718 | 22070 | 23415 | 24754 | 26087 | 27414 | 28734 | 30049 | 31357 | 32660 | 31 |
| 8 0 | 19383 | 20741 | 22092 | 23437 | 24776 | 26109 | 27436 | 28756 | 30071 | 31379 | 32681 | 32 |
| 15 | 19406 | 20763 | 22115 | 23460 | 24799 | 26131 | 27458 | 28778 | 30093 | 31401 | 32703 | 33 |
| 30 | 19428 | 20786 | 22137 | 23482 | 24821 | 26153 | 27480 | 28800 | 30114 | 31422 | 32724 | 34 |
| 45 | 19451 | 20808 | 22159 | 23504 | 24843 | 26176 | 27502 | 28822 | 30136 | 31444 | 32746 | 35 |
| 9 0 | 19474 | 20831 | 22182 | 23527 | 24865 | 26198 | 27524 | 28844 | 30158 | 31466 | 32768 | 36 |
| 15 | 19496 | 20853 | 22204 | 23549 | 24888 | 26220 | 27546 | 28866 | 30180 | 31488 | 32789 | 37 |
| 30 | 19519 | 20876 | 22227 | 23571 | 24910 | 26242 | 27568 | 28888 | 30202 | 31509 | 32811 | 38 |
| 45 | 19542 | 20899 | 22249 | 23594 | 24932 | 26264 | 27590 | 28910 | 30224 | 31531 | 32833 | 39 |
| 10 0 | 19564 | 20921 | 22272 | 23616 | 24954 | 26286 | 27612 | 28932 | 30245 | 31553 | 32854 | 40 |
| 15 | 19587 | 20944 | 22294 | 23639 | 24977 | 26309 | 27634 | 28954 | 30267 | 31575 | 32876 | 41 |
| 30 | 19610 | 20966 | 22317 | 23661 | 24999 | 26331 | 27656 | 28976 | 30289 | 31596 | 32898 | 42 |
| 45 | 19632 | 20989 | 22339 | 23683 | 25021 | 26353 | 27678 | 28998 | 30311 | 31618 | 32919 | 43 |
| 11 0 | 19655 | 21011 | 22362 | 23706 | 25043 | 26375 | 27700 | 29020 | 30333 | 31640 | 32941 | 44 |
| 15 | 19678 | 21034 | 22384 | 23728 | 25066 | 26397 | 27722 | 29042 | 30355 | 31662 | 32963 | 45 |
| 30 | 19700 | 21056 | 22406 | 23750 | 25088 | 26419 | 27744 | 29064 | 30377 | 31683 | 32984 | 46 |
| 45 | 19723 | 21079 | 22429 | 23773 | 25110 | 26441 | 27767 | 29086 | 30398 | 31705 | 33006 | 47 |
| 12 0 | 19746 | 21101 | 22451 | 23795 | 25132 | 26463 | 27789 | 29107 | 30420 | 31727 | 33027 | 48 |
| 15 | 19768 | 21124 | 22474 | 23817 | 25155 | 26486 | 27811 | 29129 | 30442 | 31749 | 33049 | 49 |
| 30 | 19791 | 21147 | 22496 | 23840 | 25177 | 26508 | 27833 | 29151 | 30464 | 31770 | 33071 | 50 |
| 45 | 19814 | 21169 | 22519 | 23862 | 25199 | 26530 | 27855 | 29173 | 30486 | 31792 | 33092 | 51 |
| 13 0 | 19836 | 21192 | 22541 | 23884 | 25221 | 26552 | 27877 | 29195 | 30507 | 31814 | 33114 | 52 |
| 15 | 19859 | 21214 | 22564 | 23907 | 25243 | 26574 | 27899 | 29217 | 30529 | 31835 | 33135 | 53 |
| 30 | 19881 | 21237 | 22586 | 23929 | 25266 | 26596 | 27921 | 29239 | 30551 | 31857 | 33157 | 54 |
| 45 | 19904 | 21259 | 22609 | 23951 | 25288 | 26618 | 27943 | 29261 | 30573 | 31880 | 33179 | 55 |
| 14 0 | 19927 | 21282 | 22631 | 23974 | 25310 | 26641 | 27965 | 29283 | 30595 | 31901 | 33200 | 56 |
| 15 | 19949 | 21304 | 22653 | 23996 | 25332 | 26663 | 27987 | 29305 | 30617 | 31922 | 33222 | 57 |
| 30 | 19972 | 21327 | 22676 | 24018 | 25355 | 26685 | 28009 | 29327 | 30638 | 31944 | 33244 | 58 |
| 45 | 19995 | 21350 | 22698 | 24041 | 25377 | 26707 | 28031 | 29349 | 30660 | 31966 | 33265 | 59 |

| Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 23. Parts | 2 | 3 | 5 | 6 | 8 | 9 | 11 | 12 | 14 | 15 | 17 | 18 | 20 | 22 | 23 |

## LOG. SINE SQUARE

| | 111° | | | 112° | | | | 113° | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | |
| | 7h 25m | 7h 26m | 7h 27m | 7h 28m | 7h 29m | 7h 30m | 7h 31m | 7h 32m | 7h 33m | 7h 34m | 7h 35m | e. |
| ′ ″ | 9·8 | 9·8 | 9·8 | 9·8 | 9·8 | 9·8 | 9·8 | 9·8 | 9·8 | 9·8 | 9·8 | |
| 0 0 | 33287 | 34580 | 35867 | 37148 | 38424 | 39693 | 40956 | 42213 | 43464 | 44710 | 45949 | 0 |
| 15 | 33308 | 34601 | 35889 | 37170 | 38445 | 39714 | 40977 | 42234 | 43485 | 44730 | 45970 | 1 |
| 30 | 33330 | 34623 | 35910 | 37191 | 38466 | 39735 | 40998 | 42255 | 43506 | 44751 | 45990 | 2 |
| 45 | 33352 | 34644 | 35931 | 37212 | 38487 | 39756 | 41019 | 42276 | 43527 | 44772 | 46011 | 3 |
| 1 0 | 33373 | 34666 | 35953 | 37234 | 38508 | 39777 | 41040 | 42297 | 43548 | 44793 | 46032 | 4 |
| 15 | 33395 | 34687 | 35974 | 37255 | 38530 | 39798 | 41061 | 42318 | 43568 | 44813 | 46052 | 5 |
| 30 | 33416 | 34709 | 35996 | 37276 | 38551 | 39819 | 41082 | 42339 | 43589 | 44834 | 46073 | 6 |
| 45 | 33438 | 34730 | 36017 | 37297 | 38572 | 39840 | 41103 | 42359 | 43610 | 44855 | 46093 | 7 |
| 2 0 | 33460 | 34752 | 36038 | 37319 | 38593 | 39861 | 41124 | 42380 | 43631 | 44875 | 46114 | 8 |
| 15 | 33481 | 34773 | 36060 | 37340 | 38614 | 39883 | 41145 | 42401 | 43652 | 44896 | 46135 | 9 |
| 30 | 33503 | 34795 | 36081 | 37361 | 38636 | 39904 | 41166 | 42422 | 43672 | 44917 | 46155 | 10 |
| 45 | 33524 | 34816 | 36103 | 37383 | 38657 | 39925 | 41187 | 42443 | 43693 | 44937 | 46176 | 11 |
| 3 0 | 33546 | 34838 | 36124 | 37404 | 38678 | 39946 | 41208 | 42464 | 43714 | 44958 | 46196 | 12 |
| 15 | 33568 | 34859 | 36145 | 37425 | 38699 | 39967 | 41229 | 42485 | 43735 | 44979 | 46217 | 13 |
| 30 | 33589 | 34881 | 36167 | 37446 | 38720 | 39988 | 41250 | 42506 | 43756 | 45000 | 46238 | 14 |
| 45 | 33611 | 34902 | 36188 | 37468 | 38741 | 40009 | 41271 | 42526 | 43776 | 45020 | 46258 | 15 |
| 4 0 | 33632 | 34924 | 36209 | 37489 | 38763 | 40030 | 41292 | 42547 | 43797 | 45041 | 46279 | 16 |
| 15 | 33654 | 34945 | 36231 | 37510 | 38784 | 40051 | 41313 | 42568 | 43818 | 45062 | 46299 | 17 |
| 30 | 33675 | 34967 | 36252 | 37532 | 38805 | 40072 | 41334 | 42589 | 43839 | 45082 | 46320 | 18 |
| 45 | 33697 | 34988 | 36274 | 37553 | 38826 | 40093 | 41355 | 42610 | 43859 | 45103 | 46341 | 19 |
| 5 0 | 33718 | 35010 | 36295 | 37574 | 38847 | 40114 | 41376 | 42631 | 43880 | 45124 | 46361 | 20 |
| 15 | 33740 | 35031 | 36316 | 37595 | 38868 | 40136 | 41397 | 42652 | 43901 | 45144 | 46382 | 21 |
| 30 | 33762 | 35053 | 36338 | 37617 | 38890 | 40157 | 41418 | 42673 | 43922 | 45165 | 46402 | 22 |
| 45 | 33783 | 35074 | 36359 | 37638 | 38911 | 40178 | 41439 | 42693 | 43942 | 45186 | 46423 | 23 |
| 6 0 | 33805 | 35096 | 36380 | 37659 | 38932 | 40199 | 41460 | 42714 | 43963 | 45206 | 46443 | 24 |
| 15 | 33826 | 35117 | 36402 | 37680 | 38953 | 40220 | 41481 | 42735 | 43984 | 45227 | 46464 | 25 |
| 30 | 33848 | 35138 | 36423 | 37702 | 38974 | 40241 | 41502 | 42756 | 44005 | 45248 | 46484 | 26 |
| 45 | 33869 | 35160 | 36444 | 37723 | 38995 | 40262 | 41522 | 42777 | 44026 | 45268 | 46505 | 27 |
| 7 0 | 33891 | 35181 | 36466 | 37744 | 39017 | 40283 | 41543 | 42798 | 44046 | 45289 | 46526 | 28 |
| 15 | 33913 | 35203 | 36487 | 37766 | 39038 | 40304 | 41564 | 42819 | 44067 | 45310 | 46546 | 29 |
| 30 | 33934 | 35224 | 36509 | 37787 | 39059 | 40325 | 41585 | 42839 | 44088 | 45330 | 46567 | 30 |
| 45 | 33956 | 35246 | 36530 | 37808 | 39080 | 40346 | 41606 | 42860 | 44109 | 45351 | 46587 | 31 |
| 8 0 | 33977 | 35267 | 36551 | 37829 | 39101 | 40367 | 41627 | 42881 | 44129 | 45372 | 46608 | 32 |
| 15 | 33999 | 35289 | 36573 | 37851 | 39122 | 40388 | 41648 | 42902 | 44150 | 45392 | 46628 | 33 |
| 30 | 34020 | 35310 | 36594 | 37872 | 39143 | 40409 | 41669 | 42923 | 44171 | 45413 | 46649 | 34 |
| 45 | 34042 | 35332 | 36615 | 37893 | 39165 | 40430 | 41690 | 42944 | 44192 | 45434 | 46670 | 35 |
| 9 0 | 34063 | 35353 | 36637 | 37914 | 39186 | 40451 | 41711 | 42965 | 44212 | 45454 | 46690 | 36 |
| 15 | 34085 | 35375 | 36658 | 37935 | 39207 | 40472 | 41732 | 42986 | 44233 | 45475 | 46711 | 37 |
| 30 | 34107 | 35396 | 36679 | 37957 | 39228 | 40493 | 41753 | 43006 | 44254 | 45495 | 46731 | 38 |
| 45 | 34128 | 35417 | 36701 | 37978 | 39249 | 40515 | 41774 | 43027 | 44275 | 45516 | 46752 | 39 |
| 10 0 | 34150 | 35439 | 36722 | 37999 | 39270 | 40536 | 41795 | 43048 | 44295 | 45537 | 46772 | 40 |
| 15 | 34171 | 35460 | 36743 | 38020 | 39292 | 40557 | 41816 | 43069 | 44316 | 45557 | 46793 | 41 |
| 30 | 34193 | 35482 | 36765 | 38042 | 39313 | 40578 | 41837 | 43090 | 44337 | 45578 | 46814 | 42 |
| 45 | 34214 | 35503 | 36786 | 38063 | 39334 | 40599 | 41858 | 43111 | 44358 | 45599 | 46834 | 43 |
| 11 0 | 34236 | 35525 | 36807 | 38084 | 39355 | 40620 | 41878 | 43131 | 44378 | 45619 | 46854 | 44 |
| 15 | 34257 | 35546 | 36829 | 38105 | 39376 | 40641 | 41900 | 43152 | 44399 | 45640 | 46875 | 45 |
| 30 | 34279 | 35567 | 36850 | 38127 | 39397 | 40662 | 41920 | 43173 | 44420 | 45661 | 46895 | 46 |
| 45 | 34300 | 35589 | 36871 | 38148 | 39418 | 40683 | 41941 | 43194 | 44441 | 45681 | 46916 | 47 |
| 12 0 | 34322 | 35610 | 36893 | 38169 | 39439 | 40704 | 41962 | 43215 | 44461 | 45702 | 46937 | 48 |
| 15 | 34343 | 35632 | 36914 | 38190 | 39460 | 40725 | 41983 | 43235 | 44482 | 45722 | 46957 | 49 |
| 30 | 34365 | 35653 | 36935 | 38211 | 39482 | 40746 | 42004 | 43256 | 44503 | 45743 | 46978 | 50 |
| 45 | 34386 | 35675 | 36957 | 38233 | 39513 | 40767 | 42025 | 43277 | 44523 | 45764 | 46998 | 51 |
| 13 0 | 34408 | 35696 | 36978 | 38254 | 39524 | 40788 | 42046 | 43298 | 44544 | 45784 | 47019 | 52 |
| 15 | 34429 | 35717 | 36999 | 38275 | 39545 | 40809 | 42067 | 43319 | 44565 | 45805 | 47039 | 53 |
| 30 | 34451 | 35739 | 37021 | 38296 | 39566 | 40830 | 42088 | 43340 | 44586 | 45826 | 47060 | 54 |
| 45 | 34472 | 35760 | 37042 | 38318 | 39587 | 40851 | 42109 | 43360 | 44606 | 45846 | 47080 | 55 |
| 14 0 | 34494 | 35782 | 37063 | 38339 | 39608 | 40872 | 42130 | 43381 | 44627 | 45867 | 47101 | 56 |
| 15 | 34515 | 35803 | 37084 | 38360 | 39629 | 40893 | 42150 | 43402 | 44648 | 45887 | 47121 | 57 |
| 30 | 34537 | 35824 | 37106 | 38381 | 39651 | 40914 | 42171 | 43423 | 44668 | 45908 | 47142 | 58 |
| 45 | 34558 | 35846 | 37127 | 38402 | 39672 | 40933 | 42192 | 43444 | 44689 | 45929 | 47162 | 59 |

| | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 21. | Parts | 1 | 3 | 4 | 6 | 7 | 8 | 10 | 11 | 13 | 14 | 15 | 17 | 18 | 20 | 21 |

## LOG. SINE SQUARE

| | 114° | | | | 115° | | | | 116° | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | |
| ′ ″ | 7h 36m | 7h 37m | 7h 38m | 7h 39m | 7h 40m | 7h 41m | 7h 42m | 7h 43m | 7h 44m | 7h 45m | 7h 46m | s. |
| | 9·8 | 9·8 | 9·8 | 9·8 | 9·8 | 9·8 | 9·8 | 9·8 | 9·8 | 9·8 | 9·8 | |
| 0 0 | 47183 | 48410 | 49632 | 50848 | 52058 | 53263 | 54461 | 55654 | 56841 | 58022 | 59198 | 0 |
| 15 | 47203 | 48431 | 49653 | 50868 | 52078 | 53283 | 54481 | 55674 | 56861 | 58042 | 59217 | 1 |
| 30 | 47224 | 48451 | 49673 | 50889 | 52099 | 53303 | 54501 | 55694 | 56880 | 58061 | 59237 | 2 |
| 45 | 47244 | 48472 | 49693 | 50909 | 52119 | 53323 | 54521 | 55713 | 56900 | 58081 | 59257 | 3 |
| 1 0 | 47265 | 48492 | 49713 | 50929 | 52139 | 53343 | 54541 | 55733 | 56920 | 58101 | 59276 | 4 |
| 15 | 47285 | 48512 | 49734 | 50949 | 52159 | 53363 | 54561 | 55753 | 56940 | 58120 | 59295 | 5 |
| 30 | 47306 | 48533 | 49754 | 50969 | 52179 | 53383 | 54581 | 55773 | 56959 | 58140 | 59315 | 6 |
| 45 | 47326 | 48553 | 49774 | 50990 | 52199 | 53403 | 54601 | 55793 | 56979 | 58160 | 59334 | 7 |
| 2 0 | 47347 | 48574 | 49795 | 51010 | 52219 | 53423 | 54621 | 55813 | 56999 | 58179 | 59354 | 8 |
| 15 | 47367 | 48594 | 49815 | 51030 | 52239 | 53443 | 54640 | 55832 | 57019 | 58199 | 59373 | 9 |
| 30 | 47388 | 48615 | 49835 | 51050 | 52260 | 53463 | 54660 | 55852 | 57038 | 58219 | 59393 | 10 |
| 45 | 47408 | 48635 | 49856 | 51071 | 52280 | 53483 | 54680 | 55872 | 57058 | 58238 | 59413 | 11 |
| 3 0 | 47429 | 48655 | 49876 | 51091 | 52300 | 53503 | 54700 | 55892 | 57078 | 58258 | 59432 | 12 |
| 15 | 47449 | 48676 | 49896 | 51111 | 52320 | 53523 | 54720 | 55912 | 57097 | 58277 | 59452 | 13 |
| 30 | 47470 | 48696 | 49917 | 51131 | 52340 | 53543 | 54740 | 55931 | 57117 | 58297 | 59471 | 14 |
| 45 | 47490 | 48716 | 49937 | 51151 | 52360 | 53563 | 54760 | 55951 | 57137 | 58317 | 59491 | 15 |
| 4 0 | 47511 | 48737 | 49957 | 51172 | 52380 | 53583 | 54780 | 55971 | 57157 | 58336 | 59510 | 16 |
| 15 | 47531 | 48757 | 49977 | 51192 | 52400 | 53603 | 54800 | 55991 | 57176 | 58356 | 59530 | 17 |
| 30 | 47552 | 48778 | 49998 | 51212 | 52420 | 53623 | 54820 | 56011 | 57196 | 58375 | 59549 | 18 |
| 45 | 47572 | 48798 | 50018 | 51232 | 52440 | 53643 | 54840 | 56030 | 57216 | 58395 | 59569 | 19 |
| 5 0 | 47593 | 48818 | 50038 | 51252 | 52460 | 53663 | 54860 | 56050 | 57235 | 58415 | 59588 | 20 |
| 15 | 47613 | 48839 | 50059 | 51272 | 52481 | 53683 | 54879 | 56070 | 57255 | 58434 | 59608 | 21 |
| 30 | 47634 | 48859 | 50079 | 51293 | 52501 | 53703 | 54899 | 56090 | 57275 | 58454 | 59627 | 22 |
| 45 | 47654 | 48879 | 50099 | 51313 | 52521 | 53723 | 54919 | 56110 | 57294 | 58473 | 59647 | 23 |
| 6 0 | 47675 | 48900 | 50119 | 51333 | 52541 | 53743 | 54939 | 56129 | 57314 | 58493 | 59666 | 24 |
| 15 | 47695 | 48920 | 50140 | 51353 | 52561 | 53763 | 54959 | 56149 | 57334 | 58513 | 59686 | 25 |
| 30 | 47715 | 48941 | 50160 | 51373 | 52581 | 53783 | 54979 | 56169 | 57354 | 58532 | 59705 | 26 |
| 45 | 47736 | 48961 | 50180 | 51393 | 52601 | 53803 | 54999 | 56189 | 57373 | 58552 | 59725 | 27 |
| 7 0 | 47756 | 48981 | 50200 | 51414 | 52621 | 53823 | 55019 | 56209 | 57393 | 58571 | 59744 | 28 |
| 15 | 47777 | 49002 | 50221 | 51434 | 52641 | 53843 | 55039 | 56228 | 57413 | 58591 | 59764 | 29 |
| 30 | 47797 | 49022 | 50241 | 51454 | 52661 | 53863 | 55058 | 56248 | 57432 | 58611 | 59783 | 30 |
| 45 | 47818 | 49042 | 50261 | 51474 | 52681 | 53883 | 55078 | 56268 | 57452 | 58630 | 59803 | 31 |
| 8 0 | 47838 | 49063 | 50282 | 51494 | 52701 | 53903 | 55098 | 56288 | 57472 | 58650 | 59822 | 32 |
| 15 | 47859 | 49083 | 50302 | 51515 | 52721 | 53923 | 55118 | 56308 | 57491 | 58669 | 59842 | 33 |
| 30 | 47879 | 49103 | 50322 | 51535 | 52742 | 53943 | 55138 | 56327 | 57511 | 58689 | 59861 | 34 |
| 45 | 47900 | 49124 | 50342 | 51555 | 52762 | 53963 | 55158 | 56347 | 57531 | 58709 | 59881 | 35 |
| 9 0 | 47920 | 49144 | 50363 | 51575 | 52782 | 53982 | 55178 | 56367 | 57550 | 58728 | 59900 | 36 |
| 15 | 47941 | 49165 | 50383 | 51595 | 52802 | 54002 | 55197 | 56387 | 57570 | 58748 | 59920 | 37 |
| 30 | 47961 | 49185 | 50403 | 51615 | 52822 | 54022 | 55217 | 56406 | 57590 | 58767 | 59939 | 38 |
| 45 | 47981 | 49205 | 50423 | 51635 | 52842 | 54042 | 55237 | 56426 | 57609 | 58787 | 59959 | 39 |
| 10 0 | 48002 | 49226 | 50444 | 51656 | 52862 | 54062 | 55257 | 56446 | 57629 | 58806 | 59978 | 40 |
| 15 | 48022 | 49246 | 50464 | 51676 | 52882 | 54082 | 55277 | 56466 | 57649 | 58826 | 59998 | 41 |
| 30 | 48043 | 49266 | 50484 | 51696 | 52902 | 54102 | 55297 | 56485 | 57668 | 58846 | 60017 | 42 |
| 45 | 48063 | 49287 | 50504 | 51716 | 52922 | 54122 | 55317 | 56505 | 57688 | 58865 | 60037 | 43 |
| 11 0 | 48084 | 49307 | 50525 | 51736 | 52942 | 54142 | 55336 | 56525 | 57708 | 58885 | 60056 | 44 |
| 15 | 48104 | 49327 | 50545 | 51756 | 52962 | 54162 | 55356 | 56545 | 57727 | 58904 | 60075 | 45 |
| 30 | 48125 | 49348 | 50565 | 51777 | 52982 | 54182 | 55376 | 56564 | 57747 | 58924 | 60095 | 46 |
| 45 | 48145 | 49368 | 50585 | 51797 | 53002 | 54202 | 55396 | 56584 | 57767 | 58944 | 60114 | 47 |
| 12 0 | 48166 | 49388 | 50605 | 51817 | 53022 | 54222 | 55416 | 56604 | 57786 | 58963 | 60134 | 48 |
| 15 | 48186 | 49409 | 50626 | 51837 | 53042 | 54242 | 55436 | 56624 | 57806 | 58983 | 60153 | 49 |
| 30 | 48207 | 49429 | 50646 | 51857 | 53062 | 54262 | 55455 | 56643 | 57826 | 59002 | 60173 | 50 |
| 45 | 48227 | 49449 | 50666 | 51877 | 53082 | 54282 | 55475 | 56663 | 57845 | 59022 | 60192 | 51 |
| 13 0 | 48247 | 49470 | 50686 | 51897 | 53102 | 54302 | 55495 | 56683 | 57865 | 59041 | 60212 | 52 |
| 15 | 48267 | 49490 | 50707 | 51918 | 53123 | 54322 | 55515 | 56703 | 57885 | 59061 | 60231 | 53 |
| 30 | 48288 | 49510 | 50727 | 51938 | 53143 | 54342 | 55535 | 56722 | 57904 | 59080 | 60251 | 54 |
| 45 | 48308 | 49531 | 50747 | 51958 | 53163 | 54362 | 55555 | 56742 | 57924 | 59100 | 60270 | 55 |
| 14 0 | 48329 | 49551 | 50767 | 51978 | 53183 | 54381 | 55575 | 56762 | 57944 | 59120 | 60290 | 56 |
| 15 | 48349 | 49571 | 50788 | 51998 | 53203 | 54401 | 55594 | 56782 | 57963 | 59139 | 60309 | 57 |
| 30 | 48370 | 49592 | 50808 | 52018 | 53223 | 54421 | 55614 | 56801 | 57983 | 59159 | 60328 | 58 |
| 45 | 48390 | 49612 | 50828 | 52038 | 53243 | 54441 | 55634 | 56821 | 58003 | 59178 | 60348 | 59 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
| D. 20. Parts | 1 | 3 | 4 | 5 | 7 | 8 | 9 | 11 | 12 | 13 | 15 | 16 | 17 | 19 | 20 |

## LOG. SINE SQUARE

| | | 116° | 117° | | | | 118° | | | | 119° | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | |
| ′ | ″ | 7h 47m | 7h 48m | 7h 49m | 7h 50m | 7h 51m | 7h 52m | 7h 53m | 7h 54m | 7h 55m | 7h 56m | 7h 57m | s. |
| | | 9·8 | 9·8 | 9·8 | 9·8 | 9·8 | 9·8 | 9·8 | 9·8 | 9·8 | 9·8 | 9·8 | |
| 0 | 0 | 60367 | 61532 | 62690 | 63843 | 64990 | 66131 | 67267 | 68397 | 69522 | 70641 | 71754 | 0 |
| | 15 | 60387 | 61551 | 62709 | 63862 | 65009 | 66150 | 67286 | 68416 | 69540 | 70659 | 71773 | 1 |
| | 30 | 60406 | 61570 | 62728 | 63881 | 65028 | 66169 | 67305 | 68435 | 69559 | 70678 | 71791 | 2 |
| | 45 | 60426 | 61590 | 62748 | 63900 | 65047 | 66188 | 67324 | 68454 | 69578 | 70697 | 71810 | 3 |
| 1 | 0 | 60445 | 61609 | 62767 | 63919 | 65066 | 66207 | 67342 | 68472 | 69597 | 70715 | 71828 | 4 |
| | 15 | 60465 | 61628 | 62786 | 63938 | 65085 | 66226 | 67361 | 68491 | 69615 | 70734 | 71847 | 5 |
| | 30 | 60484 | 61648 | 62805 | 63958 | 65104 | 66245 | 67380 | 68510 | 69634 | 70752 | 71865 | 6 |
| | 45 | 60504 | 61667 | 62825 | 63977 | 65123 | 66264 | 67399 | 68529 | 69653 | 70771 | 71884 | 7 |
| 2 | 0 | 60523 | 61686 | 62844 | 63996 | 65142 | 66283 | 67418 | 68547 | 69671 | 70790 | 71902 | 8 |
| | 15 | 60542 | 61706 | 62863 | 64015 | 65161 | 66302 | 67437 | 68566 | 69690 | 70808 | 71921 | 9 |
| | 30 | 60562 | 61725 | 62882 | 64034 | 65180 | 66321 | 67456 | 68585 | 69709 | 70827 | 71939 | 10 |
| | 45 | 60581 | 61744 | 62902 | 64053 | 65199 | 66340 | 67475 | 68604 | 69727 | 70845 | 71958 | 11 |
| 3 | 0 | 60601 | 61764 | 62921 | 64073 | 65218 | 66359 | 67493 | 68622 | 69746 | 70864 | 71976 | 12 |
| | 15 | 60620 | 61783 | 62940 | 64092 | 65238 | 66378 | 67512 | 68641 | 69765 | 70882 | 71995 | 13 |
| | 30 | 60640 | 61802 | 62959 | 64111 | 65257 | 66397 | 67531 | 68660 | 69783 | 70901 | 72013 | 14 |
| | 45 | 60659 | 61822 | 62979 | 64130 | 65276 | 66416 | 67550 | 68679 | 69802 | 70920 | 72032 | 15 |
| 4 | 0 | 60678 | 61841 | 62998 | 64149 | 65295 | 66435 | 67569 | 68698 | 69821 | 70938 | 72050 | 16 |
| | 15 | 60698 | 61860 | 63017 | 64168 | 65314 | 66454 | 67588 | 68716 | 69839 | 70957 | 72069 | 17 |
| | 30 | 60717 | 61880 | 63036 | 64187 | 65333 | 66472 | 67607 | 68735 | 69858 | 70975 | 72087 | 18 |
| | 45 | 60737 | 61899 | 63056 | 64207 | 65352 | 66491 | 67625 | 68754 | 69877 | 70994 | 72106 | 19 |
| 5 | 0 | 60756 | 61918 | 63075 | 64226 | 65371 | 66510 | 67644 | 68773 | 69895 | 71012 | 72124 | 20 |
| | 15 | 60776 | 61938 | 63094 | 64245 | 65390 | 66529 | 67663 | 68791 | 69914 | 71031 | 72143 | 21 |
| | 30 | 60795 | 61957 | 63113 | 64264 | 65409 | 66548 | 67682 | 68810 | 69933 | 71050 | 72161 | 22 |
| | 45 | 60814 | 61976 | 63132 | 64283 | 65428 | 66567 | 67701 | 68829 | 69951 | 71068 | 72179 | 23 |
| 6 | 0 | 60834 | 61995 | 63152 | 64302 | 65447 | 66586 | 67720 | 68848 | 69970 | 71087 | 72198 | 24 |
| | 15 | 60853 | 62015 | 63171 | 64321 | 65466 | 66605 | 67739 | 68866 | 69989 | 71105 | 72216 | 25 |
| | 30 | 60873 | 62034 | 63190 | 64340 | 65485 | 66624 | 67757 | 68885 | 70007 | 71124 | 72235 | 26 |
| | 45 | 60892 | 62053 | 63209 | 64360 | 65504 | 66643 | 67776 | 68904 | 70026 | 71143 | 72253 | 27 |
| 7 | 0 | 60911 | 62073 | 63228 | 64379 | 65523 | 66662 | 67795 | 68923 | 70045 | 71161 | 72272 | 28 |
| | 15 | 60931 | 62092 | 63248 | 64398 | 65542 | 66681 | 67814 | 68941 | 70063 | 71180 | 72290 | 29 |
| | 30 | 60950 | 62111 | 63267 | 64417 | 65561 | 66700 | 67833 | 68960 | 70082 | 71198 | 72309 | 30 |
| | 45 | 60970 | 62131 | 63286 | 64436 | 65580 | 66719 | 67852 | 68979 | 70101 | 71217 | 72327 | 31 |
| 8 | 0 | 60989 | 62150 | 63305 | 64455 | 65599 | 66738 | 67870 | 68998 | 70119 | 71235 | 72346 | 32 |
| | 15 | 61008 | 62169 | 63325 | 64474 | 65618 | 65757 | 67889 | 69016 | 70138 | 71254 | 72364 | 33 |
| | 30 | 61028 | 62189 | 63344 | 64493 | 65637 | 66775 | 67908 | 69035 | 70157 | 71272 | 72383 | 34 |
| | 45 | 61047 | 62208 | 63363 | 64512 | 65656 | 66794 | 67927 | 69054 | 70175 | 71291 | 72401 | 35 |
| 9 | 0 | 61067 | 62227 | 63382 | 64532 | 65675 | 66813 | 67946 | 69073 | 70194 | 71310 | 72420 | 36 |
| | 15 | 61086 | 62246 | 63401 | 64551 | 65694 | 66832 | 67965 | 69091 | 70212 | 71328 | 72438 | 37 |
| | 30 | 61105 | 62266 | 63421 | 64570 | 65713 | 66851 | 67984 | 69110 | 70231 | 71347 | 72456 | 38 |
| | 45 | 61125 | 62285 | 63440 | 64589 | 65732 | 66870 | 68002 | 69129 | 70250 | 71365 | 72475 | 39 |
| 10 | 0 | 61144 | 62304 | 63459 | 64608 | 65751 | 66889 | 68021 | 69147 | 70268 | 71384 | 72493 | 40 |
| | 15 | 61164 | 62324 | 63478 | 64627 | 65770 | 66908 | 68040 | 69166 | 70287 | 71402 | 72512 | 41 |
| | 30 | 61183 | 62343 | 63497 | 64646 | 65789 | 66927 | 68059 | 69185 | 70306 | 71421 | 72530 | 42 |
| | 45 | 61202 | 62362 | 63517 | 64665 | 65808 | 66946 | 68077 | 69204 | 70324 | 71439 | 72549 | 43 |
| 11 | 0 | 61222 | 62381 | 63536 | 64684 | 65827 | 66965 | 68096 | 69222 | 70343 | 71458 | 72567 | 44 |
| | 15 | 61241 | 62401 | 63555 | 64703 | 65846 | 66984 | 68115 | 69241 | 70362 | 71476 | 72586 | 45 |
| | 30 | 61261 | 62420 | 63574 | 64723 | 65865 | 67002 | 68134 | 69260 | 70380 | 71495 | 72604 | 46 |
| | 45 | 61280 | 62439 | 63593 | 64742 | 65884 | 67021 | 68153 | 69279 | 70399 | 71513 | 72623 | 47 |
| 12 | 0 | 61299 | 62459 | 63613 | 64761 | 65903 | 67040 | 68172 | 69297 | 70417 | 71532 | 72641 | 48 |
| | 15 | 61319 | 62478 | 63632 | 64780 | 65922 | 67059 | 68190 | 69316 | 70436 | 71551 | 72659 | 49 |
| | 30 | 61338 | 62497 | 63651 | 64799 | 65941 | 67078 | 68209 | 69335 | 70455 | 71569 | 72678 | 50 |
| | 45 | 61357 | 62517 | 63670 | 64818 | 65960 | 67097 | 68228 | 69353 | 70473 | 71588 | 72696 | 51 |
| 13 | 0 | 61377 | 62536 | 63689 | 64837 | 65979 | 67116 | 68247 | 69372 | 70492 | 71606 | 72715 | 52 |
| | 15 | 61396 | 62555 | 63709 | 64856 | 65998 | 67135 | 68266 | 69391 | 70511 | 71625 | 72733 | 53 |
| | 30 | 61415 | 62574 | 63728 | 64875 | 66017 | 67154 | 68284 | 69410 | 70529 | 71643 | 72752 | 54 |
| | 45 | 61435 | 62594 | 63747 | 64894 | 66036 | 67173 | 68303 | 69428 | 70548 | 71662 | 72770 | 55 |
| 14 | 0 | 61454 | 62613 | 63766 | 64913 | 66055 | 67191 | 68322 | 69447 | 70566 | 71680 | 72788 | 56 |
| | 15 | 61474 | 62632 | 63785 | 64933 | 66074 | 67210 | 68341 | 69466 | 70585 | 71699 | 72807 | 57 |
| | 30 | 61493 | 62651 | 63804 | 64952 | 66093 | 67229 | 68360 | 69484 | 70604 | 71717 | 72825 | 58 |
| | 45 | 61512 | 62671 | 63823 | 64971 | 66112 | 67248 | 68378 | 69503 | 70622 | 71736 | 72844 | 59 |

| | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 19. | Parts | 1 | 3 | 4 | 5 | 6 | 8 | 9 | 10 | 11 | 13 | 14 | 15 | 17 | 18 | 19 |

## LOG. SINE SQUARE

| | | 119° | | 120° | | | | 121° | | | | 122° | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | |
| | | 7h 58m | 7h 59m | 8h 0m | 8h 1m | 8h 2m | 8h 3m | 8h 4m | 8h 5m | 8h 6m | 8h 7m | 8h 8m | 8h 9m | s. |
| ′ | ″ | 9·8 | 9·8 | 9·8 | 9·8 | 9·8 | 9·87 | 9·8 | 9·88 | 9·88 | 9·88 | 9·88 | 9·88 | |
| 0 | 0 | 72862 | 73964 | 75061 | 76153 | 77238 | 8319 | 79394 | 0463 | 1527 | 2585 | 3639 | 4686 | 0 |
| | 15 | 72881 | 73983 | 75080 | 76171 | 77256 | 8337 | 79411 | 0481 | 1545 | 2603 | 3656 | 4704 | 1 |
| | 30 | 72899 | 74001 | 75098 | 76189 | 77274 | 8355 | 79429 | 0499 | 1562 | 2621 | 3674 | 4721 | 2 |
| | 45 | 72917 | 74019 | 75116 | 76207 | 77293 | 8373 | 79447 | 0516 | 1580 | 2638 | 3691 | 4738 | 3 |
| 1 | 0 | 72936 | 74038 | 75134 | 76225 | 77311 | 8391 | 79465 | 0534 | 1598 | 2656 | 3709 | 4756 | 4 |
| | 15 | 72954 | 74056 | 75152 | 76243 | 77329 | 8408 | 79483 | 0552 | 1615 | 2673 | 3726 | 4773 | 5 |
| | 30 | 72973 | 74074 | 75171 | 76261 | 77347 | 8426 | 79501 | 0570 | 1633 | 2691 | 3744 | 4791 | 6 |
| | 45 | 72991 | 74093 | 75189 | 76280 | 77365 | 8444 | 79519 | 0587 | 1651 | 2709 | 3761 | 4808 | 7 |
| 2 | 0 | 73009 | 74111 | 75207 | 76298 | 77383 | 8462 | 79536 | 0605 | 1668 | 2726 | 3778 | 4826 | 8 |
| | 15 | 73028 | 74129 | 75225 | 76316 | 77401 | 8480 | 79554 | 0623 | 1686 | 2744 | 3796 | 4843 | 9 |
| | 30 | 73046 | 74148 | 75244 | 76334 | 77419 | 8498 | 79572 | 0641 | 1704 | 2761 | 3813 | 4860 | 10 |
| | 45 | 73065 | 74166 | 75262 | 76352 | 77437 | 8516 | 79590 | 0658 | 1721 | 2779 | 3831 | 4878 | 11 |
| 3 | 0 | 73083 | 74184 | 75280 | 76370 | 77455 | 8534 | 79608 | 0676 | 1739 | 2796 | 3848 | 4895 | 12 |
| | 15 | 73101 | 74202 | 75298 | 76389 | 77473 | 8552 | 79626 | 0694 | 1757 | 2814 | 3866 | 4913 | 13 |
| | 30 | 73120 | 74221 | 75316 | 76406 | 77491 | 8570 | 79644 | 0712 | 1774 | 2832 | 3883 | 4930 | 14 |
| | 45 | 73138 | 74239 | 75335 | 76425 | 77509 | 8588 | 79661 | 0729 | 1792 | 2849 | 3901 | 4947 | 15 |
| 4 | 0 | 73157 | 74257 | 75353 | 76443 | 77527 | 8606 | 79679 | 0747 | 1810 | 2867 | 3918 | 4965 | 16 |
| | 15 | 73175 | 74276 | 75371 | 76461 | 77545 | 8624 | 79697 | 0765 | 1827 | 2884 | 3936 | 4982 | 17 |
| | 30 | 73193 | 74294 | 75389 | 76479 | 77563 | 8642 | 79715 | 0783 | 1845 | 2902 | 3953 | 4999 | 18 |
| | 45 | 73212 | 74312 | 75407 | 76497 | 77581 | 8660 | 79733 | 0800 | 1863 | 2920 | 3971 | 5017 | 19 |
| 5 | 0 | 73230 | 74331 | 75426 | 76515 | 77599 | 8678 | 79751 | 0818 | 1880 | 2937 | 3988 | 5034 | 20 |
| | 15 | 73249 | 74349 | 75444 | 76533 | 77617 | 8696 | 79768 | 0836 | 1898 | 2955 | 4006 | 5052 | 21 |
| | 30 | 73267 | 74367 | 75462 | 76551 | 77635 | 8713 | 79786 | 0854 | 1916 | 2972 | 4023 | 5069 | 22 |
| | 45 | 73285 | 74386 | 75480 | 76569 | 77653 | 8731 | 79804 | 0871 | 1933 | 2990 | 4041 | 5086 | 23 |
| 6 | 0 | 73304 | 74404 | 75498 | 76588 | 77671 | 8749 | 79822 | 0889 | 1951 | 3007 | 4058 | 5104 | 24 |
| | 15 | 73322 | 74422 | 75517 | 76606 | 77689 | 8767 | 79840 | 0907 | 1969 | 3025 | 4076 | 5121 | 25 |
| | 30 | 73340 | 74440 | 75534 | 76624 | 77707 | 8785 | 79858 | 0925 | 1986 | 3042 | 4093 | 5138 | 26 |
| | 45 | 73359 | 74459 | 75553 | 76642 | 77725 | 8803 | 79875 | 0942 | 2004 | 3060 | 4111 | 5156 | 27 |
| 7 | 0 | 73377 | 74477 | 75571 | 76660 | 77743 | 8821 | 79893 | 0960 | 2022 | 3078 | 4128 | 5173 | 28 |
| | 15 | 73396 | 74495 | 75589 | 76678 | 77761 | 8839 | 79911 | 0978 | 2039 | 3095 | 4146 | 5191 | 29 |
| | 30 | 73414 | 74514 | 75608 | 76696 | 77779 | 8857 | 79929 | 0996 | 2057 | 3113 | 4163 | 5208 | 30 |
| | 45 | 73432 | 74532 | 75626 | 76714 | 77797 | 8875 | 79947 | 1013 | 2074 | 3130 | 4181 | 5225 | 31 |
| 8 | 0 | 73451 | 74550 | 75644 | 76732 | 77815 | 8893 | 79965 | 1031 | 2092 | 3148 | 4198 | 5243 | 32 |
| | 15 | 73469 | 74568 | 75662 | 76750 | 77833 | 8911 | 79982 | 1049 | 2110 | 3165 | 4215 | 5260 | 33 |
| | 30 | 73487 | 74587 | 75680 | 76769 | 77851 | 8928 | 80000 | 1067 | 2127 | 3183 | 4233 | 5277 | 34 |
| | 45 | 73506 | 74605 | 75699 | 76787 | 77869 | 8946 | 80018 | 1084 | 2145 | 3200 | 4250 | 5295 | 35 |
| 9 | 0 | 73524 | 74623 | 75717 | 76805 | 77887 | 8964 | 80036 | 1102 | 2163 | 3218 | 4268 | 5312 | 36 |
| | 15 | 73543 | 74641 | 75735 | 76823 | 77905 | 8982 | 80054 | 1120 | 2180 | 3235 | 4285 | 5330 | 37 |
| | 30 | 73561 | 74660 | 75753 | 76841 | 77922 | 9000 | 80071 | 1137 | 2198 | 3253 | 4303 | 5347 | 38 |
| | 45 | 73579 | 74678 | 75771 | 76859 | 77941 | 9018 | 80089 | 1155 | 2216 | 3271 | 4320 | 5364 | 39 |
| 10 | 0 | 73598 | 74696 | 75789 | 76877 | 77959 | 9036 | 80107 | 1173 | 2233 | 3288 | 4338 | 5382 | 40 |
| | 15 | 73616 | 74715 | 75808 | 76895 | 77977 | 9054 | 80125 | 1191 | 2251 | 3306 | 4355 | 5399 | 41 |
| | 30 | 73634 | 74733 | 75826 | 76913 | 77995 | 9072 | 80143 | 1208 | 2268 | 3323 | 4372 | 5416 | 42 |
| | 45 | 73653 | 74751 | 75844 | 76931 | 78013 | 9089 | 80160 | 1226 | 2286 | 3341 | 4390 | 5434 | 43 |
| 11 | 0 | 73671 | 74769 | 75862 | 76949 | 78031 | 9107 | 80178 | 1244 | 2304 | 3358 | 4407 | 5451 | 44 |
| | 15 | 73689 | 74788 | 75880 | 76967 | 78049 | 9125 | 80196 | 1261 | 2321 | 3376 | 4425 | 5468 | 45 |
| | 30 | 73708 | 74806 | 75898 | 76986 | 78067 | 9143 | 80214 | 1279 | 2339 | 3393 | 4442 | 5486 | 46 |
| | 45 | 73726 | 74824 | 75917 | 77004 | 78085 | 9161 | 80232 | 1297 | 2357 | 3411 | 4460 | 5503 | 47 |
| 12 | 0 | 73744 | 74842 | 75935 | 77022 | 78103 | 9179 | 80249 | 1315 | 2374 | 3428 | 4477 | 5520 | 48 |
| | 15 | 73763 | 74861 | 75953 | 77040 | 78121 | 9197 | 80267 | 1332 | 2392 | 3446 | 4495 | 5538 | 49 |
| | 30 | 73781 | 74879 | 75971 | 77058 | 78139 | 9215 | 80285 | 1350 | 2409 | 3463 | 4512 | 5555 | 50 |
| | 45 | 73799 | 74897 | 75989 | 77076 | 78157 | 9233 | 80303 | 1368 | 2427 | 3481 | 4529 | 5572 | 51 |
| 13 | 0 | 73818 | 74915 | 76007 | 77094 | 78175 | 9251 | 80321 | 1385 | 2445 | 3498 | 4547 | 5590 | 52 |
| | 15 | 73836 | 74934 | 76026 | 77112 | 78193 | 9268 | 80338 | 1403 | 2462 | 3516 | 4564 | 5607 | 53 |
| | 30 | 73854 | 74952 | 76044 | 77130 | 78211 | 9286 | 80356 | 1421 | 2480 | 3533 | 4582 | 5624 | 54 |
| | 45 | 73873 | 74970 | 76062 | 77148 | 78229 | 9304 | 80374 | 1438 | 2497 | 3551 | 4599 | 5642 | 55 |
| 14 | 0 | 73891 | 74988 | 76080 | 77166 | 78247 | 9322 | 80392 | 1456 | 2515 | 3568 | 4617 | 5659 | 56 |
| | 15 | 73909 | 75007 | 76098 | 77184 | 78265 | 9340 | 80410 | 1474 | 2533 | 3586 | 4634 | 5677 | 57 |
| | 30 | 73928 | 75025 | 76116 | 77202 | 78283 | 9358 | 80427 | 1491 | 2550 | 3604 | 4651 | 5694 | 58 |
| | 45 | 73946 | 75043 | 76134 | 77220 | 78301 | 9376 | 80445 | 1509 | 2568 | 3621 | 4669 | 5711 | 59 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
| D. 18. | Parts | 1 | 2 | 4 | 5 | 6 | 7 | 8 | 10 | 11 | 12 | 13 | 14 | 16 | 17 | 18 |

## LOG. SINE SQUARE

| | | 122° | | 123° | | | | 124° | | | | 125 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | |
| | | 8h 10m | 8h 11m | 8h 12m | 8h 13m | 8h 14m | 8h 15m | 8h 16m | 8h 17m | 8h 18m | 8h 19m | 8h 20m | s |
| ′ | ″ | 9·8 | 9·8 | 9·8 | 9·8 | 9·8 | 9·8 | 9·8 | 9·8 | 9·8 | 9·8 | 9·8 | |
| 0 | 0 | 85729 | 86765 | 87797 | 88823 | 89844 | 90860 | 91870 | 92875 | 93874 | 94869 | 95858 | 0 |
| | 15 | 85746 | 86783 | 87814 | 88840 | 89861 | 90876 | 91887 | 92891 | 93891 | 94885 | 95874 | 1 |
| | 30 | 85763 | 86800 | 87831 | 88857 | 89878 | 90893 | 91903 | 92908 | 93908 | 94902 | 95891 | 2 |
| | 45 | 85781 | 86817 | 87848 | 88874 | 89895 | 90910 | 91920 | 92925 | 93924 | 94918 | 95907 | 3 |
| 1 | 0 | 85798 | 86834 | 87866 | 88891 | 89912 | 90927 | 91937 | 92942 | 93941 | 94935 | 95924 | 4 |
| | 15 | 85815 | 86852 | 87883 | 88908 | 89929 | 90944 | 91954 | 92958 | 93957 | 94951 | 95940 | 5 |
| | 30 | 85832 | 86869 | 87900 | 88925 | 89946 | 90961 | 91971 | 92975 | 93974 | 94968 | 95956 | 6 |
| | 45 | 85850 | 86886 | 87917 | 88943 | 89963 | 90978 | 91987 | 92992 | 93991 | 94984 | 95973 | 7 |
| 2 | 0 | 85867 | 86903 | 87934 | 88960 | 89980 | 90995 | 92004 | 93008 | 94007 | 95001 | 95989 | 8 |
| | 15 | 85884 | 86920 | 87951 | 88977 | 89997 | 91011 | 92021 | 93025 | 94024 | 95017 | 96006 | 9 |
| | 30 | 85902 | 86938 | 87968 | 88994 | 90014 | 91028 | 92038 | 93042 | 94040 | 95034 | 96022 | 10 |
| | 45 | 85919 | 86955 | 87986 | 89011 | 90031 | 91045 | 92054 | 93058 | 94057 | 95050 | 96039 | 11 |
| 3 | 0 | 85936 | 86972 | 88003 | 89028 | 90048 | 91062 | 92071 | 93075 | 94074 | 95067 | 96055 | 12 |
| | 15 | 85954 | 86989 | 88020 | 89045 | 90065 | 91079 | 92088 | 93092 | 94090 | 95083 | 96071 | 13 |
| | 30 | 85971 | 87007 | 88037 | 89062 | 90081 | 91096 | 92105 | 93108 | 94107 | 95100 | 96088 | 14 |
| | 45 | 85988 | 87024 | 88054 | 89079 | 90098 | 91113 | 92122 | 93125 | 94123 | 95116 | 96104 | 15 |
| 4 | 9 | 86006 | 87041 | 88071 | 89096 | 90115 | 91129 | 92138 | 93142 | 94140 | 95133 | 96121 | 16 |
| | 15 | 86023 | 87058 | 88088 | 89113 | 90132 | 91146 | 92155 | 93159 | 94157 | 95149 | 96137 | 17 |
| | 30 | 86040 | 87075 | 88105 | 89130 | 90149 | 91163 | 92172 | 93175 | 94173 | 95166 | 96154 | 18 |
| | 45 | 86057 | 87093 | 88123 | 89147 | 90166 | 91180 | 92189 | 93192 | 94190 | 95182 | 96170 | 19 |
| 5 | 0 | 86075 | 87110 | 88140 | 89164 | 90183 | 91197 | 92205 | 93209 | 94206 | 95199 | 96186 | 20 |
| | 15 | 86092 | 87127 | 88157 | 89181 | 90200 | 91214 | 92222 | 93225 | 94223 | 95215 | 96203 | 21 |
| | 30 | 86109 | 87144 | 88174 | 89198 | 90217 | 91231 | 92239 | 93242 | 94240 | 95232 | 96219 | 22 |
| | 45 | 86127 | 87162 | 88191 | 89215 | 90234 | 91247 | 92256 | 93259 | 94256 | 95248 | 96236 | 23 |
| 6 | 0 | 86144 | 87179 | 88208 | 89232 | 90251 | 91264 | 92272 | 93275 | 94273 | 95265 | 96252 | 24 |
| | 15 | 86161 | 87196 | 88225 | 89249 | 90268 | 91281 | 92289 | 93292 | 94289 | 95281 | 96268 | 25 |
| | 30 | 86178 | 87213 | 88242 | 89266 | 90285 | 91298 | 92306 | 93309 | 94306 | 95298 | 96285 | 26 |
| | 45 | 86196 | 87230 | 88259 | 89283 | 90302 | 91315 | 92323 | 93325 | 94322 | 95314 | 96301 | 27 |
| 7 | 0 | 86213 | 87248 | 88277 | 89300 | 90319 | 91332 | 92339 | 93342 | 94339 | 95331 | 96318 | 28 |
| | 15 | 86230 | 87265 | 88294 | 89317 | 90336 | 91349 | 92356 | 93359 | 94356 | 95347 | 96334 | 29 |
| | 30 | 86248 | 87282 | 88311 | 89334 | 90352 | 91365 | 92373 | 93375 | 94372 | 95364 | 96350 | 30 |
| | 45 | 86265 | 87299 | 88328 | 89351 | 90369 | 91382 | 92390 | 93392 | 94389 | 95380 | 96367 | 31 |
| 8 | 0 | 86282 | 87316 | 88345 | 89368 | 90386 | 91399 | 92406 | 93409 | 94405 | 95397 | 96383 | 32 |
| | 15 | 86299 | 87333 | 88362 | 89385 | 90403 | 91416 | 92423 | 93425 | 94422 | 95413 | 96400 | 33 |
| | 30 | 86317 | 87351 | 88379 | 89402 | 90420 | 91433 | 92440 | 93442 | 94439 | 95430 | 96416 | 34 |
| | 45 | 86334 | 87368 | 88396 | 89419 | 90437 | 91450 | 92457 | 93459 | 94455 | 95446 | 96432 | 35 |
| 9 | 0 | 86351 | 87385 | 88413 | 89436 | 90454 | 91466 | 92473 | 93475 | 94472 | 95463 | 96449 | 36 |
| | 15 | 86369 | 87402 | 88430 | 89453 | 90471 | 91483 | 92490 | 93492 | 94488 | 95479 | 96465 | 37 |
| | 30 | 86386 | 87419 | 88447 | 89470 | 90488 | 91500 | 92507 | 93508 | 94505 | 95496 | 96482 | 38 |
| | 45 | 86403 | 87437 | 88465 | 89487 | 90505 | 91517 | 92524 | 93525 | 94521 | 95512 | 96498 | 39 |
| 10 | 0 | 86420 | 87454 | 88482 | 89504 | 90522 | 91534 | 92540 | 93542 | 94538 | 95529 | 96514 | 40 |
| | 15 | 86438 | 87471 | 88499 | 89521 | 90539 | 91551 | 92557 | 93558 | 94554 | 95545 | 96531 | 41 |
| | 30 | 86455 | 87488 | 88516 | 89538 | 90555 | 91567 | 92574 | 93575 | 94571 | 95562 | 96547 | 42 |
| | 45 | 86472 | 87505 | 88533 | 89555 | 90572 | 91584 | 92591 | 93592 | 94587 | 95578 | 96563 | 43 |
| 11 | 0 | 86489 | 87522 | 88550 | 89572 | 90589 | 91601 | 92607 | 93608 | 94604 | 95595 | 96580 | 44 |
| | 15 | 86507 | 87540 | 88567 | 89589 | 90606 | 91618 | 92624 | 93625 | 94621 | 95611 | 96596 | 45 |
| | 30 | 86524 | 87557 | 88584 | 89606 | 90623 | 91635 | 92641 | 93642 | 94637 | 95628 | 96613 | 46 |
| | 45 | 86541 | 87574 | 88601 | 89623 | 90640 | 91651 | 92657 | 93658 | 94654 | 95644 | 96629 | 47 |
| 12 | 0 | 86558 | 87591 | 88618 | 89640 | 90657 | 91668 | 92674 | 93675 | 94670 | 95660 | 96645 | 48 |
| | 15 | 86576 | 87608 | 88635 | 89657 | 90674 | 91685 | 92691 | 93691 | 94687 | 95677 | 96662 | 49 |
| | 30 | 86593 | 87625 | 88652 | 89674 | 90691 | 91702 | 92708 | 93708 | 94703 | 95693 | 96678 | 50 |
| | 45 | 86610 | 87643 | 88670 | 89691 | 90708 | 91719 | 92724 | 93725 | 94720 | 95710 | 96694 | 51 |
| 13 | 0 | 86627 | 87660 | 88687 | 89708 | 90724 | 91735 | 92741 | 93741 | 94736 | 95726 | 96711 | 52 |
| | 15 | 86645 | 87677 | 88704 | 89725 | 90741 | 91752 | 92758 | 93758 | 94753 | 95743 | 96727 | 53 |
| | 30 | 86662 | 87694 | 88721 | 89742 | 90758 | 91769 | 92775 | 93775 | 94770 | 95759 | 96744 | 54 |
| | 45 | 86679 | 87711 | 88738 | 89759 | 90775 | 91786 | 92791 | 93791 | 94786 | 95776 | 96760 | 55 |
| 14 | 0 | 86696 | 87728 | 88755 | 89776 | 90792 | 91803 | 92808 | 93808 | 94803 | 95792 | 96776 | 56 |
| | 15 | 86714 | 87746 | 88772 | 89793 | 90809 | 91819 | 92825 | 93825 | 94819 | 95808 | 96793 | 57 |
| | 30 | 86731 | 87763 | 88789 | 89810 | 90826 | 91836 | 92841 | 93841 | 94836 | 95825 | 96809 | 58 |
| | 45 | 86748 | 87780 | 88806 | 89827 | 90843 | 91853 | 92858 | 93858 | 94852 | 95841 | 96825 | 59 |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
| D. 17. | Parts | 1 | 2 | 3 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 14 | 15 | 16 | 17 |

## LOG. SINE SQUARE

| | 125° | | | 126° | | | | 127° | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | |
| | 8h 21m | 8h 22m | 8h 23m | 8h 24m | 8h 25m | 8h 26m | 8h 27m | 8h 28m | 8h 29m | 8h 30m | 8h 31m | s. |
| ′ ″ | 9·8 | 9·8 | 9·8 | 9· | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | |
| 0 0 | 96842 | 97820 | 98794 | 899762 | 00725 | 01682 | 02635 | 03582 | 04525 | 05462 | 06394 | 0 |
| 15 | 96858 | 97836 | 98810 | 899778 | 00741 | 01698 | 02651 | 03598 | 04540 | 05477 | 06409 | 1 |
| 30 | 96874 | 97853 | 98826 | 899794 | 00757 | 01714 | 02667 | 03614 | 04556 | 05493 | 06425 | 2 |
| 45 | 96891 | 97869 | 98842 | 899810 | 00773 | 01730 | 02682 | 03630 | 04572 | 05508 | 06440 | 3 |
| 1 0 | 96907 | 97885 | 98858 | 899826 | 00789 | 01746 | 02698 | 03645 | 04587 | 05524 | 06456 | 4 |
| 15 | 96923 | 97902 | 98874 | 899842 | 00805 | 01762 | 02714 | 03661 | 04603 | 05539 | 06471 | 5 |
| 30 | 96940 | 97918 | 98891 | 899858 | 00821 | 01778 | 02730 | 03677 | 04618 | 05555 | 06486 | 6 |
| 45 | 96956 | 97934 | 98907 | 899874 | 00837 | 01794 | 02746 | 03693 | 04634 | 05571 | 06502 | 7 |
| 2 0 | 96972 | 97950 | 98923 | 899890 | 00853 | 01810 | 02762 | 03708 | 04650 | 05586 | 06517 | 8 |
| 15 | 96989 | 97967 | 98939 | 899906 | 00869 | 01826 | 02777 | 03724 | 04665 | 05602 | 06533 | 9 |
| 30 | 97005 | 97983 | 98955 | 899923 | 00885 | 01842 | 02793 | 03740 | 04681 | 05617 | 06548 | 10 |
| 45 | 97021 | 97999 | 98971 | 899939 | 00901 | 01857 | 02809 | 03756 | 04697 | 05633 | 06564 | 11 |
| 3 0 | 97038 | 98015 | 98988 | 899955 | 00917 | 01873 | 02825 | 03771 | 04712 | 05648 | 06579 | 12 |
| 15 | 97054 | 98032 | 99004 | 899971 | 00933 | 01889 | 02841 | 03787 | 04728 | 05664 | 06595 | 13 |
| 30 | 97070 | 98048 | 99020 | 899987 | 00949 | 01905 | 02856 | 03803 | 04744 | 05679 | 06610 | 14 |
| 45 | 97087 | 98064 | 99036 | 900003 | 00965 | 01921 | 02872 | 03818 | 04759 | 05695 | 06626 | 15 |
| 4 0 | 97103 | 98080 | 99052 | 900019 | 00981 | 01937 | 02888 | 03834 | 04775 | 05711 | 06641 | 16 |
| 15 | 97119 | 98097 | 99068 | 900035 | 00997 | 01953 | 02904 | 03850 | 04791 | 05726 | 06657 | 17 |
| 30 | 97136 | 98113 | 99085 | 900051 | 01012 | 01969 | 02920 | 03866 | 04806 | 05742 | 06672 | 18 |
| 45 | 97152 | 98129 | 99101 | 900067 | 01028 | 01985 | 02935 | 03881 | 04822 | 05757 | 06688 | 19 |
| 5 0 | 97168 | 98145 | 99117 | 900083 | 01044 | 02001 | 02951 | 03897 | 04837 | 05773 | 06703 | 20 |
| 15 | 97185 | 98162 | 99133 | 900099 | 01060 | 02016 | 02967 | 03913 | 04853 | 05788 | 06719 | 21 |
| 30 | 97201 | 98178 | 99149 | 900115 | 01076 | 02032 | 02983 | 03928 | 04869 | 05804 | 06734 | 22 |
| 45 | 97217 | 98194 | 99165 | 900131 | 01092 | 02048 | 02999 | 03944 | 04884 | 05819 | 06749 | 23 |
| 6 0 | 97234 | 98210 | 99181 | 900148 | 01108 | 02064 | 03015 | 03960 | 04900 | 05835 | 06765 | 24 |
| 15 | 97250 | 98226 | 99198 | 900164 | 01124 | 02080 | 03030 | 03976 | 04916 | 05851 | 06780 | 25 |
| 30 | 97266 | 98243 | 99214 | 900180 | 01140 | 02096 | 03046 | 03991 | 04931 | 05866 | 06796 | 26 |
| 45 | 97283 | 98259 | 99230 | 900196 | 01156 | 02112 | 03062 | 04007 | 04947 | 05882 | 06811 | 27 |
| 7 0 | 97299 | 98275 | 99246 | 900212 | 01172 | 02128 | 03078 | 04023 | 04962 | 05897 | 06827 | 28 |
| 15 | 97315 | 98291 | 99262 | 900228 | 01188 | 02144 | 03094 | 04038 | 04978 | 05913 | 06842 | 29 |
| 30 | 97332 | 98307 | 99278 | 900244 | 01204 | 02159 | 03109 | 04054 | 04994 | 05928 | 06858 | 30 |
| 45 | 97348 | 98324 | 99294 | 900260 | 01220 | 02175 | 03125 | 04070 | 05009 | 05944 | 06873 | 31 |
| 8 0 | 97364 | 98340 | 99311 | 900276 | 01236 | 02191 | 03141 | 04086 | 05025 | 05959 | 06889 | 32 |
| 15 | 97380 | 98356 | 99327 | 900292 | 01252 | 02207 | 03157 | 04101 | 05041 | 05975 | 06904 | 33 |
| 30 | 97397 | 98372 | 99343 | 900308 | 01268 | 02223 | 03172 | 04117 | 05056 | 05990 | 06919 | 34 |
| 45 | 97413 | 98389 | 99359 | 900324 | 01284 | 02239 | 03188 | 04133 | 05072 | 06006 | 06935 | 35 |
| 9 0 | 97429 | 98405 | 99375 | 900340 | 01300 | 02255 | 03204 | 04148 | 05087 | 06021 | 06950 | 36 |
| 15 | 97446 | 98421 | 99391 | 900356 | 01316 | 02270 | 03220 | 04164 | 05103 | 06037 | 06966 | 37 |
| 30 | 97462 | 98437 | 99407 | 900372 | 01332 | 02286 | 03236 | 04180 | 05119 | 06052 | 06981 | 38 |
| 45 | 97478 | 98453 | 99424 | 900388 | 01348 | 02302 | 03251 | 04195 | 05134 | 06068 | 06997 | 39 |
| 10 0 | 97495 | 98470 | 99440 | 900404 | 01364 | 02318 | 03267 | 04211 | 05150 | 06083 | 07012 | 40 |
| 15 | 97511 | 98486 | 99456 | 900420 | 01380 | 02334 | 03283 | 04227 | 05165 | 06099 | 07027 | 41 |
| 30 | 97527 | 98502 | 99472 | 900436 | 01396 | 02350 | 03299 | 04242 | 05181 | 06115 | 07043 | 42 |
| 45 | 97543 | 98518 | 99488 | 900452 | 01412 | 02366 | 03314 | 04258 | 05197 | 06130 | 07058 | 43 |
| 11 0 | 97560 | 98535 | 99504 | 900468 | 01427 | 02381 | 03330 | 04274 | 05212 | 06146 | 07074 | 44 |
| 15 | 97576 | 98551 | 99520 | 900484 | 01443 | 02397 | 03346 | 04289 | 05228 | 06161 | 07089 | 45 |
| 30 | 97592 | 98567 | 99536 | 900500 | 01459 | 02413 | 03362 | 04305 | 05243 | 06177 | 07105 | 46 |
| 45 | 97609 | 98583 | 99552 | 900516 | 01475 | 02429 | 03377 | 04321 | 05259 | 06192 | 07120 | 47 |
| 12 0 | 97625 | 98599 | 99569 | 900532 | 01491 | 02445 | 03393 | 04337 | 05275 | 06208 | 07135 | 48 |
| 15 | 97641 | 98616 | 99585 | 900548 | 01507 | 02461 | 03409 | 04352 | 05290 | 06223 | 07151 | 49 |
| 30 | 97658 | 98632 | 99601 | 900565 | 01523 | 02477 | 03425 | 04368 | 05306 | 06239 | 07166 | 50 |
| 45 | 97674 | 98648 | 99617 | 900581 | 01539 | 02492 | 03441 | 04384 | 05321 | 06254 | 07182 | 51 |
| 13 0 | 97690 | 98664 | 99633 | 900597 | 01555 | 02508 | 03456 | 04399 | 05337 | 06270 | 07197 | 52 |
| 15 | 97706 | 98680 | 99649 | 900613 | 01571 | 02524 | 03472 | 04415 | 05353 | 06285 | 07213 | 53 |
| 30 | 97723 | 98697 | 99665 | 900629 | 01587 | 02540 | 03488 | 04431 | 05368 | 06301 | 07228 | 54 |
| 45 | 97739 | 98713 | 99681 | 900645 | 01603 | 02556 | 03504 | 04446 | 05384 | 06316 | 07243 | 55 |
| 14 0 | 97755 | 98729 | 99697 | 900661 | 01619 | 02572 | 03519 | 04462 | 05399 | 06332 | 07259 | 56 |
| 15 | 97771 | 98745 | 99713 | 900677 | 01635 | 02587 | 03535 | 04478 | 05415 | 06347 | 07274 | 57 |
| 30 | 97788 | 98761 | 99730 | 900693 | 01651 | 02603 | 03551 | 04493 | 05430 | 06363 | 07290 | 58 |
| 45 | 97804 | 98777 | 99746 | 900709 | 01666 | 02619 | 03567 | 04509 | 05446 | 06378 | 07305 | 59 |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
| D. 16. | Parts | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 11 | 12 | 13 | 14 | 15 | 16 |

## LOG. SINE SQUARE

| | 128° | | | | 129° | | | | 130° | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | |
| | 8h 32m | 8h 33m | 8h 34m | 8h 35m | 8h 36m | 8h 37m | 8h 38m | 8h 39m | 8h 40m | 8h 41m | 8h 42m | s. |
| ′ ″ | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | |
| 0 0 | 07320 | 08242 | 09159 | 10070 | 10976 | 11878 | 12774 | 13665 | 14551 | 15433 | 16309 | 0 |
| 15 | 07336 | 08257 | 09174 | 10085 | 10992 | 11893 | 12789 | 13680 | 14566 | 15447 | 16323 | 1 |
| 30 | 07351 | 08273 | 09189 | 10100 | 11007 | 11908 | 12804 | 13695 | 14581 | 15462 | 16338 | 2 |
| 45 | 07367 | 08288 | 09204 | 10116 | 11022 | 11923 | 12819 | 13710 | 14596 | 15476 | 16352 | 3 |
| 1 0 | 07382 | 08303 | 09220 | 10131 | 11037 | 11938 | 12834 | 13724 | 14610 | 15491 | 16367 | 4 |
| 15 | 07397 | 08319 | 09235 | 10146 | 11052 | 11953 | 12848 | 13739 | 14625 | 15506 | 16381 | 5 |
| 30 | 07413 | 08334 | 09250 | 10161 | 11067 | 11968 | 12863 | 13754 | 14640 | 15520 | 16396 | 6 |
| 45 | 07428 | 08349 | 09265 | 10176 | 11082 | 11983 | 12878 | 13769 | 14654 | 15535 | 16411 | 7 |
| 2 0 | 07444 | 08365 | 09280 | 10191 | 11097 | 11998 | 12893 | 13784 | 14669 | 15550 | 16425 | 8 |
| 15 | 07459 | 08380 | 09296 | 10206 | 11112 | 12012 | 12908 | 13799 | 14684 | 15564 | 16440 | 9 |
| 30 | 07474 | 08395 | 09311 | 10222 | 11127 | 12027 | 12923 | 13813 | 14699 | 15579 | 16454 | 10 |
| 45 | 07490 | 08410 | 09326 | 10237 | 11142 | 12042 | 12938 | 13828 | 14713 | 15594 | 16469 | 11 |
| 3 0 | 07505 | 08426 | 09341 | 10252 | 11157 | 12057 | 12953 | 13843 | 14728 | 15608 | 16483 | 12 |
| 15 | 07520 | 08441 | 09357 | 10267 | 11172 | 12072 | 12968 | 13858 | 14743 | 15623 | 16498 | 13 |
| 30 | 07536 | 08456 | 09372 | 10282 | 11187 | 12087 | 12982 | 13873 | 14757 | 15637 | 16512 | 14 |
| 45 | 07551 | 08472 | 09387 | 10297 | 11202 | 12102 | 12997 | 13887 | 14772 | 15652 | 16527 | 15 |
| 4 0 | 07567 | 08487 | 09402 | 10312 | 11217 | 12117 | 13012 | 13902 | 14787 | 15667 | 16541 | 16 |
| 15 | 07582 | 08502 | 09417 | 10327 | 11232 | 12132 | 13027 | 13917 | 14801 | 15681 | 16556 | 17 |
| 30 | 07597 | 08518 | 09433 | 10343 | 11247 | 12147 | 13042 | 13932 | 14816 | 15696 | 16570 | 18 |
| 45 | 07613 | 08533 | 09449 | 10358 | 11262 | 12162 | 13057 | 13946 | 14831 | 15710 | 16585 | 19 |
| 5 0 | 07628 | 08548 | 09463 | 10373 | 11277 | 12177 | 13072 | 13961 | 14846 | 15725 | 16600 | 20 |
| 15 | 07644 | 08563 | 09478 | 10388 | 11293 | 12192 | 13087 | 13976 | 14860 | 15740 | 16614 | 21 |
| 30 | 07659 | 08579 | 09493 | 10403 | 11308 | 12207 | 13101 | 13991 | 14875 | 15754 | 16629 | 22 |
| 45 | 07674 | 08594 | 09509 | 10418 | 11323 | 12222 | 13116 | 14006 | 14890 | 15769 | 16643 | 23 |
| 6 0 | 07690 | 08609 | 09524 | 10433 | 11338 | 12237 | 13131 | 14020 | 14904 | 15783 | 16658 | 24 |
| 15 | 07705 | 08625 | 09539 | 10448 | 11353 | 12252 | 13146 | 14035 | 14919 | 15798 | 16672 | 25 |
| 30 | 07720 | 08640 | 09554 | 10464 | 11368 | 12267 | 13161 | 14049 | 14934 | 15813 | 16687 | 26 |
| 45 | 07736 | 08655 | 09569 | 10479 | 11383 | 12282 | 13176 | 14065 | 14948 | 15827 | 16701 | 27 |
| 7 0 | 07751 | 08670 | 09585 | 10494 | 11398 | 12297 | 13191 | 14079 | 14963 | 15842 | 16716 | 28 |
| 15 | 07766 | 08686 | 09600 | 10509 | 11413 | 12312 | 13205 | 14094 | 14978 | 15857 | 16730 | 29 |
| 30 | 07782 | 08701 | 09615 | 10524 | 11428 | 12326 | 13220 | 14109 | 14993 | 15871 | 16745 | 30 |
| 45 | 07797 | 08716 | 09630 | 10539 | 11443 | 12341 | 13235 | 14124 | 15007 | 15886 | 16759 | 31 |
| 8 0 | 07813 | 08731 | 09645 | 10554 | 11458 | 12356 | 13250 | 14139 | 15022 | 15900 | 16774 | 32 |
| 15 | 07828 | 08747 | 09661 | 10569 | 11473 | 12371 | 13265 | 14153 | 15037 | 15915 | 16788 | 33 |
| 30 | 07843 | 08762 | 09676 | 10584 | 11488 | 12386 | 13280 | 14168 | 15051 | 15930 | 16803 | 34 |
| 45 | 07859 | 08777 | 09691 | 10599 | 11503 | 12401 | 13294 | 14183 | 15066 | 15944 | 16817 | 35 |
| 9 0 | 07874 | 08793 | 09706 | 10615 | 11518 | 12416 | 13309 | 14198 | 15081 | 15959 | 16832 | 36 |
| 15 | 07889 | 08808 | 09721 | 10630 | 11533 | 12431 | 13324 | 14212 | 15095 | 15973 | 16846 | 37 |
| 30 | 07906 | 08823 | 09736 | 10645 | 11548 | 12446 | 13339 | 14227 | 15110 | 15988 | 16861 | 38 |
| 45 | 07920 | 08838 | 09752 | 10660 | 11563 | 12461 | 13354 | 14242 | 15125 | 16003 | 16875 | 39 |
| 10 0 | 07935 | 08854 | 09767 | 10675 | 11578 | 12476 | 13369 | 14257 | 15139 | 16017 | 16890 | 40 |
| 15 | 07951 | 08869 | 09782 | 10690 | 11593 | 12491 | 13383 | 14271 | 15154 | 16032 | 16904 | 41 |
| 30 | 07966 | 08884 | 09797 | 10705 | 11608 | 12506 | 13398 | 14286 | 15169 | 16046 | 16919 | 42 |
| 45 | 07981 | 08899 | 09812 | 10720 | 11623 | 12521 | 13413 | 14301 | 15183 | 16061 | 16933 | 43 |
| 11 0 | 07997 | 08915 | 09828 | 10735 | 11638 | 12535 | 13428 | 14316 | 15198 | 16075 | 16948 | 44 |
| 15 | 08012 | 08930 | 09843 | 10750 | 11653 | 12550 | 13443 | 14330 | 15213 | 16090 | 16962 | 45 |
| 30 | 08027 | 08945 | 09858 | 10765 | 11668 | 12565 | 13458 | 14345 | 15227 | 16105 | 16977 | 46 |
| 45 | 08043 | 08960 | 09873 | 10781 | 11683 | 12580 | 13472 | 14360 | 15242 | 16119 | 16991 | 47 |
| 12 0 | 08058 | 08976 | 09888 | 10796 | 11698 | 12595 | 13487 | 14374 | 15257 | 16134 | 17006 | 48 |
| 15 | 08073 | 08991 | 09903 | 10811 | 11713 | 12610 | 13502 | 14389 | 15271 | 16148 | 17020 | 49 |
| 30 | 08089 | 09006 | 09919 | 10826 | 11728 | 12625 | 13517 | 14404 | 15286 | 16163 | 17035 | 50 |
| 45 | 08104 | 09021 | 09934 | 10841 | 11743 | 12640 | 13532 | 14419 | 15301 | 16178 | 17049 | 51 |
| 13 0 | 08119 | 09037 | 09949 | 10856 | 11758 | 12655 | 13547 | 14433 | 15315 | 16192 | 17064 | 52 |
| 15 | 08135 | 09052 | 09964 | 10871 | 11773 | 12670 | 13561 | 14448 | 15330 | 16207 | 17078 | 53 |
| 30 | 08150 | 09067 | 09979 | 10886 | 11788 | 12685 | 13576 | 14463 | 15345 | 16221 | 17093 | 54 |
| 45 | 08165 | 09082 | 09994 | 10901 | 11803 | 12700 | 13591 | 14478 | 15359 | 16236 | 17107 | 55 |
| 14 0 | 08181 | 09098 | 10009 | 10916 | 11818 | 12714 | 13606 | 14492 | 15374 | 16250 | 17122 | 56 |
| 15 | 08196 | 09113 | 10025 | 10931 | 11833 | 12729 | 13621 | 14507 | 15389 | 16265 | 17136 | 57 |
| 30 | 08211 | 09128 | 10040 | 10946 | 11848 | 12744 | 13636 | 14522 | 15403 | 16279 | 17151 | 58 |
| 45 | 08227 | 09143 | 10055 | 10961 | 11863 | 12759 | 13650 | 14537 | 15418 | 16294 | 17165 | 59 |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
| D. 15. | Parts | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |

## LOG. SINE SQUARE

| | 130° | 131° | | | | 132° | | | | 133° | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | |
| | 8ʰ 43ᵐ | 8ʰ 44ᵐ | 8ʰ 45ᵐ | 8ʰ 46ᵐ | 8ʰ 47ᵐ | 8ʰ 48ᵐ | 8ʰ 49ᵐ | 8ʰ 50ᵐ | 8ʰ 51ᵐ | 8ʰ 52ᵐ | 8ʰ 53ᵐ | s. |
| ′ ″ | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | |
| 0 0 | 17180 | 18046 | 18907 | 19763 | 20614 | 21460 | 22302 | 23138 | 23969 | 24794 | 25617 | 0 |
| 15 | 17194 | 18060 | 18921 | 19777 | 20628 | 21474 | 22316 | 23152 | 23983 | 24809 | 25631 | 1 |
| 30 | 17209 | 18075 | 18936 | 19791 | 20642 | 21488 | 22330 | 23166 | 23997 | 24823 | 25644 | 2 |
| 45 | 17223 | 18089 | 18950 | 19806 | 20657 | 21502 | 22343 | 23179 | 24011 | 24837 | 25658 | 3 |
| 1 0 | 17238 | 18103 | 18964 | 19820 | 20671 | 21516 | 22357 | 23193 | 24024 | 24850 | 25672 | 4 |
| 15 | 17252 | 18118 | 18978 | 19834 | 20685 | 21531 | 22371 | 23207 | 24038 | 24864 | 25685 | 5 |
| 30 | 17267 | 18132 | 18993 | 19848 | 20699 | 21545 | 22385 | 23221 | 24052 | 24878 | 25699 | 6 |
| 45 | 17281 | 18147 | 19007 | 19863 | 20713 | 21559 | 22399 | 23235 | 24066 | 24892 | 25713 | 7 |
| 2 0 | 17296 | 18161 | 19021 | 19877 | 20727 | 21573 | 22413 | 23249 | 24079 | 24905 | 25726 | 8 |
| 15 | 17310 | 18175 | 19036 | 19891 | 20741 | 21587 | 22427 | 23263 | 24093 | 24919 | 25740 | 9 |
| 30 | 17324 | 18190 | 19050 | 19905 | 20755 | 21601 | 22441 | 23277 | 24107 | 24933 | 25753 | 10 |
| 45 | 17339 | 18204 | 19064 | 19919 | 20770 | 21615 | 22455 | 23291 | 24121 | 24947 | 25767 | 11 |
| 3 0 | 17353 | 18218 | 19079 | 19934 | 20784 | 21629 | 22469 | 23304 | 24134 | 24960 | 25781 | 12 |
| 15 | 17368 | 18233 | 19093 | 19948 | 20798 | 21643 | 22483 | 23318 | 24148 | 24974 | 25794 | 13 |
| 30 | 17382 | 18247 | 19107 | 19962 | 20812 | 21657 | 22497 | 23332 | 24162 | 24988 | 25808 | 14 |
| 45 | 17397 | 18262 | 19121 | 19976 | 20826 | 21671 | 22511 | 23346 | 24176 | 25001 | 25822 | 15 |
| 4 0 | 17411 | 18276 | 19136 | 19990 | 20840 | 21685 | 22525 | 23360 | 24190 | 25015 | 25835 | 16 |
| 15 | 17426 | 18290 | 19150 | 20005 | 20854 | 21699 | 22539 | 23374 | 24203 | 25029 | 25849 | 17 |
| 30 | 17440 | 18305 | 19164 | 20019 | 20868 | 21713 | 22553 | 23388 | 24217 | 25043 | 25863 | 18 |
| 45 | 17454 | 18319 | 19179 | 20033 | 20883 | 21727 | 22567 | 23402 | 24231 | 25056 | 25876 | 19 |
| 5 0 | 17469 | 18333 | 19193 | 20047 | 20897 | 21741 | 22581 | 23415 | 24245 | 25070 | 25890 | 20 |
| 15 | 17483 | 18348 | 19207 | 20061 | 20911 | 21755 | 22595 | 23429 | 24258 | 25084 | 25903 | 21 |
| 30 | 17498 | 18362 | 19221 | 20076 | 20925 | 21769 | 22609 | 23443 | 24272 | 25097 | 25917 | 22 |
| 45 | 17512 | 18376 | 19236 | 20090 | 20939 | 21783 | 22623 | 23457 | 24286 | 25111 | 25931 | 23 |
| 6 0 | 17527 | 18391 | 19250 | 20104 | 20953 | 21797 | 22637 | 23471 | 24299 | 25125 | 25944 | 24 |
| 15 | 17541 | 18405 | 19264 | 20118 | 20967 | 21811 | 22651 | 23485 | 24313 | 25138 | 25958 | 25 |
| 30 | 17556 | 18419 | 19278 | 20132 | 20981 | 21825 | 22664 | 23499 | 24327 | 25152 | 25972 | 26 |
| 45 | 17570 | 18434 | 19293 | 20147 | 20995 | 21839 | 22678 | 23512 | 24341 | 25166 | 25985 | 27 |
| 7 0 | 17585 | 18448 | 19307 | 20161 | 21010 | 21853 | 22692 | 23526 | 24354 | 25180 | 25999 | 28 |
| 15 | 17599 | 18463 | 19321 | 20175 | 21024 | 21868 | 22706 | 23540 | 24368 | 25193 | 26012 | 29 |
| 30 | 17613 | 18477 | 19336 | 20189 | 21038 | 21882 | 22720 | 23554 | 24382 | 25207 | 26026 | 30 |
| 45 | 17628 | 18491 | 19350 | 20203 | 21052 | 21896 | 22734 | 23568 | 24396 | 25221 | 26040 | 31 |
| 8 0 | 17642 | 18506 | 19364 | 20218 | 21066 | 21910 | 22748 | 23582 | 24410 | 25234 | 26053 | 32 |
| 15 | 17657 | 18520 | 19378 | 20232 | 21080 | 21924 | 22762 | 23596 | 24424 | 25248 | 26067 | 33 |
| 30 | 17671 | 18534 | 19393 | 20246 | 21094 | 21938 | 22776 | 23609 | 24438 | 25262 | 26080 | 34 |
| 45 | 17686 | 18549 | 19407 | 20260 | 21108 | 21952 | 22790 | 23623 | 24452 | 25275 | 26094 | 35 |
| 9 0 | 17700 | 18563 | 19421 | 20274 | 21122 | 21966 | 22804 | 23637 | 24466 | 25289 | 26108 | 36 |
| 15 | 17714 | 18577 | 19435 | 20288 | 21136 | 21980 | 22818 | 23651 | 24479 | 25303 | 26121 | 37 |
| 30 | 17729 | 18592 | 19450 | 20303 | 21151 | 21994 | 22832 | 23665 | 24493 | 25316 | 26135 | 38 |
| 45 | 17743 | 18606 | 19464 | 20317 | 21165 | 22008 | 22846 | 23679 | 24507 | 25330 | 26148 | 39 |
| 10 0 | 17758 | 18620 | 19478 | 20331 | 21179 | 22022 | 22860 | 23693 | 24521 | 25344 | 26162 | 40 |
| 15 | 17772 | 18635 | 19492 | 20345 | 21193 | 22036 | 22874 | 23707 | 24534 | 25357 | 26176 | 41 |
| 30 | 17787 | 18649 | 19507 | 20359 | 21207 | 22050 | 22887 | 23721 | 24548 | 25371 | 26189 | 42 |
| 45 | 17801 | 18663 | 19521 | 20373 | 21221 | 22064 | 22901 | 23735 | 24562 | 25385 | 26203 | 43 |
| 11 0 | 17815 | 18678 | 19535 | 20388 | 21235 | 22078 | 22915 | 23749 | 24576 | 25398 | 26216 | 44 |
| 15 | 17830 | 18692 | 19549 | 20402 | 21249 | 22092 | 22929 | 23762 | 24589 | 25412 | 26230 | 45 |
| 30 | 17844 | 18706 | 19564 | 20416 | 21263 | 22106 | 22943 | 23776 | 24603 | 25426 | 26244 | 46 |
| 45 | 17859 | 18721 | 19578 | 20430 | 21278 | 22120 | 22957 | 23790 | 24617 | 25439 | 26257 | 47 |
| 12 0 | 17873 | 18735 | 19592 | 20444 | 21292 | 22134 | 22971 | 23804 | 24631 | 25453 | 26271 | 48 |
| 15 | 17887 | 18749 | 19606 | 20458 | 21306 | 22148 | 22985 | 23818 | 24644 | 25467 | 26284 | 49 |
| 30 | 17902 | 18764 | 19621 | 20473 | 21320 | 22162 | 22999 | 23831 | 24658 | 25480 | 26298 | 50 |
| 45 | 17916 | 18778 | 19635 | 20487 | 21334 | 22176 | 23013 | 23845 | 24672 | 25494 | 26311 | 51 |
| 13 0 | 17931 | 18792 | 19649 | 20501 | 21348 | 22190 | 23027 | 23859 | 24686 | 25508 | 26325 | 52 |
| 15 | 17945 | 18807 | 19663 | 20515 | 21362 | 22204 | 23040 | 23873 | 24699 | 25521 | 26339 | 53 |
| 30 | 17959 | 18821 | 19678 | 20529 | 21376 | 22218 | 23054 | 23886 | 24713 | 25535 | 26352 | 54 |
| 45 | 17974 | 18835 | 19692 | 20543 | 21390 | 22232 | 23068 | 23900 | 24727 | 25549 | 26366 | 55 |
| 14 0 | 17988 | 18850 | 19706 | 20558 | 21404 | 22246 | 23082 | 23914 | 24740 | 25562 | 26379 | 56 |
| 15 | 18003 | 18864 | 19720 | 20572 | 21418 | 22260 | 23096 | 23928 | 24754 | 25576 | 26393 | 57 |
| 30 | 18017 | 18878 | 19735 | 20586 | 21432 | 22274 | 23110 | 23942 | 24768 | 25590 | 26407 | 58 |
| 45 | 18031 | 18893 | 19749 | 20600 | 21446 | 22288 | 23124 | 23955 | 24782 | 25603 | 26420 | 59 |

| | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 14. | Parts | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |

## LOG. SINE SQUARE

| | 133° | | 134° | | | | 135° | | | | 136° | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | |
| | 8h 54m | 8h 55m | 8h 56m | 8h 57m | 8h 58m | 8h 59m | 9h 0m | 9h 1m | 9h 2m | 9h 3m | 9h 4m | s. |
| ′ ″ | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | |
| 0 0 | 26434 | 27245 | 28052 | 28854 | 29651 | 30443 | 31231 | 32013 | 32791 | 33564 | 34332 | 0 |
| 15 | 26447 | 27259 | 28066 | 28867 | 29664 | 30457 | 31244 | 32026 | 32804 | 33576 | 34345 | 1 |
| 30 | 26461 | 27272 | 28079 | 28881 | 29678 | 30470 | 31257 | 32039 | 32817 | 33589 | 34357 | 2 |
| 45 | 26474 | 27286 | 28092 | 28894 | 29691 | 30483 | 31270 | 32052 | 32830 | 33602 | 34370 | 3 |
| 1 0 | 26488 | 27299 | 28106 | 28907 | 29704 | 30496 | 31283 | 32065 | 32842 | 33615 | 34383 | 4 |
| 15 | 26501 | 27313 | 28119 | 28921 | 29717 | 30509 | 31296 | 32078 | 32855 | 33628 | 34396 | 5 |
| 30 | 26515 | 27326 | 28133 | 28934 | 29731 | 30522 | 31309 | 32091 | 32868 | 33641 | 34408 | 6 |
| 45 | 26529 | 27340 | 28146 | 28947 | 29744 | 30535 | 31322 | 32104 | 32881 | 33653 | 34421 | 7 |
| 2 0 | 26542 | 27353 | 28159 | 28961 | 29757 | 30549 | 31335 | 32117 | 32894 | 33666 | 34434 | 8 |
| 15 | 26556 | 27367 | 28173 | 28974 | 29770 | 30562 | 31348 | 32130 | 32907 | 33679 | 34447 | 9 |
| 30 | 26569 | 27380 | 28186 | 28987 | 29783 | 30575 | 31361 | 32143 | 32920 | 33692 | 34459 | 10 |
| 45 | 26583 | 27394 | 28199 | 29000 | 29797 | 30588 | 31374 | 32156 | 32933 | 33705 | 34472 | 11 |
| 3 0 | 26596 | 27407 | 28213 | 29014 | 29810 | 30601 | 31388 | 32169 | 32946 | 33718 | 34485 | 12 |
| 15 | 26610 | 27421 | 28226 | 29027 | 29823 | 30614 | 31401 | 32182 | 32959 | 33730 | 34498 | 13 |
| 30 | 26623 | 27434 | 28240 | 29040 | 29836 | 30627 | 31414 | 32195 | 32972 | 33743 | 34510 | 14 |
| 45 | 26637 | 27448 | 28253 | 29054 | 29850 | 30641 | 31427 | 32208 | 32984 | 33756 | 34523 | 15 |
| 4 0 | 26651 | 27461 | 28266 | 29067 | 29863 | 30654 | 31440 | 32221 | 32997 | 33769 | 34536 | 16 |
| 15 | 26664 | 27474 | 28280 | 29080 | 29876 | 30667 | 31453 | 32234 | 33010 | 33782 | 34549 | 17 |
| 30 | 26678 | 27488 | 28293 | 29094 | 29889 | 30680 | 31466 | 32247 | 33023 | 33795 | 34561 | 18 |
| 45 | 26691 | 27501 | 28307 | 29107 | 29902 | 30693 | 31479 | 32260 | 33036 | 33807 | 34574 | 19 |
| 5 0 | 26705 | 27515 | 28320 | 29120 | 29916 | 30706 | 31492 | 32273 | 33049 | 33820 | 34587 | 20 |
| 15 | 26718 | 27528 | 28333 | 29134 | 29929 | 30719 | 31505 | 32286 | 33062 | 33833 | 34599 | 21 |
| 30 | 26732 | 27542 | 28347 | 29147 | 29942 | 30733 | 31518 | 32299 | 33075 | 33846 | 34612 | 22 |
| 45 | 26745 | 27555 | 28360 | 29160 | 29955 | 30746 | 31531 | 32312 | 33088 | 33859 | 34625 | 23 |
| 6 0 | 26759 | 27569 | 28374 | 29173 | 29969 | 30759 | 31544 | 32325 | 33100 | 33871 | 34638 | 24 |
| 15 | 26772 | 27582 | 28387 | 29187 | 29982 | 30772 | 31557 | 32338 | 33113 | 33884 | 34650 | 25 |
| 30 | 26786 | 27596 | 28400 | 29200 | 29995 | 30785 | 31570 | 32351 | 33126 | 33897 | 34663 | 26 |
| 45 | 26800 | 27609 | 28414 | 29213 | 30008 | 30798 | 31583 | 32364 | 33139 | 33910 | 34676 | 27 |
| 7 0 | 26813 | 27622 | 28427 | 29227 | 30021 | 30811 | 31596 | 32377 | 33152 | 33923 | 34688 | 28 |
| 15 | 26827 | 27636 | 28440 | 29240 | 30035 | 30825 | 31609 | 32390 | 33165 | 33936 | 34701 | 29 |
| 30 | 26840 | 27649 | 28454 | 29253 | 30048 | 30838 | 31622 | 32403 | 33178 | 33948 | 34714 | 30 |
| 45 | 26854 | 27663 | 28467 | 29266 | 30061 | 30851 | 31636 | 32416 | 33191 | 33961 | 34727 | 31 |
| 8 0 | 26867 | 27676 | 28480 | 29280 | 30074 | 30864 | 31649 | 32429 | 33204 | 33974 | 34739 | 32 |
| 15 | 26881 | 27690 | 28494 | 29293 | 30087 | 30877 | 31662 | 32441 | 33216 | 33987 | 34752 | 33 |
| 30 | 26894 | 27703 | 28507 | 29306 | 30101 | 30890 | 31675 | 32454 | 33229 | 34000 | 34765 | 34 |
| 45 | 26908 | 27716 | 28520 | 29320 | 30114 | 30903 | 31688 | 32467 | 33242 | 34012 | 34777 | 35 |
| 9 0 | 26921 | 27730 | 28534 | 29333 | 30127 | 30916 | 31701 | 32480 | 33255 | 34025 | 34790 | 36 |
| 15 | 26935 | 27743 | 28547 | 29346 | 30140 | 30929 | 31714 | 32493 | 33268 | 34038 | 34803 | 37 |
| 30 | 26948 | 27757 | 28561 | 29359 | 30153 | 30943 | 31727 | 32506 | 33281 | 34051 | 34816 | 38 |
| 45 | 26962 | 27770 | 28574 | 29373 | 30167 | 30956 | 31740 | 32519 | 33294 | 34063 | 34828 | 39 |
| 10 0 | 26975 | 27784 | 28587 | 29386 | 30180 | 30969 | 31753 | 32532 | 33307 | 34076 | 34841 | 40 |
| 15 | 26989 | 27797 | 28601 | 29399 | 30193 | 30982 | 31766 | 32545 | 33319 | 34089 | 34854 | 41 |
| 30 | 27002 | 27811 | 28614 | 29413 | 30206 | 30995 | 31779 | 32558 | 33332 | 34102 | 34866 | 42 |
| 45 | 27016 | 27824 | 28627 | 29426 | 30219 | 31008 | 31792 | 32571 | 33345 | 34115 | 34879 | 43 |
| 11 0 | 27029 | 27837 | 28641 | 29439 | 30233 | 31021 | 31805 | 32584 | 33358 | 34127 | 34892 | 44 |
| 15 | 27043 | 27851 | 28654 | 29452 | 30246 | 31034 | 31818 | 32597 | 33371 | 34140 | 34905 | 45 |
| 30 | 27056 | 27864 | 28667 | 29466 | 30259 | 31047 | 31831 | 32610 | 33384 | 34153 | 34917 | 46 |
| 45 | 27070 | 27878 | 28681 | 29479 | 30272 | 31060 | 31844 | 32623 | 33397 | 34166 | 34930 | 47 |
| 12 0 | 27083 | 27891 | 28694 | 29492 | 30285 | 31074 | 31857 | 32636 | 33409 | 34178 | 34943 | 48 |
| 15 | 27097 | 27905 | 28707 | 29505 | 30298 | 31087 | 31870 | 32649 | 33422 | 34191 | 34955 | 49 |
| 30 | 27110 | 27918 | 28721 | 29519 | 30312 | 31100 | 31883 | 32662 | 33435 | 34204 | 34968 | 50 |
| 45 | 27124 | 27931 | 28734 | 29532 | 30325 | 31113 | 31896 | 32674 | 33448 | 34217 | 34981 | 51 |
| 13 0 | 27137 | 27945 | 28747 | 29545 | 30338 | 31126 | 31909 | 32687 | 33461 | 34230 | 34993 | 52 |
| 15 | 27151 | 27958 | 28761 | 29558 | 30351 | 31139 | 31922 | 32700 | 33474 | 34242 | 35006 | 53 |
| 30 | 27164 | 27972 | 28774 | 29572 | 30364 | 31152 | 31935 | 32713 | 33487 | 34255 | 35019 | 54 |
| 45 | 27178 | 27985 | 28787 | 29585 | 30377 | 31165 | 31948 | 32726 | 33500 | 34268 | 35031 | 55 |
| 14 0 | 27191 | 27999 | 28801 | 29598 | 30391 | 31178 | 31961 | 32739 | 33512 | 34281 | 35044 | 56 |
| 15 | 27205 | 28012 | 28814 | 29611 | 30404 | 31191 | 31974 | 32752 | 33525 | 34293 | 35057 | 57 |
| 30 | 27218 | 28025 | 28827 | 29625 | 30417 | 31204 | 31987 | 32765 | 33538 | 34306 | 35070 | 58 |
| 45 | 27232 | 28039 | 28841 | 29638 | 30430 | 31218 | 32000 | 32778 | 33551 | 34319 | 35082 | 59 |

| | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 13. | Parts | 1 | 2 | 3 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 10 | 11 | 12 | 13 |

## LOG. SINE SQUARE

| | | 136° | | | 137° | | | | 138° | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | |
| ′ | ″ | 9h 5m | 9h 6m | 9h 7m | 9h 8m | 9h 9m | 9h 10m | 9h 11m | 9h 12m | 9h 13m | 9h 14m | 9h 15m | s. |
| | | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | |
| 0 | 0 | 35095 | 35853 | 36607 | 37356 | 38100 | 38839 | 39574 | 40303 | 41029 | 41749 | 42464 | 0 |
| | 15 | 35108 | 35866 | 36620 | 37368 | 38112 | 38851 | 39586 | 40316 | 41041 | 41761 | 42476 | 1 |
| | 30 | 35120 | 35879 | 36632 | 37381 | 38125 | 38864 | 39598 | 40328 | 41053 | 41773 | 42488 | 2 |
| | 45 | 35133 | 35891 | 36645 | 37393 | 38137 | 38876 | 39610 | 40340 | 41065 | 41785 | 42500 | 3 |
| 1 | 0 | 35146 | 35904 | 36657 | 37405 | 38149 | 38888 | 39622 | 40352 | 41077 | 41797 | 42512 | 4 |
| | 15 | 35158 | 35916 | 36670 | 37418 | 38162 | 38901 | 39635 | 40364 | 41089 | 41809 | 42524 | 5 |
| | 30 | 35171 | 35929 | 36682 | 37430 | 38174 | 38913 | 39647 | 40376 | 41101 | 41821 | 42536 | 6 |
| | 45 | 35184 | 35942 | 36695 | 37443 | 38186 | 38925 | 39659 | 40388 | 41113 | 41833 | 42548 | 7 |
| 2 | 0 | 35196 | 35954 | 36707 | 37455 | 38199 | 38937 | 39671 | 40400 | 41125 | 41844 | 42559 | 8 |
| | 15 | 35209 | 35967 | 36720 | 37468 | 38211 | 38950 | 39683 | 40413 | 41137 | 41856 | 42571 | 9 |
| | 30 | 35222 | 35979 | 36732 | 37480 | 38223 | 38962 | 39696 | 40425 | 41149 | 41868 | 42583 | 10 |
| | 45 | 35234 | 35992 | 36745 | 37493 | 38236 | 38974 | 39708 | 40437 | 41161 | 41880 | 42595 | 11 |
| 3 | 0 | 35247 | 36004 | 36757 | 37505 | 38248 | 38986 | 39720 | 40449 | 41173 | 41892 | 42607 | 12 |
| | 15 | 35260 | 36017 | 36770 | 37517 | 38261 | 38999 | 39732 | 40461 | 41185 | 41904 | 42619 | 13 |
| | 30 | 35272 | 36030 | 36782 | 37530 | 38273 | 39011 | 39744 | 40473 | 41197 | 41916 | 42631 | 14 |
| | 45 | 35285 | 36042 | 36795 | 37542 | 38285 | 39023 | 39757 | 40485 | 41209 | 41928 | 42643 | 15 |
| 4 | 0 | 35298 | 36055 | 36807 | 57555 | 38297 | 39035 | 39769 | 40497 | 41221 | 41940 | 42654 | 16 |
| | 15 | 35310 | 36067 | 36820 | 37567 | 38310 | 39048 | 39781 | 40509 | 41233 | 41952 | 42666 | 17 |
| | 30 | 35323 | 36080 | 36832 | 37579 | 38322 | 39060 | 39793 | 40521 | 41245 | 41964 | 42678 | 18 |
| | 45 | 35336 | 36092 | 36845 | 37592 | 38334 | 39072 | 39805 | 40534 | 41257 | 41976 | 42690 | 19 |
| 5 | 0 | 35348 | 36105 | 36857 | 37604 | 38347 | 39084 | 39817 | 40546 | 41269 | 41988 | 42702 | 20 |
| | 15 | 35361 | 36118 | 36870 | 37617 | 38359 | 39097 | 39830 | 40558 | 41281 | 42000 | 42714 | 21 |
| | 30 | 35373 | 36130 | 36882 | 37629 | 38371 | 39109 | 39842 | 40570 | 41293 | 42012 | 42726 | 22 |
| | 45 | 35386 | 36143 | 36895 | 37642 | 38384 | 39121 | 39854 | 40582 | 41305 | 42024 | 42737 | 23 |
| 6 | 0 | 35399 | 36155 | 36907 | 37654 | 38396 | 39134 | 39866 | 40594 | 41317 | 42036 | 42749 | 24 |
| | 15 | 35411 | 36168 | 36920 | 37666 | 38408 | 39146 | 39878 | 40606 | 41329 | 42048 | 42761 | 25 |
| | 30 | 35424 | 36180 | 36932 | 37679 | 38421 | 39158 | 39890 | 40618 | 41341 | 42059 | 42773 | 26 |
| | 45 | 35437 | 36193 | 36945 | 37691 | 38433 | 39170 | 39903 | 40630 | 41353 | 42071 | 42785 | 27 |
| 7 | 0 | 35449 | 36206 | 36957 | 37704 | 38445 | 39183 | 39915 | 40642 | 41365 | 42083 | 42797 | 28 |
| | 15 | 35462 | 36218 | 36969 | 37716 | 38458 | 39195 | 39927 | 40654 | 41377 | 42095 | 42809 | 29 |
| | 30 | 35475 | 36231 | 36982 | 37728 | 38470 | 39207 | 39939 | 40667 | 41389 | 42107 | 42820 | 30 |
| | 45 | 35487 | 36243 | 36994 | 37741 | 38482 | 39219 | 39951 | 40679 | 41401 | 42119 | 42832 | 31 |
| 8 | 0 | 35500 | 36256 | 37007 | 37753 | 38495 | 39232 | 39963 | 40691 | 41413 | 42131 | 42844 | 32 |
| | 15 | 35513 | 36268 | 37019 | 37766 | 38507 | 39244 | 39976 | 40703 | 41425 | 42143 | 42856 | 33 |
| | 30 | 35525 | 36281 | 37032 | 37778 | 38519 | 39256 | 39988 | 40715 | 41437 | 42155 | 42868 | 34 |
| | 45 | 35538 | 36294 | 37044 | 37790 | 38532 | 39268 | 40000 | 40727 | 41449 | 42167 | 42880 | 35 |
| 9 | 0 | 35551 | 36306 | 37057 | 37803 | 38544 | 39280 | 40012 | 40739 | 41461 | 42179 | 42891 | 36 |
| | 15 | 35563 | 36319 | 37069 | 37815 | 38556 | 39293 | 40024 | 40751 | 41473 | 42191 | 42903 | 37 |
| | 30 | 35576 | 36331 | 37082 | 37828 | 38569 | 39305 | 40036 | 40763 | 41485 | 42203 | 42915 | 38 |
| | 45 | 35588 | 36344 | 37094 | 37840 | 38581 | 39317 | 40049 | 40775 | 41497 | 42214 | 42927 | 39 |
| 10 | 0 | 35601 | 36356 | 37107 | 37852 | 38593 | 39329 | 40061 | 40787 | 41509 | 42226 | 42939 | 40 |
| | 15 | 35614 | 36369 | 37119 | 37865 | 38606 | 39342 | 40073 | 40799 | 41521 | 42238 | 42951 | 41 |
| | 30 | 35626 | 36381 | 37132 | 37877 | 38618 | 39354 | 40085 | 40811 | 41533 | 42250 | 42963 | 42 |
| | 45 | 35639 | 36394 | 37144 | 37890 | 38630 | 39366 | 40097 | 40824 | 41545 | 42262 | 42974 | 43 |
| 11 | 0 | 35652 | 36406 | 37157 | 37902 | 38642 | 39378 | 40109 | 40836 | 41557 | 42274 | 42986 | 44 |
| | 15 | 35664 | 36419 | 37169 | 37914 | 38655 | 39390 | 40121 | 40848 | 41569 | 42286 | 42998 | 45 |
| | 30 | 35677 | 36431 | 37181 | 37927 | 38667 | 39403 | 40134 | 40860 | 41581 | 42298 | 43010 | 46 |
| | 45 | 35689 | 36444 | 37194 | 37939 | 38679 | 39415 | 40146 | 40872 | 41593 | 42310 | 43022 | 47 |
| 12 | 0 | 35702 | 36457 | 37206 | 37951 | 38692 | 39427 | 40158 | 40884 | 41605 | 42322 | 43033 | 48 |
| | 15 | 35715 | 36469 | 37219 | 37964 | 38704 | 39439 | 40170 | 40896 | 41617 | 42334 | 43045 | 49 |
| | 30 | 35727 | 36482 | 37231 | 37976 | 38716 | 39452 | 40182 | 40908 | 41629 | 42345 | 43057 | 50 |
| | 45 | 35740 | 36494 | 37244 | 37989 | 38729 | 39464 | 40194 | 40920 | 41641 | 42357 | 43069 | 51 |
| 13 | 0 | 35753 | 36507 | 37256 | 38001 | 38741 | 39476 | 40206 | 40932 | 41653 | 42369 | 43081 | 52 |
| | 15 | 35765 | 36519 | 37269 | 38013 | 38753 | 39488 | 40219 | 40944 | 41665 | 42381 | 43093 | 53 |
| | 30 | 35778 | 36532 | 37281 | 38026 | 38765 | 39500 | 40231 | 40956 | 41677 | 42393 | 43104 | 54 |
| | 45 | 35790 | 36544 | 37294 | 38038 | 38778 | 39513 | 40243 | 40968 | 41689 | 42405 | 43116 | 55 |
| 14 | 0 | 35803 | 36557 | 37306 | 38050 | 38790 | 39525 | 40255 | 40980 | 41701 | 42417 | 43128 | 56 |
| | 15 | 35816 | 36569 | 37318 | 38063 | 38802 | 39537 | 40267 | 40992 | 41713 | 42429 | 43140 | 57 |
| | 30 | 35828 | 36582 | 37331 | 38075 | 38815 | 39549 | 40279 | 41004 | 41725 | 42441 | 43152 | 58 |
| | 45 | 35841 | 36594 | 37343 | 38087 | 38827 | 39561 | 40291 | 41016 | 41737 | 42452 | 43163 | 59 |

| | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 12. | Parts | 1 | 2 | 2 | 3 | 4 | 5 | 6 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |

## LOG. SINE SQUARE

| | | 139° | | | | 140° | | | | 141° | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30 | |
| | | 9h 16m | 9h 17m | 9h 18m | 9h 19m | 9h 20m | 9h 21m | 9h 22m | 9h 23m | 9h 24m | 9h 25m | 9h 26m | s. |
| ′ | ″ | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | |
| 0 | 0 | 43175 | 43881 | 44583 | 45280 | 45972 | 46659 | 47342 | 48020 | 48693 | 49362 | 50026 | 0 |
| | 15 | 43187 | 43893 | 44594 | 45291 | 45983 | 46670 | 47353 | 48031 | 48704 | 49373 | 50037 | 1 |
| | 30 | 43199 | 43905 | 44606 | 45303 | 45995 | 46682 | 47364 | 48042 | 48716 | 49384 | 50048 | 2 |
| | 45 | 43211 | 43917 | 44618 | 45314 | 46006 | 46693 | 47376 | 48054 | 48727 | 49395 | 50059 | 3 |
| 1 | 0 | 43222 | 43928 | 44629 | 45326 | 46018 | 46705 | 47387 | 48065 | 48738 | 49406 | 50070 | 4 |
| | 15 | 43234 | 43940 | 44641 | 45337 | 46029 | 46716 | 47398 | 48076 | 48749 | 49417 | 50081 | 5 |
| | 30 | 43246 | 43952 | 44653 | 45349 | 46041 | 46727 | 47410 | 48087 | 48760 | 49428 | 50092 | 6 |
| | 45 | 43258 | 43963 | 44664 | 45361 | 46052 | 46739 | 47421 | 48099 | 48771 | 49439 | 50103 | 7 |
| 2 | 0 | 43270 | 43975 | 44676 | 45372 | 46064 | 46750 | 47432 | 48110 | 48782 | 49451 | 50114 | 8 |
| | 15 | 43281 | 43987 | 44688 | 45384 | 46075 | 46762 | 47444 | 48121 | 48794 | 49462 | 50125 | 9 |
| | 30 | 43293 | 43999 | 44699 | 45395 | 46086 | 46773 | 47455 | 48132 | 48805 | 49473 | 50136 | 10 |
| | 45 | 43305 | 44010 | 44711 | 45407 | 46098 | 46785 | 47466 | 48144 | 48816 | 49484 | 50147 | 11 |
| 3 | 0 | 43317 | 44022 | 44723 | 45418 | 46109 | 46796 | 47478 | 48155 | 48827 | 49495 | 50158 | 12 |
| | 15 | 43329 | 44034 | 44734 | 45430 | 46121 | 46807 | 47489 | 48166 | 48838 | 49506 | 50169 | 13 |
| | 30 | 43340 | 44045 | 44746 | 45441 | 46132 | 46819 | 47500 | 48177 | 48849 | 49517 | 50180 | 14 |
| | 45 | 43352 | 44057 | 44757 | 45453 | 46144 | 46830 | 47512 | 48189 | 48861 | 49528 | 50191 | 15 |
| 4 | 0 | 43364 | 44069 | 44769 | 45465 | 46155 | 46842 | 47523 | 48200 | 48872 | 49539 | 50202 | 16 |
| | 15 | 43376 | 44081 | 44781 | 45476 | 46167 | 46853 | 47534 | 48211 | 48883 | 49550 | 50213 | 17 |
| | 30 | 43388 | 44092 | 44792 | 45488 | 46178 | 46864 | 47546 | 48222 | 48894 | 49561 | 50224 | 18 |
| | 45 | 43399 | 44104 | 44804 | 45499 | 46190 | 46876 | 47557 | 48233 | 48905 | 49573 | 50235 | 19 |
| 5 | 0 | 43411 | 44116 | 44816 | 45511 | 46201 | 46887 | 47568 | 48245 | 48916 | 49584 | 50246 | 20 |
| | 15 | 43423 | 44127 | 44827 | 45522 | 46213 | 46898 | 47579 | 48256 | 48928 | 49595 | 50257 | 21 |
| | 30 | 43435 | 44139 | 44839 | 45534 | 46224 | 46910 | 47591 | 48267 | 48939 | 49606 | 50268 | 22 |
| | 45 | 43446 | 44151 | 44850 | 45545 | 46236 | 46921 | 47602 | 48278 | 48950 | 49617 | 50279 | 23 |
| 6 | 0 | 43458 | 44162 | 44862 | 45557 | 46247 | 46933 | 47613 | 48290 | 48961 | 49628 | 50290 | 24 |
| | 15 | 43470 | 44174 | 44874 | 45569 | 46259 | 46944 | 47625 | 48301 | 48972 | 49639 | 50301 | 25 |
| | 30 | 43482 | 44186 | 44885 | 45580 | 46270 | 46955 | 47636 | 48312 | 48983 | 49650 | 50312 | 26 |
| | 45 | 43494 | 44198 | 44897 | 45592 | 46281 | 46967 | 47647 | 48323 | 48995 | 49661 | 50323 | 27 |
| 7 | 0 | 43505 | 44209 | 44909 | 45603 | 46293 | 46978 | 47659 | 48335 | 49006 | 49672 | 50334 | 28 |
| | 15 | 43517 | 44221 | 44920 | 45615 | 46304 | 46990 | 47670 | 48346 | 49017 | 49684 | 50345 | 29 |
| | 30 | 43529 | 44233 | 44932 | 45626 | 46316 | 47001 | 47681 | 48357 | 49028 | 49694 | 50356 | 30 |
| | 45 | 43541 | 44244 | 44943 | 55638 | 46327 | 47012 | 47693 | 48368 | 49039 | 49705 | 50367 | 31 |
| 8 | 0 | 43552 | 44256 | 44955 | 45649 | 46339 | 47024 | 47704 | 48379 | 49050 | 49716 | 50378 | 32 |
| | 15 | 43564 | 44268 | 44967 | 45661 | 46350 | 47035 | 47715 | 48391 | 49062 | 49728 | 50389 | 33 |
| | 30 | 43576 | 44279 | 44978 | 45672 | 46362 | 47046 | 47726 | 48402 | 49073 | 49739 | 50400 | 34 |
| | 45 | 43588 | 44291 | 44990 | 45684 | 46373 | 47058 | 47738 | 48413 | 49084 | 49750 | 50411 | 35 |
| 9 | 0 | 43599 | 44303 | 45001 | 45695 | 46385 | 47069 | 47749 | 48424 | 49095 | 49761 | 50422 | 36 |
| | 15 | 43611 | 44314 | 45013 | 45707 | 46396 | 47081 | 47760 | 48436 | 49106 | 49772 | 50433 | 37 |
| | 30 | 43623 | 44326 | 45025 | 45718 | 46407 | 47092 | 47772 | 48447 | 49117 | 49783 | 50444 | 38 |
| | 45 | 43635 | 44338 | 45036 | 45730 | 46419 | 47103 | 47783 | 48458 | 49128 | 49794 | 50455 | 39 |
| 10 | 0 | 43647 | 44350 | 45048 | 45741 | 46430 | 47115 | 47794 | 48469 | 49139 | 49805 | 50466 | 40 |
| | 15 | 43658 | 44361 | 45059 | 45753 | 46442 | 47126 | 47805 | 48480 | 49151 | 49816 | 50477 | 41 |
| | 30 | 43670 | 44373 | 45071 | 45765 | 46453 | 47137 | 47817 | 48492 | 49162 | 49827 | 50488 | 42 |
| | 45 | 43682 | 44385 | 45083 | 45776 | 46465 | 47149 | 47828 | 48503 | 49173 | 49838 | 50499 | 43 |
| 11 | 0 | 43694 | 44396 | 45094 | 45788 | 46476 | 47160 | 47839 | 48514 | 49184 | 49849 | 50510 | 44 |
| | 15 | 43705 | 44408 | 45106 | 45799 | 46488 | 47171 | 47851 | 48525 | 49195 | 49860 | 50521 | 45 |
| | 30 | 43717 | 44420 | 45117 | 45811 | 46499 | 47183 | 47862 | 48536 | 49206 | 49871 | 50532 | 46 |
| | 45 | 43729 | 44431 | 45129 | 45822 | 46510 | 47194 | 47874 | 48548 | 49217 | 49882 | 50543 | 47 |
| 12 | 0 | 43741 | 44443 | 45141 | 45834 | 46522 | 47206 | 47884 | 48559 | 49228 | 49893 | 50554 | 48 |
| | 15 | 43752 | 44455 | 45152 | 45845 | 46533 | 47217 | 47896 | 48570 | 49240 | 49904 | 50565 | 49 |
| | 30 | 43764 | 44466 | 45164 | 45857 | 46545 | 47228 | 47907 | 48581 | 49251 | 49916 | 50576 | 50 |
| | 45 | 43776 | 44478 | 45175 | 45868 | 46556 | 47240 | 47918 | 48592 | 49262 | 49927 | 50587 | 51 |
| 13 | 0 | 43787 | 44490 | 45187 | 45880 | 46568 | 47251 | 47930 | 48604 | 49273 | 49938 | 50598 | 52 |
| | 15 | 43799 | 44501 | 45199 | 45891 | 46579 | 47262 | 47941 | 48615 | 49284 | 49949 | 50609 | 53 |
| | 30 | 43811 | 44513 | 45210 | 45903 | 46591 | 47274 | 47952 | 48626 | 49295 | 49960 | 50620 | 54 |
| | 45 | 43823 | 44525 | 45222 | 45914 | 46602 | 47285 | 47963 | 48637 | 49306 | 49971 | 50631 | 55 |
| 14 | 0 | 43834 | 44536 | 45233 | 45926 | 46613 | 47296 | 47975 | 48648 | 49317 | 49982 | 50642 | 56 |
| | 15 | 43846 | 44548 | 45245 | 45937 | 46625 | 47308 | 47986 | 48660 | 49328 | 49993 | 50653 | 57 |
| | 30 | 43858 | 44560 | 45256 | 45949 | 46636 | 47319 | 47997 | 48671 | 49340 | 50004 | 50663 | 58 |
| | 45 | 43870 | 44571 | 45268 | 45960 | 46648 | 47330 | 48008 | 48682 | 49351 | 50015 | 50674 | 59 |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
| D. 11. | Parts | 1 | 1 | 2 | 3 | 4 | 4 | 5 | 6 | 7 | 7 | 8 | 9 | 9 | 10 | 11 |

## LOG. SINE SQUARE

| | 141° | 142° | | | | 143° | | | | 144° | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | |
| ′ ″ | 9h 27m | 9h 28m | 9h 29m | 9h 30m | 9h 31m | 9h 32m | 9h 33m | 9h 34m | 9h 35m | 9h 36m | 9h 37m | s. |
| | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | |
| 0 0 | 50685 | 51340 | 51990 | 52636 | 53277 | 53913 | 54545 | 55172 | 55795 | 56413 | 57026 | 0 |
| 15 | 50696 | 51351 | 52001 | 52647 | 53287 | 53924 | 54555 | 55182 | 55805 | 56423 | 57036 | 1 |
| 30 | 50707 | 51362 | 52012 | 52657 | 53298 | 53934 | 54566 | 55193 | 55815 | 56433 | 57046 | 2 |
| 45 | 50718 | 51373 | 52023 | 52668 | 53309 | 53945 | 54576 | 55203 | 55826 | 56443 | 57057 | 3 |
| 1 0 | 50729 | 51384 | 52034 | 52679 | 53319 | 53955 | 54587 | 55214 | 55836 | 56454 | 57067 | 4 |
| 15 | 50740 | 51395 | 52045 | 52689 | 53330 | 53966 | 54597 | 55224 | 55846 | 56464 | 57077 | 5 |
| 30 | 50751 | 51405 | 52055 | 52700 | 53341 | 53977 | 54608 | 55235 | 55857 | 56474 | 57087 | 6 |
| 45 | 50762 | 51416 | 52066 | 52711 | 53351 | 53987 | 54618 | 55245 | 55867 | 56484 | 57097 | 7 |
| 2 0 | 50773 | 51427 | 52077 | 52722 | 53362 | 53998 | 54629 | 55255 | 55877 | 56495 | 57107 | 8 |
| 15 | 50784 | 51438 | 52087 | 52732 | 53372 | 54008 | 54639 | 55266 | 55888 | 56505 | 57118 | 9 |
| 30 | 50795 | 51449 | 52098 | 52743 | 53383 | 54019 | 54650 | 55276 | 55898 | 56515 | 57128 | 10 |
| 45 | 50806 | 51460 | 52109 | 52754 | 53394 | 54029 | 54660 | 55287 | 55908 | 56525 | 57138 | 11 |
| 3 0 | 50817 | 51471 | 52120 | 52764 | 53404 | 54040 | 54671 | 55297 | 55919 | 56536 | 57148 | 12 |
| 15 | 50828 | 51481 | 52131 | 52775 | 53415 | 54050 | 54681 | 55307 | 55929 | 56546 | 57158 | 13 |
| 30 | 50838 | 51492 | 52141 | 52786 | 54425 | 54061 | 54692 | 55318 | 55939 | 56556 | 57169 | 14 |
| 45 | 50849 | 51503 | 52152 | 52796 | 53436 | 54071 | 54702 | 55328 | 55950 | 56566 | 57179 | 15 |
| 4 0 | 50860 | 51514 | 52163 | 52807 | 53447 | 54082 | 54713 | 55339 | 55960 | 56577 | 57189 | 16 |
| 15 | 50871 | 51525 | 52174 | 52818 | 53457 | 54093 | 54723 | 55349 | 55970 | 56587 | 57199 | 17 |
| 30 | 50882 | 51536 | 52184 | 52829 | 53468 | 54103 | 54734 | 55359 | 55981 | 56597 | 57209 | 18 |
| 45 | 50893 | 51547 | 52195 | 52839 | 53479 | 54114 | 54744 | 55370 | 55991 | 56607 | 57219 | 19 |
| 5 0 | 50904 | 51557 | 52206 | 52850 | 53489 | 54124 | 54754 | 55380 | 56001 | 56618 | 57229 | 20 |
| 15 | 50915 | 51568 | 52217 | 52861 | 53500 | 54135 | 54765 | 55390 | 56011 | 56628 | 57240 | 21 |
| 30 | 50926 | 51579 | 52228 | 52871 | 53511 | 54145 | 54775 | 55401 | 56022 | 56638 | 57250 | 22 |
| 45 | 50937 | 51590 | 52238 | 52882 | 53521 | 54156 | 54786 | 55411 | 56032 | 56648 | 57260 | 23 |
| 6 0 | 50948 | 51601 | 52249 | 52893 | 53532 | 54166 | 54796 | 55422 | 56042 | 56659 | 57270 | 24 |
| 15 | 50959 | 51612 | 52260 | 52903 | 53542 | 54177 | 54807 | 55432 | 56053 | 56669 | 57280 | 25 |
| 30 | 50970 | 51622 | 52271 | 52914 | 53553 | 54187 | 54817 | 55442 | 56063 | 56679 | 57290 | 26 |
| 45 | 50980 | 51633 | 52281 | 52925 | 53564 | 54198 | 54828 | 55453 | 56073 | 56689 | 57301 | 27 |
| 7 0 | 50991 | 51644 | 52292 | 52936 | 53574 | 54209 | 54838 | 55463 | 56084 | 56699 | 57311 | 28 |
| 15 | 51002 | 51655 | 52303 | 52946 | 53585 | 54219 | 54849 | 55473 | 56094 | 56710 | 57321 | 29 |
| 30 | 51013 | 51666 | 52314 | 52957 | 53596 | 54230 | 54859 | 55484 | 56104 | 56720 | 57331 | 30 |
| 45 | 51024 | 51677 | 52324 | 52968 | 53606 | 54240 | 54870 | 55494 | 56114 | 56730 | 57341 | 31 |
| 8 0 | 51035 | 51687 | 52335 | 52978 | 53617 | 54251 | 54880 | 55505 | 56125 | 56740 | 57351 | 32 |
| 15 | 51046 | 51698 | 52346 | 52989 | 53627 | 54261 | 54890 | 55515 | 56135 | 56751 | 57362 | 33 |
| 30 | 51057 | 51709 | 52357 | 53000 | 53638 | 54272 | 54901 | 55525 | 56145 | 56761 | 57372 | 34 |
| 45 | 51068 | 51720 | 52367 | 53010 | 53649 | 54282 | 54911 | 55536 | 56156 | 56771 | 57382 | 35 |
| 9 0 | 51079 | 51731 | 52378 | 53021 | 53659 | 54293 | 54922 | 55546 | 56166 | 56781 | 57392 | 36 |
| 15 | 51090 | 51742 | 52389 | 53032 | 53670 | 54303 | 54932 | 55556 | 56176 | 56791 | 57402 | 37 |
| 30 | 51101 | 51752 | 52400 | 53042 | 53680 | 54314 | 54943 | 55567 | 56187 | 56802 | 57412 | 38 |
| 45 | 51111 | 51763 | 52410 | 53053 | 53691 | 54324 | 54953 | 55577 | 56197 | 56812 | 57422 | 39 |
| 10 0 | 51122 | 51774 | 52421 | 53064 | 53702 | 54335 | 54964 | 55588 | 56207 | 56822 | 57433 | 40 |
| 15 | 51133 | 51785 | 52432 | 53074 | 53712 | 54345 | 54974 | 55598 | 56217 | 56832 | 57443 | 41 |
| 30 | 51144 | 51796 | 52443 | 53085 | 53723 | 54356 | 54984 | 55608 | 56228 | 56842 | 57453 | 42 |
| 45 | 51155 | 51806 | 52453 | 53096 | 53733 | 54366 | 54995 | 55619 | 56238 | 56853 | 57463 | 43 |
| 11 0 | 51166 | 51817 | 52464 | 53106 | 53744 | 54377 | 55005 | 55629 | 56248 | 56863 | 57473 | 44 |
| 15 | 51177 | 51828 | 52475 | 53117 | 53755 | 54387 | 55016 | 55639 | 56258 | 56873 | 57483 | 45 |
| 30 | 51188 | 51839 | 52486 | 53128 | 53765 | 54398 | 55026 | 55650 | 56269 | 56883 | 57493 | 46 |
| 45 | 51199 | 51850 | 52496 | 53138 | 53776 | 54408 | 55037 | 55660 | 56279 | 56894 | 57503 | 47 |
| 12 0 | 51210 | 51861 | 52507 | 53149 | 53786 | 54419 | 55047 | 55670 | 56289 | 56904 | 57513 | 48 |
| 15 | 51220 | 51871 | 52518 | 53160 | 53797 | 54429 | 55057 | 55681 | 56300 | 56914 | 57524 | 49 |
| 30 | 51231 | 51882 | 52529 | 53170 | 53807 | 54440 | 55068 | 55691 | 56310 | 56924 | 57534 | 50 |
| 45 | 51242 | 51893 | 52539 | 53181 | 53818 | 54450 | 55078 | 55701 | 56320 | 56934 | 57544 | 51 |
| 13 0 | 51253 | 51904 | 52550 | 53192 | 53829 | 54461 | 55089 | 55712 | 56330 | 56945 | 57554 | 52 |
| 15 | 51264 | 51915 | 52561 | 53202 | 53839 | 54471 | 55099 | 55722 | 56341 | 56955 | 57564 | 53 |
| 30 | 51275 | 51926 | 52571 | 53213 | 53850 | 54482 | 55110 | 55733 | 56351 | 56965 | 57574 | 54 |
| 45 | 51286 | 51936 | 52582 | 53224 | 53860 | 54492 | 55120 | 55743 | 56361 | 56975 | 57584 | 55 |
| 14 0 | 51297 | 51947 | 52593 | 53234 | 53871 | 54503 | 55130 | 55753 | 56371 | 56985 | 57594 | 56 |
| 15 | 51308 | 51958 | 52604 | 53245 | 53881 | 54513 | 55141 | 55764 | 56382 | 56996 | 57605 | 57 |
| 30 | 51318 | 51969 | 52614 | 53256 | 53892 | 54524 | 55151 | 55774 | 56392 | 57006 | 57615 | 58 |
| 45 | 51329 | 51980 | 52625 | 53266 | 53903 | 54534 | 55162 | 55784 | 56402 | 57016 | 57625 | 59 |

| | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 10. | Parts | 1 | 1 | 2 | 3 | 3 | 4 | 5 | 5 | 6 | 7 | 7 | 8 | 9 | 9 | 10 |

## LOG. SINE SQUARE

| ′ ″ | 144° | | 145° | | | | 146° | | | | 147° | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | |
| | 9h 38m | 9h 39m | 9h 40m | 9h 41m | 9h 42m | 9h 43m | 9h 44m | 9h 45m | 9h 46m | 9h 47m | 9h 48m | s. |
| | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | |
| 0 0 | 57635 | 58239 | 58839 | 59434 | 60025 | 60611 | 61193 | 61770 | 62342 | 62910 | 63474 | 0 |
| 15 | 57645 | 58249 | 58849 | 59444 | 60035 | 60621 | 61202 | 61779 | 62352 | 62920 | 63483 | 1 |
| 30 | 57655 | 58259 | 58859 | 59454 | 60044 | 60630 | 61212 | 61789 | 62361 | 62929 | 63493 | 2 |
| 45 | 57665 | 58269 | 58869 | 59464 | 60054 | 60640 | 61222 | 61798 | 62371 | 62939 | 63502 | 3 |
| 1 0 | 57675 | 58279 | 58879 | 59474 | 60064 | 60650 | 61231 | 61808 | 62380 | 62948 | 63511 | 4 |
| 15 | 57685 | 58289 | 58889 | 59484 | 60074 | 60660 | 61241 | 61818 | 62390 | 62957 | 63521 | 5 |
| 30 | 57696 | 58299 | 58899 | 59493 | 60084 | 60669 | 61250 | 61827 | 62399 | 62967 | 63530 | 6 |
| 45 | 57706 | 58309 | 58909 | 59503 | 60093 | 60679 | 61260 | 61837 | 62409 | 62976 | 63539 | 7 |
| 2 0 | 57716 | 58319 | 58919 | 59513 | 60103 | 60689 | 61270 | 61846 | 62418 | 62986 | 63549 | 8 |
| 15 | 57726 | 58329 | 58929 | 59523 | 60113 | 60699 | 61279 | 61856 | 62428 | 62995 | 63558 | 9 |
| 30 | 57736 | 58340 | 58938 | 59533 | 60123 | 60708 | 61289 | 61865 | 62437 | 63005 | 63567 | 10 |
| 45 | 57746 | 58350 | 58948 | 59543 | 60133 | 60718 | 61299 | 61875 | 62447 | 63014 | 63577 | 11 |
| 3 0 | 57756 | 58360 | 58958 | 59553 | 60142 | 60728 | 61308 | 61885 | 62456 | 63023 | 63586 | 12 |
| 15 | 57766 | 58370 | 58968 | 59563 | 60152 | 60737 | 61318 | 61894 | 62466 | 63033 | 63595 | 13 |
| 30 | 57776 | 58380 | 58978 | 59572 | 60162 | 60747 | 61328 | 61904 | 62475 | 63042 | 63605 | 14 |
| 45 | 57786 | 58390 | 58988 | 59582 | 60172 | 60757 | 61337 | 61913 | 62485 | 63052 | 63614 | 15 |
| 4 0 | 57797 | 58400 | 58998 | 59592 | 60182 | 60767 | 61347 | 61923 | 62494 | 63061 | 63623 | 16 |
| 15 | 57807 | 58410 | 59008 | 59602 | 60191 | 60776 | 61357 | 61932 | 62504 | 63070 | 63633 | 17 |
| 30 | 57817 | 58420 | 59018 | 59612 | 60201 | 60786 | 61366 | 61942 | 62513 | 63080 | 63642 | 18 |
| 45 | 57827 | 58430 | 59028 | 59622 | 60211 | 60796 | 61376 | 61951 | 62523 | 63089 | 63651 | 19 |
| 5 0 | 57837 | 58440 | 59038 | 59632 | 60221 | 60805 | 61385 | 61961 | 62532 | 63099 | 63661 | 20 |
| 15 | 57847 | 58450 | 59048 | 59641 | 60230 | 60815 | 61395 | 61970 | 62542 | 63108 | 63670 | 21 |
| 30 | 57857 | 58460 | 59058 | 59651 | 60240 | 60825 | 61405 | 61980 | 62551 | 63118 | 63679 | 22 |
| 45 | 57867 | 58470 | 59068 | 59661 | 60250 | 60834 | 61414 | 61990 | 62561 | 63127 | 63689 | 23 |
| 6 0 | 57877 | 58480 | 59078 | 59671 | 60260 | 60844 | 61424 | 61999 | 62570 | 63136 | 63698 | 24 |
| 15 | 57887 | 58490 | 59088 | 59681 | 60270 | 60854 | 61434 | 62009 | 62579 | 63146 | 63707 | 25 |
| 30 | 57897 | 58500 | 59097 | 59691 | 60279 | 60864 | 61443 | 62018 | 62589 | 63155 | 63717 | 26 |
| 45 | 57907 | 58510 | 59107 | 59701 | 60289 | 60873 | 61453 | 62028 | 62598 | 63165 | 63726 | 27 |
| 7 0 | 57917 | 58520 | 59117 | 59710 | 60299 | 60883 | 61462 | 62037 | 62608 | 63174 | 63735 | 28 |
| 15 | 57928 | 58530 | 59127 | 59720 | 60309 | 60893 | 61472 | 62047 | 62617 | 63183 | 63745 | 29 |
| 30 | 57938 | 58540 | 59137 | 59730 | 60318 | 60902 | 61482 | 62057 | 62627 | 63193 | 63754 | 30 |
| 45 | 57948 | 58550 | 59147 | 59740 | 60328 | 60912 | 61491 | 62066 | 62636 | 63202 | 63763 | 31 |
| 8 0 | 57958 | 58560 | 59157 | 59750 | 60338 | 60922 | 61501 | 62076 | 62646 | 63211 | 63773 | 32 |
| 15 | 57968 | 58570 | 59167 | 59760 | 60348 | 60931 | 61511 | 62085 | 62655 | 63221 | 63782 | 33 |
| 30 | 57978 | 58580 | 59177 | 59769 | 60357 | 60941 | 61520 | 62095 | 62665 | 63230 | 63791 | 34 |
| 45 | 57988 | 58590 | 59187 | 59779 | 60367 | 60951 | 61530 | 62104 | 62674 | 63240 | 63801 | 35 |
| 9 0 | 57998 | 58600 | 59197 | 59789 | 60377 | 60960 | 61539 | 62114 | 62684 | 63249 | 63810 | 36 |
| 15 | 58008 | 58610 | 59207 | 59799 | 60387 | 60970 | 61549 | 62123 | 62693 | 63258 | 63819 | 37 |
| 30 | 58018 | 58620 | 59216 | 59809 | 60396 | 60980 | 61559 | 62133 | 62703 | 63268 | 63828 | 38 |
| 45 | 58028 | 58630 | 59226 | 59819 | 60406 | 60990 | 61568 | 62142 | 62712 | 63277 | 63838 | 39 |
| 10 0 | 58038 | 58640 | 59236 | 59828 | 60416 | 60999 | 61578 | 62152 | 62721 | 63287 | 63847 | 40 |
| 15 | 58048 | 58650 | 59246 | 59838 | 60426 | 61009 | 61587 | 62161 | 62731 | 63296 | 63856 | 41 |
| 30 | 58058 | 58660 | 59256 | 59848 | 60436 | 61019 | 61597 | 62171 | 62740 | 63305 | 63866 | 42 |
| 45 | 58068 | 58670 | 59266 | 59858 | 60445 | 61028 | 61607 | 62180 | 62750 | 63315 | 63875 | 43 |
| 11 0 | 58078 | 58680 | 59276 | 59868 | 60455 | 61038 | 61616 | 62190 | 62759 | 63324 | 63884 | 44 |
| 15 | 58089 | 58690 | 59286 | 59878 | 60465 | 61048 | 61626 | 62200 | 62769 | 63333 | 63894 | 45 |
| 30 | 58099 | 58700 | 59296 | 59887 | 60475 | 61057 | 61635 | 62209 | 62778 | 63343 | 63903 | 46 |
| 45 | 58109 | 58709 | 59306 | 59897 | 60484 | 61067 | 61645 | 62219 | 62788 | 63352 | 63912 | 47 |
| 12 0 | 58119 | 58719 | 59315 | 59907 | 60494 | 61077 | 61655 | 62228 | 62797 | 63362 | 63922 | 48 |
| 15 | 58129 | 58729 | 59325 | 59917 | 60504 | 61086 | 61664 | 62238 | 62807 | 63371 | 63931 | 49 |
| 30 | 58139 | 58739 | 59335 | 59927 | 60514 | 61096 | 61674 | 62247 | 62816 | 63380 | 63940 | 50 |
| 45 | 58149 | 58749 | 59345 | 59937 | 60523 | 61106 | 61683 | 62257 | 62825 | 63390 | 63949 | 51 |
| 13 0 | 58159 | 58759 | 59355 | 59946 | 60533 | 61115 | 61693 | 62266 | 62835 | 63399 | 63959 | 52 |
| 15 | 58169 | 58769 | 59365 | 59956 | 60543 | 61125 | 61703 | 62276 | 62844 | 63408 | 63968 | 53 |
| 30 | 58179 | 58779 | 59375 | 59966 | 60553 | 61135 | 61712 | 62285 | 62854 | 634.8 | 63977 | 54 |
| 45 | 58189 | 58789 | 59385 | 59976 | 60562 | 61144 | 61722 | 62295 | 62863 | 63427 | 63987 | 55 |
| 14 0 | 58199 | 58799 | 59395 | 59986 | 60572 | 61154 | 61731 | 62304 | 62873 | 63436 | 63996 | 56 |
| 15 | 58209 | 58809 | 59405 | 59995 | 60582 | 61164 | 61741 | 62314 | 62882 | 63446 | 64005 | 57 |
| 30 | 58219 | 58819 | 59414 | 60005 | 60591 | 61173 | 61751 | 62323 | 62891 | 63455 | 64014 | 58 |
| 45 | 58229 | 58829 | 59424 | 60015 | 60601 | 61183 | 61760 | 62333 | 62901 | 63465 | 64024 | 59 |

| | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 10. | Parts | 1 | 1 | 2 | 3 | 3 | 4 | 5 | 5 | 6 | 7 | 7 | 8 | 9 | 9 | 10 |

## LOG. SINE SQUARE

| ′ | ″ | 147° 15′ 9h 49m | 147° 30′ 9h 50m | 147° 45′ 9h 51m | 148° 0′ 9h 52m | 148° 15′ 9h 53m | 148° 30′ 9h 54m | 148° 45′ 9h 55m | 149° 0′ 9h 56m | 149° 15′ 9h 57m | 149° 30′ 9h 58m | 149° 45′ 9h 59m | s. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | |
| 0 | 0 | 64033 | 64588 | 65138 | 65683 | 66224 | 66761 | 67293 | 67821 | 68344 | 68863 | 69378 | 0 |
| | 15 | 64042 | 64597 | 65147 | 65692 | 66233 | 66770 | 67302 | 67830 | 68353 | 68872 | 69386 | 1 |
| | 30 | 64052 | 64606 | 65156 | 65701 | 66242 | 66779 | 67311 | 67839 | 68362 | 68880 | 69395 | 2 |
| | 45 | 64061 | 64615 | 65165 | 65710 | 66251 | 66788 | 67320 | 67847 | 68370 | 68889 | 69403 | 3 |
| 1 | 0 | 64070 | 64624 | 65174 | 65719 | 66260 | 66707 | 67329 | 67856 | 68379 | 68898 | 69412 | 4 |
| | 15 | 64079 | 64634 | 65183 | 65729 | 66269 | 66806 | 67337 | 67865 | 68388 | 68906 | 69420 | 5 |
| | 30 | 64089 | 64643 | 65192 | 65738 | 66278 | 66814 | 67346 | 67874 | 68396 | 68915 | 69429 | 6 |
| | 45 | 64099 | 64652 | 65202 | 65747 | 66287 | 66823 | 67355 | 67882 | 68405 | 68923 | 69437 | 7 |
| 2 | 0 | 64107 | 64661 | 65211 | 65756 | 66296 | 66832 | 67364 | 67891 | 68414 | 68932 | 69446 | 8 |
| | 15 | 64116 | 64670 | 65220 | 65765 | 66305 | 66841 | 67373 | 67900 | 68423 | 68941 | 69454 | 9 |
| | 30 | 64126 | 64680 | 65229 | 65774 | 66314 | 66850 | 67382 | 67909 | 68431 | 68949 | 69463 | 10 |
| | 45 | 64135 | 64689 | 65238 | 65783 | 66323 | 66859 | 67390 | 67917 | 68440 | 68958 | 69471 | 11 |
| 3 | 0 | 64144 | 64698 | 65247 | 65792 | 66332 | 66868 | 67399 | 67926 | 68448 | 68966 | 69480 | 12 |
| | 15 | 64154 | 64707 | 65256 | 65801 | 66341 | 66877 | 67408 | 67935 | 68457 | 68975 | 69488 | 13 |
| | 30 | 64163 | 64716 | 65265 | 65810 | 66350 | 66886 | 67417 | 67943 | 68466 | 68984 | 69497 | 14 |
| | 45 | 64172 | 64726 | 65274 | 65819 | 66359 | 56895 | 67426 | 67952 | 68474 | 68992 | 69506 | 15 |
| 4 | 0 | 64181 | 64735 | 65284 | 65828 | 66368 | 66903 | 67434 | 67961 | 68483 | 69001 | 69514 | 16 |
| | 15 | 64191 | 64744 | 65293 | 65837 | 66377 | 66912 | 67443 | 67970 | 68492 | 69009 | 69523 | 17 |
| | 30 | 64200 | 64753 | 65302 | 65846 | 66386 | 66921 | 67452 | 67978 | 68500 | 69018 | 69531 | 18 |
| | 45 | 64209 | 64762 | 65311 | 65855 | 66395 | 66930 | 67461 | 67987 | 68509 | 69027 | 69540 | 19 |
| 5 | 0 | 64218 | 64771 | 65320 | 65864 | 66404 | 66939 | 67470 | 67996 | 68518 | 69035 | 69548 | 20 |
| | 15 | 64228 | 64781 | 65329 | 65873 | 66413 | 66948 | 67479 | 68005 | 68526 | 69044 | 69557 | 21 |
| | 30 | 64237 | 64790 | 65338 | 65882 | 66422 | 66957 | 67487 | 68013 | 68535 | 69052 | 69565 | 22 |
| | 45 | 64246 | 64799 | 65347 | 65891 | 66431 | 66966 | 67496 | 68022 | 68544 | 69061 | 69574 | 23 |
| 6 | 0 | 64255 | 64808 | 65356 | 65900 | 66440 | 66974 | 67505 | 68031 | 68552 | 69069 | 69582 | 24 |
| | 15 | 64265 | 64817 | 65366 | 65909 | 66449 | 66983 | 67514 | 68040 | 68561 | 69078 | 69591 | 25 |
| | 30 | 64274 | 64827 | 65375 | 65918 | 66458 | 66992 | 67523 | 68048 | 68570 | 69087 | 69599 | 26 |
| | 45 | 64283 | 64836 | 65384 | 65927 | 66466 | 67001 | 67531 | 68057 | 68578 | 69095 | 69608 | 27 |
| 7 | 0 | 64292 | 64845 | 65393 | 65936 | 66475 | 67010 | 67540 | 68066 | 68587 | 69104 | 69616 | 28 |
| | 15 | 64302 | 64854 | 65402 | 65945 | 66484 | 67019 | 67549 | 68074 | 68596 | 69112 | 69625 | 29 |
| | 30 | 64311 | 64863 | 65411 | 65954 | 66493 | 67028 | 67558 | 68083 | 68604 | 69121 | 69633 | 30 |
| | 45 | 64320 | 64873 | 65420 | 65963 | 66502 | 67037 | 67567 | 68092 | 68613 | 69129 | 69642 | 31 |
| 8 | 0 | 64329 | 64882 | 65429 | 65972 | 66511 | 67045 | 67575 | 68101 | 68622 | 69138 | 69650 | 32 |
| | 15 | 64339 | 64891 | 65438 | 65981 | 66520 | 67054 | 67584 | 68109 | 68630 | 69147 | 69659 | 33 |
| | 30 | 64348 | 64900 | 65447 | 65990 | 66529 | 67063 | 67593 | 68118 | 68639 | 69155 | 69667 | 34 |
| | 45 | 64357 | 64909 | 65456 | 65999 | 66538 | 67072 | 67602 | 68127 | 68648 | 69164 | 69676 | 35 |
| 9 | 0 | 64366 | 64918 | 65466 | 66008 | 66547 | 67081 | 67610 | 68136 | 68656 | 69172 | 69684 | 36 |
| | 15 | 64375 | 64927 | 65475 | 66018 | 66556 | 67090 | 67619 | 68144 | 68665 | 69181 | 69693 | 37 |
| | 30 | 64385 | 64936 | 65484 | 66027 | 66565 | 67099 | 67628 | 68153 | 68673 | 69189 | 69701 | 38 |
| | 45 | 64394 | 64946 | 65493 | 66035 | 66574 | 67108 | 67637 | 68162 | 68682 | 69198 | 69710 | 39 |
| 10 | 0 | 64403 | 64955 | 65502 | 66044 | 66583 | 67116 | 67646 | 68170 | 68691 | 69206 | 69718 | 40 |
| | 15 | 64413 | 64964 | 65511 | 66054 | 66592 | 67125 | 67654 | 68179 | 68699 | 69215 | 69727 | 41 |
| | 30 | 64422 | 64973 | 65520 | 66063 | 66601 | 67134 | 67663 | 68188 | 68708 | 69224 | 69735 | 42 |
| | 45 | 64431 | 64982 | 65529 | 66072 | 66609 | 67143 | 67672 | 68196 | 68717 | 69232 | 69744 | 43 |
| 11 | 0 | 64440 | 64991 | 65538 | 66081 | 66618 | 67152 | 67681 | 68205 | 68725 | 69241 | 69752 | 44 |
| | 15 | 64449 | 65001 | 65547 | 66089 | 66627 | 67161 | 67690 | 68214 | 68734 | 69249 | 69760 | 45 |
| | 30 | 64459 | 65010 | 65556 | 66098 | 66636 | 67169 | 67698 | 68223 | 68742 | 69258 | 69769 | 46 |
| | 45 | 64468 | 65019 | 65565 | 66108 | 66645 | 67178 | 67707 | 68231 | 68751 | 69266 | 69777 | 47 |
| 12 | 0 | 64477 | 65028 | 65575 | 66117 | 66654 | 67187 | 67716 | 68240 | 68760 | 69275 | 69786 | 48 |
| | 15 | 64486 | 65037 | 65584 | 66126 | 66663 | 67196 | 67725 | 68249 | 68768 | 69284 | 69794 | 49 |
| | 30 | 64495 | 65046 | 65593 | 66135 | 66672 | 67205 | 67733 | 68257 | 68777 | 69292 | 69803 | 50 |
| | 45 | 64505 | 65055 | 65602 | 66144 | 66681 | 67214 | 67742 | 68266 | 68786 | 69301 | 69811 | 51 |
| 13 | 0 | 64514 | 65065 | 65611 | 66153 | 66690 | 67223 | 67751 | 68275 | 68794 | 69309 | 69820 | 52 |
| | 15 | 64523 | 65074 | 65620 | 66162 | 66699 | 67231 | 67760 | 68283 | 68803 | 69318 | 69828 | 53 |
| | 30 | 64532 | 65083 | 65629 | 66170 | 66708 | 67240 | 67768 | 68292 | 68811 | 69326 | 69837 | 54 |
| | 45 | 64542 | 65092 | 65638 | 66179 | 66717 | 67249 | 67777 | 68301 | 68820 | 69335 | 69845 | 55 |
| 14 | 0 | 64551 | 6510· | 65647 | 66188 | 66725 | 67258 | 67786 | 68310 | 68829 | 69343 | 69854 | 56 |
| | 15 | 64560 | 65110 | 65656 | 66197 | 66734 | 67267 | 67795 | 68318 | 68837 | 69352 | 69862 | 57 |
| | 30 | 64569 | 65119 | 65665 | 66206 | 66743 | 67276 | 67803 | 68327 | 68846 | 69360 | 69871 | 58 |
| | 45 | 64578 | 65129 | 65674 | 66215 | 66752 | 67284 | 67812 | 68336 | 68855 | 69369 | 69879 | 59 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 9 | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
| | Parts | 1 | 1 | 2 | 2 | 3 | 4 | 4 | 5 | 5 | 6 | 7 | 7 | 8 | 8 | 9 |

## LOG. SINE SQUARE

| | 150° | | | | 151° | | | | 152° | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | |
| | 10h 0m | 10h 1m | 10h 2m | 10h 3m | 10h 4m | 10h 5m | 10h 6m | 10h 7m | 10h 8m | 10h 9m | 10h 10m | s. |
| ′ ″ | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | |
| 0 0 | 69888 | 70393 | 70894 | 71391 | 71883 | 72371 | 72855 | 73334 | 73808 | 74279 | 74744 | 0 |
| 15 | 69896 | 70401 | 70902 | 71399 | 71891 | 72379 | 72863 | 73342 | 73816 | 74286 | 74752 | 1 |
| 30 | 69905 | 70410 | 70911 | 71408 | 71900 | 72387 | 72871 | 73349 | 73824 | 74294 | 74760 | 2 |
| 45 | 69913 | 70418 | 70919 | 71416 | 71908 | 72395 | 72879 | 73357 | 73832 | 74302 | 74768 | 3 |
| 1 0 | 69921 | 70427 | 70927 | 71424 | 71916 | 72403 | 72887 | 73365 | 73840 | 74310 | 74775 | 4 |
| 15 | 69930 | 70435 | 70936 | 71432 | 71924 | 72411 | 72895 | 73373 | 73848 | 74318 | 74783 | 5 |
| 30 | 69938 | 70443 | 70944 | 71440 | 71932 | 72420 | 72903 | 73381 | 73855 | 74325 | 74791 | 6 |
| 45 | 69947 | 70452 | 70952 | 71449 | 71940 | 72428 | 72911 | 73389 | 73863 | 74333 | 74798 | 7 |
| 2 0 | 69955 | 70460 | 70961 | 71457 | 71949 | 72436 | 72919 | 73397 | 73871 | 74341 | 74806 | 8 |
| 15 | 69964 | 70469 | 70969 | 71465 | 71957 | 72444 | 72927 | 73405 | 73879 | 74349 | 74814 | 9 |
| 30 | 69972 | 70477 | 70977 | 71473 | 71965 | 72452 | 72935 | 73413 | 73887 | 74356 | 74822 | 10 |
| 45 | 69981 | 70485 | 70986 | 71481 | 71973 | 72460 | 72943 | 73421 | 73895 | 74364 | 74829 | 11 |
| 3 0 | 69989 | 70494 | 70994 | 71489 | 71981 | 72468 | 72951 | 73429 | 73903 | 74372 | 74837 | 12 |
| 15 | 69997 | 70502 | 71002 | 71497 | 71989 | 72476 | 72959 | 73437 | 73910 | 74380 | 74845 | 13 |
| 30 | 70006 | 70510 | 71010 | 71506 | 71997 | 72484 | 72967 | 73445 | 73918 | 74388 | 74852 | 14 |
| 45 | 70014 | 70519 | 71019 | 71514 | 72006 | 72492 | 72975 | 73453 | 73926 | 74395 | 74860 | 15 |
| 4 0 | 70023 | 70527 | 71027 | 71522 | 72014 | 72500 | 72983 | 73461 | 73934 | 74403 | 74868 | 16 |
| 15 | 70031 | 70535 | 71035 | 71531 | 72022 | 72508 | 72991 | 73468 | 73942 | 74411 | 74876 | 17 |
| 30 | 70040 | 70544 | 71044 | 71539 | 72030 | 72516 | 72999 | 73476 | 73950 | 74419 | 74883 | 18 |
| 45 | 70048 | 70552 | 71052 | 71547 | 72038 | 72525 | 73007 | 73484 | 73958 | 74426 | 74891 | 19 |
| 5 0 | 70057 | 70561 | 71060 | 71555 | 72046 | 72533 | 73015 | 73492 | 73965 | 74434 | 74899 | 20 |
| 15 | 70065 | 70569 | 71069 | 71564 | 72054 | 72541 | 73023 | 73500 | 73973 | 74442 | 74906 | 21 |
| 30 | 70073 | 70577 | 71077 | 71572 | 72063 | 72549 | 73031 | 73508 | 73981 | 74450 | 74914 | 22 |
| 45 | 70082 | 70586 | 71085 | 71580 | 72071 | 72557 | 73039 | 73516 | 73989 | 74458 | 74922 | 23 |
| 6 0 | 70090 | 70594 | 71093 | 71588 | 72079 | 72565 | 73047 | 73524 | 73997 | 74465 | 74929 | 24 |
| 15 | 70099 | 70602 | 71102 | 71597 | 72087 | 72573 | 73055 | 73532 | 74005 | 74473 | 74937 | 25 |
| 30 | 70107 | 70611 | 71110 | 71605 | 72095 | 72581 | 73063 | 73540 | 74013 | 74481 | 74945 | 26 |
| 45 | 70116 | 70619 | 71118 | 71613 | 72103 | 72589 | 73071 | 73548 | 74020 | 74489 | 74953 | 27 |
| 7 0 | 70124 | 70627 | 71126 | 71621 | 72111 | 72597 | 73079 | 73556 | 74028 | 74496 | 74960 | 28 |
| 15 | 70132 | 70636 | 71135 | 71629 | 72120 | 72605 | 73087 | 73563 | 74036 | 74504 | 74968 | 29 |
| 30 | 70141 | 70644 | 71143 | 71638 | 72128 | 72613 | 73095 | 73571 | 74044 | 74512 | 74976 | 30 |
| 45 | 70149 | 70653 | 71151 | 71646 | 72136 | 72621 | 73103 | 73579 | 74052 | 74520 | 74983 | 31 |
| 8 0 | 70158 | 70661 | 71160 | 71654 | 72144 | 72629 | 73111 | 73587 | 74060 | 74528 | 74991 | 32 |
| 15 | 70166 | 70669 | 71168 | 71662 | 72152 | 72637 | 73119 | 73595 | 74067 | 74535 | 74999 | 33 |
| 30 | 70175 | 70678 | 71176 | 71670 | 72160 | 72645 | 73127 | 73603 | 74075 | 74543 | 75006 | 34 |
| 45 | 70183 | 70686 | 71184 | 71679 | 72168 | 72654 | 73135 | 73611 | 74083 | 74551 | 75014 | 35 |
| 9 0 | 70191 | 70694 | 71193 | 71687 | 72176 | 72662 | 73142 | 73619 | 74091 | 74559 | 75022 | 36 |
| 15 | 70200 | 70703 | 71201 | 71695 | 72185 | 72670 | 73150 | 73627 | 74099 | 74566 | 75029 | 37 |
| 30 | 70208 | 70711 | 71209 | 71703 | 72193 | 72678 | 73158 | 73635 | 74107 | 74574 | 75037 | 38 |
| 45 | 70217 | 70719 | 71218 | 71711 | 72201 | 72686 | 73166 | 73643 | 74114 | 74582 | 75045 | 39 |
| 10 0 | 70225 | 70728 | 71226 | 71720 | 72209 | 72694 | 73174 | 73650 | 74122 | 74590 | 75053 | 40 |
| 15 | 70233 | 70736 | 71234 | 71728 | 72217 | 72702 | 73182 | 73658 | 74130 | 74597 | 75060 | 41 |
| 30 | 70242 | 70744 | 71242 | 71736 | 72225 | 72710 | 73190 | 73666 | 74138 | 74605 | 75068 | 42 |
| 45 | 70250 | 70753 | 71251 | 71744 | 72233 | 72718 | 73198 | 73674 | 74146 | 74613 | 75076 | 43 |
| 11 0 | 70259 | 70761 | 71259 | 71752 | 72241 | 72726 | 73206 | 73682 | 74154 | 74621 | 75083 | 44 |
| 15 | 70267 | 70769 | 71267 | 71761 | 72249 | 72734 | 73214 | 73690 | 74161 | 74628 | 75091 | 45 |
| 30 | 70276 | 70778 | 71275 | 71769 | 72258 | 72742 | 73222 | 73698 | 74169 | 74636 | 75099 | 46 |
| 45 | 70284 | 70786 | 71284 | 71777 | 72266 | 72750 | 73230 | 73706 | 74177 | 74644 | 75106 | 47 |
| 12 0 | 70292 | 70794 | 71292 | 71785 | 72274 | 72758 | 73238 | 73714 | 74185 | 74652 | 75114 | 48 |
| 15 | 70301 | 70803 | 71300 | 71793 | 72282 | 72766 | 73246 | 73721 | 74193 | 74659 | 75122 | 49 |
| 30 | 70309 | 70811 | 71308 | 71801 | 72290 | 72774 | 73254 | 73729 | 74200 | 74667 | 75129 | 50 |
| 45 | 70318 | 70819 | 71317 | 71810 | 72298 | 72782 | 73262 | 73737 | 74208 | 74675 | 75137 | 51 |
| 13 0 | 70326 | 70828 | 71325 | 71818 | 72306 | 72790 | 73270 | 73745 | 74216 | 74683 | 75145 | 52 |
| 15 | 70334 | 70836 | 71333 | 71826 | 72314 | 72798 | 73278 | 73753 | 74224 | 74690 | 75152 | 53 |
| 30 | 70343 | 70844 | 71341 | 71834 | 72322 | 72806 | 73286 | 73761 | 74232 | 74698 | 75160 | 54 |
| 45 | 70351 | 70853 | 71350 | 71842 | 72331 | 72814 | 73294 | 73769 | 74239 | 74706 | 75168 | 55 |
| 14 0 | 70360 | 70861 | 71358 | 71851 | 72339 | 72823 | 73302 | 73777 | 74247 | 74713 | 75175 | 56 |
| 15 | 70368 | 70869 | 71366 | 71859 | 72347 | 72831 | 73310 | 73785 | 74255 | 74721 | 75183 | 57 |
| 30 | 70376 | 70878 | 71374 | 71867 | 72355 | 72839 | 73318 | 73792 | 74263 | 74729 | 75191 | 58 |
| 45 | 70385 | 70886 | 71383 | 71875 | 72363 | 72847 | 73326 | 73800 | 74271 | 74737 | 75198 | 59 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
| D. S. Parts | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 | 5 | 6 | 6 | 7 | 7 | 8 |

## LOG. SINE SQUARE

| | 152° | 153° | | | | 154° | | | | 155° | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | |
| ′ ″ | 10ʰ11ᵐ | 10ʰ12ᵐ | 10ʰ13ᵐ | 10ʰ14ᵐ | 10ʰ15ᵐ | 10ʰ16ᵐ | 10ʰ17ᵐ | 10ʰ18ᵐ | 10ʰ19ᵐ | 10ʰ20ᵐ | 10ʰ21ᵐ | s. |
| | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | |
| 0 0 | 75206 | 75663 | 76116 | 76564 | 77008 | 77448 | 77883 | 78314 | 78741 | 79163 | 79581 | 0 |
| 15 | 75214 | 75671 | 76123 | 76572 | 77016 | 77455 | 77890 | 78321 | 78748 | 79170 | 79588 | 1 |
| 30 | 75221 | 75678 | 76131 | 76579 | 77023 | 77462 | 77898 | 78328 | 78755 | 79177 | 79595 | 2 |
| 45 | 75229 | 75686 | 76138 | 76586 | 77030 | 77470 | 77905 | 78336 | 78762 | 79184 | 79602 | 3 |
| 1 0 | 75237 | 75693 | 76146 | 76594 | 77038 | 77477 | 77912 | 78343 | 78769 | 79191 | 79609 | 4 |
| 15 | 75244 | 75701 | 76153 | 76601 | 77045 | 77484 | 77919 | 78350 | 78776 | 79198 | 79616 | 5 |
| 30 | 75252 | 75708 | 76161 | 76609 | 77052 | 77492 | 77926 | 78357 | 78783 | 79205 | 79622 | 6 |
| 45 | 75259 | 75716 | 76168 | 76616 | 77060 | 77499 | 77934 | 78364 | 78790 | 79212 | 79629 | 7 |
| 2 0 | 75267 | 75724 | 76176 | 76624 | 77067 | 77506 | 77941 | 78371 | 78797 | 79219 | 79636 | 8 |
| 15 | 75275 | 75731 | 76183 | 76631 | 77074 | 77513 | 77948 | 78378 | 78804 | 79226 | 79643 | 9 |
| 30 | 75282 | 75739 | 76191 | 76638 | 77082 | 77521 | 77955 | 78386 | 78811 | 79233 | 79650 | 10 |
| 45 | 75290 | 75746 | 76198 | 76646 | 77089 | 77528 | 77963 | 78393 | 78819 | 79240 | 79657 | 11 |
| 3 0 | 75298 | 75754 | 76206 | 76653 | 77096 | 77535 | 77970 | 78400 | 78826 | 79247 | 79664 | 12 |
| 15 | 75305 | 75761 | 76213 | 76661 | 77104 | 77543 | 77977 | 78407 | 78833 | 79254 | 79671 | 13 |
| 30 | 75313 | 75769 | 76221 | 76668 | 77111 | 77550 | 77984 | 78414 | 78840 | 79261 | 79678 | 14 |
| 45 | 75321 | 75777 | 76228 | 76676 | 77118 | 77557 | 77991 | 78421 | 78847 | 79268 | 79685 | 15 |
| 4 0 | 75328 | 75784 | 76236 | 76683 | 77126 | 77564 | 77999 | 78428 | 78854 | 79275 | 79692 | 16 |
| 15 | 75336 | 75792 | 76243 | 76690 | 77133 | 77572 | 78006 | 78436 | 78861 | 79282 | 79699 | 17 |
| 30 | 75343 | 75799 | 76251 | 76698 | 77141 | 77579 | 78013 | 78443 | 78868 | 79289 | 79705 | 18 |
| 45 | 75351 | 75807 | 76258 | 76705 | 77148 | 77586 | 78020 | 78450 | 78875 | 79296 | 79712 | 19 |
| 5 0 | 75359 | 75814 | 76266 | 76713 | 77155 | 77593 | 78027 | 78457 | 78882 | 79303 | 79719 | 20 |
| 15 | 75366 | 75822 | 76273 | 76720 | 77163 | 77601 | 78034 | 78464 | 78889 | 79310 | 79726 | 21 |
| 30 | 75374 | 75830 | 76281 | 76727 | 77170 | 77608 | 78042 | 78471 | 78896 | 79317 | 79733 | 22 |
| 45 | 75382 | 75837 | 76288 | 76735 | 77177 | 77615 | 78049 | 78478 | 78903 | 79324 | 79740 | 23 |
| 6 0 | 75389 | 75845 | 76296 | 76742 | 77185 | 77622 | 78056 | 78485 | 78910 | 79331 | 79747 | 24 |
| 15 | 75397 | 75852 | 76303 | 76750 | 77192 | 77630 | 78063 | 78492 | 78917 | 79338 | 79754 | 25 |
| 30 | 75405 | 75860 | 76311 | 76757 | 77199 | 77637 | 78070 | 78500 | 78924 | 79345 | 79761 | 26 |
| 45 | 75412 | 75867 | 76318 | 76765 | 77207 | 77644 | 78078 | 78507 | 78931 | 79352 | 79768 | 27 |
| 7 0 | 75420 | 75875 | 76326 | 76772 | 77214 | 77652 | 78085 | 78514 | 78938 | 79359 | 79775 | 28 |
| 15 | 75427 | 75882 | 76333 | 76779 | 77221 | 77659 | 78092 | 78521 | 78945 | 79366 | 79781 | 29 |
| 30 | 75435 | 75890 | 76341 | 76787 | 77229 | 77666 | 78099 | 78528 | 78952 | 79373 | 79788 | 30 |
| 45 | 75443 | 75897 | 76348 | 76794 | 77236 | 77673 | 78106 | 78535 | 78959 | 79379 | 79795 | 31 |
| 8 0 | 75450 | 75905 | 76355 | 76802 | 77243 | 77681 | 78114 | 78542 | 78967 | 79386 | 79802 | 32 |
| 15 | 75458 | 75912 | 76363 | 76809 | 77251 | 77688 | 78121 | 78549 | 78974 | 79393 | 79809 | 33 |
| 30 | 75465 | 75920 | 76370 | 76816 | 77258 | 77695 | 78128 | 78556 | 78981 | 79400 | 79816 | 34 |
| 45 | 75473 | 75928 | 76378 | 76824 | 77265 | 77702 | 78135 | 78563 | 78988 | 79407 | 79823 | 35 |
| 9 0 | 75481 | 75935 | 76385 | 76831 | 77272 | 77710 | 78142 | 78571 | 78995 | 79414 | 79830 | 36 |
| 15 | 75488 | 75943 | 76393 | 76839 | 77280 | 77717 | 78149 | 78578 | 79002 | 79421 | 79836 | 37 |
| 30 | 75496 | 75950 | 76400 | 76846 | 77287 | 77724 | 78157 | 78585 | 79009 | 79428 | 79843 | 38 |
| 45 | 75504 | 75958 | 76408 | 76853 | 77294 | 77731 | 78164 | 78592 | 79016 | 79435 | 79850 | 39 |
| 10 0 | 75511 | 75965 | 76415 | 76861 | 77302 | 77739 | 78171 | 78599 | 79023 | 79442 | 79857 | 40 |
| 15 | 75519 | 75973 | 76423 | 76868 | 77309 | 77746 | 78178 | 78606 | 79030 | 79449 | 79864 | 41 |
| 30 | 75526 | 75980 | 76430 | 76875 | 77316 | 77753 | 78185 | 78613 | 79037 | 79456 | 79871 | 42 |
| 45 | 75534 | 75988 | 76438 | 76883 | 77324 | 77760 | 78192 | 78620 | 79044 | 79463 | 79878 | 43 |
| 11 0 | 75542 | 75995 | 76445 | 76890 | 77331 | 77768 | 78200 | 78627 | 79051 | 79470 | 79885 | 44 |
| 15 | 75549 | 76003 | 76452 | 76898 | 77338 | 77775 | 78207 | 78634 | 79058 | 79477 | 79892 | 45 |
| 30 | 75557 | 76011 | 76460 | 76905 | 77346 | 77782 | 78214 | 78643 | 79065 | 79484 | 79898 | 46 |
| 45 | 75564 | 76018 | 76467 | 76912 | 77353 | 77789 | 78221 | 78649 | 79072 | 79491 | 79905 | 47 |
| 12 0 | 75572 | 76026 | 76475 | 76920 | 77360 | 77796 | 78228 | 78656 | 79079 | 79498 | 79912 | 48 |
| 15 | 75580 | 76033 | 76482 | 76927 | 77367 | 77804 | 78235 | 78663 | 79086 | 79505 | 79919 | 49 |
| 30 | 75587 | 76041 | 76490 | 76934 | 77375 | 77811 | 78243 | 78670 | 79093 | 79512 | 79926 | 50 |
| 45 | 75595 | 76048 | 76497 | 76942 | 77382 | 77818 | 78250 | 78677 | 79100 | 79519 | 79933 | 51 |
| 13 0 | 75602 | 76056 | 76505 | 76949 | 77389 | 77825 | 78257 | 78684 | 79107 | 79525 | 79940 | 52 |
| 15 | 75610 | 76063 | 76512 | 76957 | 77397 | 77833 | 78264 | 78691 | 79114 | 79532 | 79946 | 53 |
| 30 | 75618 | 76071 | 76520 | 76964 | 77404 | 77840 | 78271 | 78698 | 79121 | 79539 | 79953 | 54 |
| 45 | 75625 | 76078 | 76527 | 76971 | 77411 | 77847 | 78278 | 78705 | 79128 | 79546 | 79960 | 55 |
| 14 0 | 75633 | 76086 | 76534 | 76979 | 77419 | 77854 | 78286 | 78712 | 79135 | 79553 | 79967 | 56 |
| 15 | 75640 | 76093 | 76542 | 76986 | 77426 | 77861 | 78293 | 78719 | 79142 | 79560 | 79974 | 57 |
| 30 | 75648 | 76101 | 76549 | 76993 | 77433 | 77869 | 78300 | 78727 | 79149 | 79567 | 79981 | 58 |
| 45 | 75655 | 76108 | 76557 | 77001 | 77440 | 77876 | 78307 | 78734 | 79156 | 79574 | 79988 | 59 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sec. | 1′ | 2′ | 3′ | 4′ | 5′ | 6′ | 7′ | 8′ | 9′ | 10′ | 11′ | 12′ | 13′ | 14′ | 15′ |
| D. 7. Parts | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 | 5 | 6 | 6 | 7 | 7 |

## LOG. SINE SQUARE

| m | s | 155° 30′ 10ʰ22ᵐ | 155° 45′ 10ʰ23ᵐ | 156° 0′ 10ʰ24ᵐ | 156° 15′ 10ʰ25ᵐ | 156° 30′ 10ʰ26ᵐ | 156° 45′ 10ʰ27ᵐ | 157° 0′ 10ʰ28ᵐ | 157° 15′ 10ʰ29ᵐ | 157° 30′ 10ʰ30ᵐ | 157° 45′ 10ʰ31ᵐ | 158° 0′ 10ʰ32ᵐ | s |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ′ | ″ | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | |
| 0 | 0 | 79995 | 80404 | 80809 | 81209 | 81606 | 81998 | 82385 | 82769 | 83148 | 83523 | 83893 | 0 |
| | 15 | 80001 | 80411 | 80816 | 81216 | 81612 | 82004 | 82392 | 82775 | 83154 | 83529 | 83899 | 1 |
| | 30 | 80008 | 80417 | 80822 | 81223 | 81619 | 82011 | 82398 | 82782 | 83160 | 83535 | 83905 | 2 |
| | 45 | 80015 | 80424 | 80829 | 81229 | 81625 | 82017 | 82405 | 82788 | 83167 | 83541 | 83912 | 3 |
| 1 | 0 | 80022 | 80431 | 80836 | 81236 | 81632 | 82024 | 82411 | 82794 | 83173 | 83547 | 83918 | 4 |
| | 15 | 80029 | 80438 | 80842 | 81243 | 81639 | 82030 | 82417 | 82801 | 83179 | 83554 | 83924 | 5 |
| | 30 | 80036 | 80444 | 80849 | 81249 | 81645 | 82037 | 82424 | 82807 | 83186 | 83560 | 83930 | 6 |
| | 45 | 80043 | 80451 | 80856 | 81256 | 81652 | 82043 | 82430 | 82813 | 83192 | 83566 | 83936 | 7 |
| 2 | 0 | 80049 | 80458 | 80862 | 81262 | 81658 | 82050 | 82437 | 82820 | 83198 | 83572 | 83942 | 8 |
| | 15 | 80056 | 80465 | 80869 | 81269 | 81665 | 82056 | 82443 | 82826 | 83204 | 83579 | 83948 | 9 |
| | 30 | 80063 | 80472 | 80876 | 81276 | 81671 | 82063 | 82450 | 82832 | 83211 | 83585 | 83954 | 10 |
| | 45 | 80070 | 80478 | 80883 | 81282 | 81678 | 82069 | 82456 | 82839 | 83217 | 83591 | 83961 | 11 |
| 3 | 0 | 80077 | 80485 | 80889 | 81289 | 81684 | 82076 | 82462 | 82845 | 83223 | 83597 | 83967 | 12 |
| | 15 | 80084 | 80492 | 80896 | 81296 | 81691 | 82082 | 82469 | 82851 | 83229 | 83603 | 83973 | 13 |
| | 30 | 80090 | 80499 | 80903 | 81302 | 81698 | 82089 | 82475 | 82857 | 83236 | 83610 | 83979 | 14 |
| | 45 | 80097 | 80505 | 80909 | 81309 | 81704 | 82095 | 82482 | 82864 | 83242 | 83616 | 83985 | 15 |
| 4 | 0 | 80104 | 80512 | 80916 | 81315 | 81711 | 82102 | 82488 | 82870 | 83248 | 83622 | 83991 | 16 |
| | 15 | 80111 | 80519 | 80923 | 81322 | 81717 | 82108 | 82494 | 82877 | 83254 | 83628 | 83997 | 17 |
| | 30 | 80118 | 80526 | 80929 | 81329 | 81724 | 82114 | 82501 | 82883 | 83261 | 83634 | 84003 | 18 |
| | 45 | 80125 | 80533 | 80936 | 81335 | 81730 | 82121 | 82507 | 82889 | 83267 | 83640 | 84010 | 19 |
| 5 | 0 | 80131 | 80539 | 80943 | 81342 | 81737 | 82127 | 82514 | 82896 | 83273 | 83647 | 84016 | 20 |
| | 15 | 80138 | 80546 | 80949 | 81348 | 81743 | 82134 | 82520 | 82902 | 83280 | 83653 | 84022 | 21 |
| | 30 | 80145 | 80553 | 80956 | 81355 | 81750 | 82140 | 82526 | 82908 | 83286 | 83659 | 84028 | 22 |
| | 45 | 80152 | 80560 | 80963 | 81362 | 81756 | 82147 | 82533 | 82915 | 83292 | 83665 | 84034 | 23 |
| 6 | 0 | 80159 | 80566 | 80970 | 81368 | 81763 | 82153 | 82539 | 82921 | 83298 | 83671 | 84040 | 24 |
| | 15 | 80166 | 80573 | 80976 | 81375 | 81770 | 82160 | 82546 | 82927 | 83305 | 83678 | 84046 | 25 |
| | 30 | 80172 | 80580 | 80983 | 81382 | 81776 | 82166 | 82552 | 82934 | 83311 | 83684 | 84052 | 26 |
| | 45 | 80179 | 80587 | 80990 | 81388 | 81783 | 82173 | 82558 | 82940 | 83317 | 83690 | 84058 | 27 |
| 7 | 0 | 80186 | 80593 | 80996 | 81395 | 81789 | 82179 | 82565 | 82946 | 83323 | 83696 | 84065 | 28 |
| | 15 | 80193 | 80600 | 81003 | 81401 | 81796 | 82186 | 82571 | 82953 | 83330 | 83702 | 84071 | 29 |
| | 30 | 80200 | 80607 | 81010 | 81408 | 81802 | 82192 | 82578 | 82959 | 83336 | 83708 | 84077 | 30 |
| | 45 | 80207 | 80614 | 81016 | 81415 | 81809 | 82199 | 82584 | 82965 | 83342 | 83715 | 84083 | 31 |
| 8 | 0 | 80213 | 80620 | 81023 | 81421 | 81815 | 82205 | 82590 | 82972 | 83348 | 83721 | 84089 | 32 |
| | 15 | 80220 | 80627 | 81030 | 81428 | 81822 | 82211 | 82597 | 82978 | 83355 | 83727 | 84095 | 33 |
| | 30 | 80227 | 80634 | 81036 | 81435 | 81828 | 82218 | 82603 | 82984 | 83361 | 83733 | 84101 | 34 |
| | 45 | 80234 | 80641 | 81043 | 81441 | 81835 | 82224 | 82610 | 82990 | 83367 | 83739 | 84107 | 35 |
| 9 | 0 | 80241 | 80647 | 81050 | 81448 | 81841 | 82231 | 82616 | 82997 | 83373 | 83745 | 84113 | 36 |
| | 15 | 80247 | 80654 | 81056 | 81454 | 81848 | 82237 | 82622 | 83003 | 83379 | 83752 | 84119 | 37 |
| | 30 | 80254 | 80661 | 81063 | 81461 | 81854 | 82244 | 8262[illegible] | 83009 | 83386 | 83758 | 84126 | 38 |
| | 45 | 80261 | 80668 | 81070 | 81468 | 81861 | 82250 | 82635 | 83016 | 83392 | 83764 | 84132 | 39 |
| 10 | 0 | 80268 | 80674 | 81076 | 81474 | 81867 | 82257 | 82641 | 83022 | 83398 | 83770 | 84138 | 40 |
| | 15 | 80275 | 80681 | 81083 | 81481 | 81874 | 82263 | 82648 | 83028 | 83404 | 83776 | 84144 | 41 |
| | 30 | 80282 | 80688 | 81090 | 81487 | 81881 | 82270 | 82654 | 83035 | 83411 | 83782 | 84150 | 42 |
| | 45 | 80288 | 80694 | 81096 | 81494 | 81887 | 82276 | 82661 | 83041 | 83417 | 83789 | 84156 | 43 |
| 11 | 0 | 80295 | 80701 | 81103 | 81501 | 81894 | 82282 | 82667 | 83047 | 83423 | 83795 | 84162 | 44 |
| | 15 | 80302 | 80708 | 81110 | 81507 | 81900 | 82289 | 82673 | 83054 | 83429 | 83801 | 84168 | 45 |
| | 30 | 80309 | 80715 | 81116 | 81514 | 81907 | 82295 | 82680 | 83060 | 83436 | 83807 | 84174 | 46 |
| | 45 | 80316 | 80721 | 81123 | 81520 | 81913 | 82302 | 82686 | 83066 | 83442 | 83813 | 84180 | 47 |
| 12 | 0 | 80322 | 80728 | 81130 | 81527 | 81920 | 82308 | 82692 | 83072 | 83448 | 83819 | 84186 | 48 |
| | 15 | 80329 | 80735 | 81136 | 81533 | 81926 | 82315 | 82699 | 83079 | 83454 | 83826 | 84193 | 49 |
| | 30 | 80336 | 80742 | 81143 | 81540 | 81933 | 82321 | 82705 | 83085 | 83460 | 83832 | 84199 | 50 |
| | 45 | 80343 | 80748 | 81150 | 81547 | 81939 | 82328 | 82712 | 83091 | 83467 | 83838 | 84205 | 51 |
| 13 | 0 | 80349 | 80755 | 81156 | 81553 | 81946 | 82334 | 82718 | 83098 | 83473 | 83844 | 84211 | 52 |
| | 15 | 80356 | 80762 | 81163 | 81560 | 81952 | 82340 | 82724 | 83104 | 83479 | 83850 | 84217 | 53 |
| | 30 | 80363 | 80768 | 81169 | 81566 | 81959 | 82347 | 82731 | 83110 | 83485 | 83856 | 84223 | 54 |
| | 45 | 80370 | 80775 | 81176 | 81573 | 81965 | 82353 | 82737 | 83116 | 83492 | 83862 | 84229 | 55 |
| 14 | 0 | 80377 | 80782 | 81183 | 81580 | 81972 | 82360 | 82743 | 83123 | 83498 | 83869 | 84235 | 56 |
| | 15 | 80383 | 80789 | 81189 | 81586 | 81978 | 82366 | 82750 | 83129 | 83504 | 83875 | 84241 | 57 |
| | 30 | 80390 | 80795 | 81196 | 81593 | 81985 | 82373 | 82756 | 83135 | 83510 | 83881 | 84247 | 58 |
| | 45 | 80397 | 80802 | 81203 | 81599 | 81991 | 82379 | 82762 | 83142 | 83516 | 83887 | 84253 | 59 |

| | Sec. | 1′ | 2′ | 3′ | 4′ | 5′ | 6′ | 7′ | 8′ | 9′ | 10′ | 11′ | 12′ | 13′ | 14′ | 15′ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 7. | Parts | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 | 5 | 6 | 6 | 7 | 7 |

## LOG. SINE SQUARE

| ′ | ″ | 158° 15′ 10ʰ33ᵐ | 158° 30′ 10ʰ34ᵐ | 158° 45′ 10ʰ35ᵐ | 159° 0′ 10ʰ36ᵐ | 159° 15′ 10ʰ37ᵐ | 159° 30′ 10ʰ38ᵐ | 159° 45′ 10ʰ39ᵐ | 160° 0′ 10ʰ40ᵐ | 160° 15′ 10ʰ41ᵐ | 160° 30′ 10ʰ42ᵐ | 160° 45′ 10ʰ43ᵐ | s. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | |
| 0 | 0 | 84259 | 84621 | 84979 | 85332 | 85681 | 86026 | 86367 | 86703 | 87035 | 87363 | 87686 | 0 |
| | 15 | 84265 | 84627 | 84985 | 85338 | 85687 | 86032 | 86372 | 86709 | 87040 | 87368 | 87692 | 1 |
| | 30 | 84271 | 84633 | 84991 | 85344 | 85693 | 86038 | 86378 | 86714 | 87046 | 87373 | 87697 | 2 |
| | 45 | 84278 | 84639 | 84997 | 85350 | 85699 | 86043 | 86384 | 86720 | 87051 | 87379 | 87702 | 3 |
| 1 | 0 | 84284 | 84645 | 85003 | 85356 | 85704 | 86049 | 86389 | 86725 | 87057 | 87384 | 87708 | 4 |
| | 15 | 84290 | 84651 | 85008 | 85361 | 85710 | 86055 | 86395 | 86731 | 87062 | 87390 | 87713 | 5 |
| | 30 | 84296 | 84657 | 85014 | 85367 | 85716 | 86060 | 86400 | 86736 | 87068 | 87395 | 87718 | 6 |
| | 45 | 84302 | 84663 | 85020 | 85373 | 85722 | 86066 | 86406 | 86742 | 87073 | 87401 | 87724 | 7 |
| 2 | 0 | 84308 | 84669 | 85026 | 85379 | 85728 | 86072 | 86412 | 86747 | 87079 | 87406 | 87729 | 8 |
| | 15 | 84314 | 84675 | 85032 | 85385 | 85733 | 86077 | 86417 | 86753 | 87084 | 87411 | 87734 | 9 |
| | 30 | 84320 | 84681 | 85038 | 85391 | 85739 | 86083 | 86423 | 86758 | 87090 | 87417 | 87740 | 10 |
| | 45 | 84326 | 84687 | 85044 | 85397 | 85745 | 86089 | 86429 | 86764 | 87095 | 87422 | 87745 | 11 |
| 3 | 0 | 84332 | 84693 | 85050 | 85402 | 85751 | 86095 | 86434 | 86770 | 87101 | 87428 | 87750 | 12 |
| | 15 | 84338 | 84699 | 85056 | 85408 | 85756 | 86100 | 86440 | 86775 | 87106 | 87433 | 87756 | 13 |
| | 30 | 84344 | 84705 | 85062 | 85414 | 85762 | 86106 | 86445 | 86781 | 87112 | 87439 | 87761 | 14 |
| | 45 | 84350 | 84711 | 85068 | 85420 | 85768 | 86112 | 86451 | 86786 | 87117 | 87444 | 87766 | 15 |
| 4 | 0 | 84356 | 84717 | 85074 | 85426 | 85774 | 86117 | 86457 | 86792 | 87123 | 87449 | 87772 | 16 |
| | 15 | 84362 | 84723 | 85080 | 85432 | 85779 | 86123 | 86462 | 86797 | 87128 | 87455 | 87777 | 17 |
| | 30 | 84368 | 84729 | 85085 | 85437 | 85785 | 86129 | 86468 | 86803 | 87134 | 87460 | 87782 | 18 |
| | 45 | 84374 | 84735 | 85091 | 85443 | 85791 | 86134 | 86474 | 86808 | 87139 | 87466 | 87788 | 19 |
| 5 | 0 | 84380 | 84741 | 85097 | 85449 | 85797 | 86140 | 86479 | 86814 | 87145 | 87471 | 87793 | 20 |
| | 15 | 84387 | 84747 | 85103 | 85455 | 85802 | 86146 | 86485 | 86820 | 87150 | 87476 | 87798 | 21 |
| | 30 | 84393 | 84753 | 85109 | 85461 | 85808 | 86151 | 86490 | 86825 | 87156 | 87482 | 87804 | 22 |
| | 45 | 84399 | 84759 | 85115 | 85467 | 85814 | 86157 | 86496 | 86831 | 87161 | 87487 | 87809 | 23 |
| 6 | 0 | 84405 | 84765 | 85121 | 85472 | 85820 | 86163 | 86502 | 86836 | 87167 | 87493 | 87814 | 24 |
| | 15 | 84411 | 84771 | 85127 | 85478 | 85826 | 86168 | 86507 | 86842 | 87172 | 87498 | 87820 | 25 |
| | 30 | 84417 | 84777 | 85133 | 85484 | 85831 | 86174 | 86513 | 86847 | 87177 | 87503 | 87825 | 26 |
| | 45 | 84423 | 84783 | 85138 | 85490 | 85837 | 86180 | 86519 | 86853 | 87183 | 87509 | 87830 | 27 |
| 7 | 0 | 84429 | 84789 | 85144 | 85496 | 85843 | 86186 | 86524 | 86858 | 87188 | 87514 | 87836 | 28 |
| | 15 | 84435 | 84795 | 85150 | 85502 | 85848 | 86191 | 86530 | 86864 | 87194 | 87520 | 87841 | 29 |
| | 30 | 84441 | 84801 | 85156 | 85507 | 85854 | 86197 | 86535 | 86869 | 87199 | 87525 | 87846 | 30 |
| | 45 | 84447 | 84807 | 85162 | 85513 | 85860 | 86203 | 86541 | 86875 | 87205 | 87530 | 87852 | 31 |
| 8 | 0 | 84453 | 84813 | 85168 | 85519 | 85866 | 86208 | 86546 | 86881 | 87210 | 87536 | 87857 | 32 |
| | 15 | 84459 | 84818 | 85174 | 85525 | 85872 | 86214 | 86552 | 86886 | 87216 | 87541 | 87862 | 33 |
| | 30 | 84465 | 84824 | 85180 | 85531 | 85877 | 86220 | 86558 | 86892 | 87221 | 87547 | 87867 | 34 |
| | 45 | 84471 | 84830 | 85186 | 85536 | 85883 | 86225 | 86563 | 86897 | 87227 | 87552 | 87873 | 35 |
| 9 | 0 | 84477 | 84836 | 85191 | 85542 | 85889 | 86231 | 86569 | 86903 | 87232 | 87557 | 87878 | 36 |
| | 15 | 84483 | 84842 | 85197 | 85548 | 85894 | 86237 | 86574 | 86908 | 87237 | 87563 | 87883 | 37 |
| | 30 | 84489 | 84848 | 85203 | 85554 | 85900 | 86242 | 86580 | 86914 | 87243 | 87568 | 87889 | 38 |
| | 45 | 84495 | 84854 | 85209 | 85560 | 85906 | 86248 | 86586 | 86919 | 87248 | 87573 | 87894 | 39 |
| 10 | 0 | 84501 | 84860 | 85215 | 85565 | 85912 | 86254 | 86591 | 86925 | 87254 | 87579 | 87899 | 40 |
| | 15 | 84507 | 84866 | 85221 | 85571 | 85917 | 86259 | 86597 | 86930 | 87259 | 87584 | 87905 | 41 |
| | 30 | 84513 | 84872 | 85227 | 85577 | 85923 | 86265 | 86602 | 86936 | 87265 | 87590 | 87910 | 42 |
| | 45 | 84519 | 84878 | 85233 | 85583 | 85929 | 86271 | 86608 | 86941 | 87270 | 87595 | 87915 | 43 |
| 11 | 0 | 84525 | 84884 | 85238 | 85589 | 85935 | 86276 | 86614 | 86947 | 87276 | 87600 | 87921 | 44 |
| | 15 | 84531 | 84890 | 85244 | 85594 | 85940 | 86282 | 86619 | 86952 | 87281 | 87606 | 87926 | 45 |
| | 30 | 84537 | 84896 | 85250 | 85600 | 85946 | 86288 | 86625 | 86958 | 87286 | 87611 | 87931 | 46 |
| | 45 | 84543 | 84902 | 85256 | 85606 | 85952 | 86293 | 86630 | 86963 | 87292 | 87616 | 87937 | 47 |
| 12 | 0 | 84549 | 84908 | 85262 | 85612 | 85958 | 86299 | 86636 | 86969 | 87297 | 87622 | 87942 | 48 |
| | 15 | 84555 | 84914 | 85268 | 85618 | 85963 | 86305 | 86642 | 86974 | 87303 | 87627 | 87947 | 49 |
| | 30 | 84561 | 84920 | 85274 | 85623 | 85969 | 86310 | 86647 | 86980 | 87308 | 87633 | 87952 | 50 |
| | 45 | 84567 | 84926 | 85280 | 85629 | 85975 | 86316 | 86653 | 86985 | 87314 | 87638 | 87958 | 51 |
| 13 | 0 | 84573 | 84931 | 85285 | 85635 | 85980 | 86321 | 86658 | 86991 | 87319 | 87643 | 87963 | 52 |
| | 15 | 84579 | 84937 | 85291 | 85641 | 85986 | 86327 | 86664 | 86996 | 87325 | 87649 | 87968 | 53 |
| | 30 | 84585 | 84943 | 85297 | 85647 | 85992 | 86333 | 86669 | 87002 | 87330 | 87654 | 87974 | 54 |
| | 45 | 84591 | 84949 | 85303 | 85652 | 85998 | 86338 | 86675 | 87007 | 87335 | 87659 | 87979 | 55 |
| 14 | 0 | 84597 | 84955 | 85309 | 85658 | 86003 | 86344 | 86681 | 87013 | 87341 | 87665 | 87984 | 56 |
| | 15 | 84603 | 84961 | 85315 | 85664 | 86009 | 86350 | 86686 | 87018 | 87346 | 87670 | 87990 | 57 |
| | 30 | 84609 | 84967 | 85321 | 85670 | 86015 | 86355 | 86692 | 87024 | 87352 | 87675 | 87995 | 58 |
| | 45 | 84615 | 84973 | 85326 | 85676 | 86020 | 86361 | 86697 | 87029 | 87357 | 87681 | 88000 | 59 |

| Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 6. Parts | 0 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 4 | 4 | 4 | 5 | 5 | 6 | 6 |

## LOG. SINE SQUARE

| ′ | ″ | 161° 0′ 10h44m | 161° 15′ 10h45m | 161° 30′ 10h46m | 161° 45′ 10h47m | 162° 0′ 10h48m | 162° 15′ 10h49m | 162° 30′ 10h50m | 162° 45′ 10h51m | 163° 0′ 10h52m | 163° 15′ 10h53m | 163° 30′ 10h54m | s. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | |
| 0 | 0 | 88005 | 88320 | 88631 | 88938 | 89240 | 89538 | 89832 | 90121 | 90407 | 90688 | 90964 | 0 |
| | 15 | 88011 | 88326 | 88636 | 88943 | 89245 | 89543 | 89836 | 90126 | 90411 | 90692 | 90969 | 1 |
| | 30 | 88016 | 88331 | 88641 | 88948 | 89250 | 89548 | 89841 | 90131 | 90416 | 90697 | 90974 | 2 |
| | 45 | 88021 | 88336 | 88647 | 88953 | 89255 | 89553 | 89846 | 90136 | 90421 | 90702 | 90978 | 3 |
| 1 | 0 | 88026 | 88341 | 88652 | 88958 | 89260 | 89558 | 89851 | 90140 | 90425 | 90706 | 90983 | 4 |
| | 15 | 88032 | 88346 | 88657 | 88963 | 89265 | 89562 | 89856 | 90145 | 90430 | 90711 | 90987 | 5 |
| | 30 | 88037 | 88352 | 88662 | 88968 | 89270 | 89567 | 89861 | 90150 | 90435 | 90715 | 90992 | 6 |
| | 45 | 88042 | 88357 | 88667 | 88973 | 89275 | 89572 | 89866 | 90155 | 90439 | 90720 | 90996 | 7 |
| 2 | 0 | 88048 | 88362 | 88672 | 88978 | 89280 | 89577 | 89870 | 90159 | 90444 | 90725 | 91001 | 8 |
| | 15 | 88053 | 88367 | 88677 | 88983 | 89285 | 89582 | 89875 | 90164 | 90449 | 90729 | 91006 | 9 |
| | 30 | 88058 | 88372 | 88682 | 88988 | 89290 | 89587 | 89880 | 90169 | 90454 | 90734 | 91010 | 10 |
| | 45 | 88063 | 88378 | 88688 | 88993 | 89295 | 89592 | 89885 | 90174 | 90458 | 90739 | 91015 | 11 |
| 3 | 0 | 88069 | 88383 | 88693 | 88998 | 89300 | 89597 | 89890 | 90179 | 90463 | 90743 | 91019 | 12 |
| | 15 | 88074 | 88388 | 88698 | 89003 | 89305 | 89602 | 89895 | 90183 | 90468 | 90748 | 91024 | 13 |
| | 30 | 88079 | 88393 | 88703 | 89008 | 89310 | 89607 | 89899 | 90188 | 90472 | 90753 | 91028 | 14 |
| | 45 | 88085 | 88398 | 88708 | 89014 | 89315 | 89612 | 89904 | 90193 | 90477 | 90757 | 91033 | 15 |
| 4 | 0 | 88090 | 88404 | 88713 | 89019 | 89320 | 89617 | 89909 | 90198 | 90482 | 90762 | 91038 | 16 |
| | 15 | 88095 | 88409 | 88718 | 89024 | 89325 | 89621 | 89914 | 90202 | 90487 | 90766 | 91042 | 17 |
| | 30 | 88100 | 88414 | 88723 | 89029 | 89330 | 89626 | 89919 | 90207 | 90491 | 90771 | 91047 | 18 |
| | 45 | 88106 | 88419 | 88729 | 89034 | 89335 | 89631 | 89924 | 90212 | 90496 | 90776 | 91051 | 19 |
| 5 | 0 | 88111 | 88424 | 88734 | 89039 | 89340 | 89636 | 89929 | 90217 | 90501 | 90780 | 91056 | 20 |
| | 15 | 88116 | 88430 | 88739 | 89044 | 89345 | 89641 | 89933 | 90221 | 90505 | 90785 | 91060 | 21 |
| | 30 | 88121 | 88435 | 88744 | 89049 | 89350 | 89646 | 89938 | 90226 | 90510 | 90790 | 91065 | 22 |
| | 45 | 88127 | 88440 | 88749 | 89054 | 89355 | 89651 | 89943 | 90231 | 90515 | 90794 | 91069 | 23 |
| 6 | 0 | 88132 | 88445 | 88754 | 89059 | 89360 | 89656 | 89948 | 90236 | 90519 | 90799 | 91074 | 24 |
| | 15 | 88137 | 88450 | 88759 | 89064 | 89365 | 89661 | 89953 | 90241 | 90524 | 90803 | 91079 | 25 |
| | 30 | 88142 | 88456 | 88764 | 89069 | 89370 | 89666 | 89958 | 90245 | 90529 | 90808 | 91083 | 26 |
| | 45 | 88148 | 88461 | 88769 | 89074 | 89375 | 89671 | 89962 | 90250 | 90533 | 90813 | 91088 | 27 |
| 7 | 0 | 88153 | 88466 | 88775 | 89079 | 89379 | 89675 | 89967 | 90255 | 90538 | 90817 | 91092 | 28 |
| | 15 | 88158 | 88471 | 88780 | 89084 | 89384 | 89680 | 89972 | 90260 | 90543 | 90822 | 91097 | 29 |
| | 30 | 88163 | 88476 | 88785 | 89089 | 89389 | 89685 | 89977 | 90264 | 90548 | 90827 | 91101 | 30 |
| | 45 | 88169 | 88481 | 88790 | 89094 | 89394 | 89690 | 89982 | 90269 | 90552 | 90831 | 91106 | 31 |
| 8 | 0 | 88174 | 88487 | 88795 | 89099 | 89399 | 89695 | 89987 | 90274 | 90557 | 90836 | 91110 | 32 |
| | 15 | 88179 | 88492 | 88800 | 89104 | 89404 | 89700 | 89991 | 90279 | 90562 | 90840 | 91115 | 33 |
| | 30 | 88184 | 88497 | 88805 | 89109 | 89409 | 89705 | 89996 | 90283 | 90566 | 90845 | 91119 | 34 |
| | 45 | 88190 | 88502 | 88810 | 89114 | 89414 | 89710 | 90001 | 90288 | 90571 | 90850 | 91124 | 35 |
| 9 | 0 | 88195 | 88507 | 88815 | 89119 | 89419 | 89715 | 90006 | 90293 | 90576 | 90854 | 91129 | 36 |
| | 15 | 88200 | 88513 | 88821 | 89124 | 89424 | 89719 | 90011 | 90298 | 90580 | 90859 | 91133 | 37 |
| | 30 | 88205 | 88518 | 88826 | 89129 | 89429 | 89724 | 90015 | 90302 | 90585 | 90863 | 91138 | 38 |
| | 45 | 88211 | 88523 | 88831 | 89134 | 89434 | 89729 | 90020 | 90307 | 90590 | 90868 | 91142 | 39 |
| 10 | 0 | 88216 | 88528 | 88836 | 89140 | 89439 | 89734 | 90025 | 90312 | 90594 | 90873 | 91147 | 40 |
| | 15 | 88221 | 88533 | 88841 | 89145 | 89444 | 89739 | 90030 | 90317 | 90599 | 90877 | 91151 | 41 |
| | 30 | 88226 | 88538 | 88846 | 89150 | 89449 | 89744 | 90035 | 90321 | 90604 | 90882 | 91156 | 42 |
| | 45 | 88232 | 88544 | 88851 | 89155 | 89454 | 89749 | 90040 | 90326 | 90608 | 90886 | 91160 | 43 |
| 11 | 0 | 88237 | 88549 | 88856 | 89160 | 89459 | 89754 | 90044 | 90331 | 90613 | 90891 | 91165 | 44 |
| | 15 | 88242 | 88554 | 88861 | 89165 | 89464 | 89759 | 90049 | 90336 | 90618 | 90896 | 91169 | 45 |
| | 30 | 88247 | 88559 | 88866 | 89170 | 89469 | 89763 | 90054 | 90340 | 90622 | 90900 | 91174 | 46 |
| | 45 | 88252 | 88564 | 88871 | 89175 | 89474 | 89768 | 90059 | 90345 | 90627 | 90905 | 91178 | 47 |
| 12 | 0 | 88258 | 88569 | 88877 | 89180 | 89479 | 89773 | 90064 | 90350 | 90632 | 90909 | 91183 | 48 |
| | 15 | 88263 | 88575 | 88882 | 89185 | 89484 | 89778 | 90068 | 90354 | 90636 | 90914 | 91187 | 49 |
| | 30 | 88268 | 88580 | 88887 | 89190 | 89488 | 89783 | 90073 | 90359 | 90641 | 90919 | 91192 | 50 |
| | 45 | 88273 | 88585 | 88892 | 89195 | 89493 | 89788 | 90078 | 90364 | 90646 | 90923 | 91196 | 51 |
| 13 | 0 | 88279 | 88590 | 88897 | 89200 | 89498 | 89793 | 90083 | 90369 | 90650 | 90928 | 91201 | 52 |
| | 15 | 88284 | 88595 | 88902 | 89205 | 89503 | 89798 | 90088 | 90373 | 90655 | 90932 | 91205 | 53 |
| | 30 | 88289 | 88600 | 88907 | 89210 | 89508 | 89802 | 90092 | 90378 | 90660 | 90937 | 91210 | 54 |
| | 45 | 88294 | 88605 | 88912 | 89215 | 89513 | 89807 | 90097 | 90383 | 90664 | 90942 | 91214 | 55 |
| 14 | 0 | 88300 | 88611 | 88917 | 89220 | 89518 | 89812 | 90102 | 90388 | 90669 | 90946 | 91219 | 56 |
| | 15 | 88305 | 88616 | 88922 | 89225 | 89523 | 89817 | 90107 | 90392 | 90674 | 90951 | 91224 | 57 |
| | 30 | 88310 | 88621 | 88927 | 89230 | 89528 | 89822 | 90112 | 90397 | 90678 | 90955 | 91228 | 58 |
| | 45 | 88315 | 88626 | 88933 | 89235 | 89533 | 89827 | 90116 | 90402 | 90683 | 90960 | 91233 | 59 |

| | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 5. | Parts | 0 | 1 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 3 | 4 | 4 | 4 | 5 | 5 |

## LOG. SINE SQUARE

| | 163° | 164° | | | | 165° | | | | 166° | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 45' | 0' | 15' | 30' | 45' | 0' | 15' | 30' | 45' | 0' | 15' | |
| m s | 10h 55m | 10h 56m | 10h 57m | 10h 58m | 10h 59m | 11h 0m | 11h 1m | 11h 2m | 11h 3m | 11h 4m | 11h 5m | s. |
| | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | |
| 0 0 | 91237 | 91506 | 91770 | 92030 | 92286 | 92537 | 92785 | 93028 | 93267 | 93501 | 93732 | 0 |
| 15 | 91242 | 91510 | 91774 | 92034 | 92290 | 92541 | 92789 | 93032 | 93271 | 93505 | 93736 | 1 |
| 30 | 91246 | 91514 | 91779 | 92038 | 92294 | 92545 | 92793 | 93036 | 93274 | 93509 | 93740 | 2 |
| 45 | 91251 | 91519 | 91783 | 92043 | 92298 | 92550 | 92797 | 93040 | 93278 | 93513 | 93743 | 3 |
| 1 0 | 91255 | 91523 | 91787 | 92047 | 92302 | 92554 | 92801 | 93044 | 93282 | 93517 | 93747 | 4 |
| 15 | 91260 | 91528 | 91792 | 92051 | 92307 | 92558 | 92805 | 93048 | 93286 | 93521 | 93751 | 5 |
| 30 | 91264 | 91532 | 91796 | 92056 | 92311 | 92562 | 92809 | 93052 | 93290 | 93525 | 93755 | 6 |
| 45 | 91269 | 91537 | 91800 | 92060 | 92315 | 92566 | 92813 | 93056 | 93294 | 93528 | 93759 | 7 |
| 2 0 | 91273 | 91541 | 91805 | 92064 | 92319 | 92570 | 92817 | 93060 | 93298 | 93532 | 93762 | 8 |
| 15 | 91278 | 91545 | 91809 | 92068 | 92324 | 92575 | 92821 | 93064 | 93302 | 93536 | 93766 | 9 |
| 30 | 91282 | 91550 | 91813 | 92073 | 92328 | 92579 | 92825 | 93068 | 93306 | 93540 | 93770 | 10 |
| 45 | 91287 | 91554 | 91818 | 92077 | 92332 | 92583 | 92829 | 93072 | 93310 | 93544 | 93774 | 11 |
| 3 0 | 91291 | 91559 | 91822 | 92081 | 92336 | 92587 | 92833 | 93076 | 93314 | 93548 | 93778 | 12 |
| 15 | 91296 | 91563 | 91827 | 92086 | 92340 | 92591 | 92837 | 93080 | 93318 | 93552 | 93781 | 13 |
| 30 | 91300 | 91568 | 91831 | 92090 | 92345 | 92595 | 92842 | 93084 | 93322 | 93556 | 93785 | 14 |
| 45 | 91305 | 91572 | 91835 | 92094 | 92349 | 92599 | 92846 | 93088 | 93326 | 93559 | 93789 | 15 |
| 4 0 | 91309 | 91576 | 91840 | 92098 | 92353 | 92604 | 92850 | 93092 | 93330 | 93563 | 93793 | 16 |
| 15 | 91314 | 91581 | 91844 | 92103 | 92357 | 92608 | 92854 | 93096 | 93334 | 93567 | 93797 | 17 |
| 30 | 91318 | 91585 | 91848 | 92107 | 92361 | 92612 | 92858 | 93100 | 93338 | 93571 | 93800 | 18 |
| 45 | 91323 | 91590 | 91853 | 92111 | 92366 | 92616 | 92862 | 93104 | 93341 | 93575 | 93804 | 19 |
| 5 0 | 91327 | 91594 | 91857 | 92116 | 92370 | 92620 | 92866 | 93108 | 93345 | 93579 | 93808 | 20 |
| 15 | 91332 | 91598 | 91861 | 92120 | 92374 | 92624 | 92870 | 93112 | 93349 | 93583 | 93812 | 21 |
| 30 | 91336 | 91603 | 91866 | 92124 | 92378 | 92628 | 92874 | 93116 | 93353 | 93586 | 93815 | 22 |
| 45 | 91341 | 91607 | 91870 | 92128 | 92382 | 92632 | 92878 | 93120 | 93357 | 93590 | 93819 | 23 |
| 6 0 | 91345 | 91612 | 91874 | 92133 | 92387 | 92637 | 92882 | 93124 | 93361 | 93594 | 93823 | 24 |
| 15 | 91350 | 91616 | 91879 | 92137 | 92391 | 92641 | 92886 | 93128 | 93365 | 93598 | 93827 | 25 |
| 30 | 91354 | 91621 | 91883 | 92141 | 92395 | 92645 | 92890 | 93132 | 93369 | 93602 | 93831 | 26 |
| 45 | 91359 | 91625 | 91887 | 92145 | 92399 | 92649 | 92894 | 93136 | 93373 | 93606 | 93834 | 27 |
| 7 0 | 91363 | 91629 | 91892 | 92150 | 92403 | 92653 | 92898 | 93140 | 93377 | 93609 | 93838 | 28 |
| 15 | 91367 | 91634 | 91896 | 92154 | 92408 | 92657 | 92903 | 93144 | 93381 | 93613 | 93842 | 29 |
| 30 | 91372 | 91638 | 91900 | 92158 | 92412 | 92661 | 92907 | 93148 | 93385 | 93617 | 93846 | 30 |
| 45 | 91376 | 91643 | 91905 | 92163 | 92416 | 92665 | 92911 | 93152 | 93389 | 93621 | 93849 | 31 |
| 8 0 | 91381 | 91647 | 91909 | 92167 | 92420 | 92670 | 92915 | 93156 | 93392 | 93625 | 93853 | 32 |
| 15 | 91385 | 91651 | 91913 | 92171 | 92424 | 92674 | 92919 | 93160 | 93396 | 93629 | 93857 | 33 |
| 30 | 91390 | 91656 | 91918 | 92175 | 92429 | 92678 | 92923 | 93164 | 93400 | 93633 | 93861 | 34 |
| 45 | 91394 | 91660 | 91922 | 92180 | 92433 | 92682 | 92927 | 93168 | 93404 | 93636 | 93865 | 35 |
| 9 0 | 91399 | 91665 | 91926 | 92184 | 92437 | 92686 | 92931 | 93172 | 93408 | 93640 | 93868 | 36 |
| 15 | 91403 | 91669 | 91930 | 92188 | 92441 | 92690 | 92935 | 93176 | 93412 | 93644 | 93872 | 37 |
| 30 | 91408 | 91673 | 91935 | 92192 | 92445 | 92694 | 92939 | 93179 | 93416 | 93648 | 93876 | 38 |
| 45 | 91412 | 91678 | 91939 | 92197 | 92449 | 92698 | 92943 | 93183 | 93420 | 93652 | 93880 | 39 |
| 10 0 | 91417 | 91682 | 91944 | 92201 | 92454 | 92703 | 92947 | 93187 | 93424 | 93656 | 93883 | 40 |
| 15 | 91421 | 91687 | 91948 | 92205 | 92458 | 92707 | 92951 | 93191 | 93427 | 93659 | 93887 | 41 |
| 30 | 91425 | 91691 | 91952 | 92209 | 92462 | 92711 | 92955 | 93195 | 93431 | 93663 | 93891 | 42 |
| 45 | 91430 | 91695 | 91956 | 92214 | 92466 | 92715 | 92959 | 93199 | 93435 | 93667 | 93895 | 43 |
| 11 0 | 91434 | 91700 | 91961 | 92218 | 92470 | 92719 | 92963 | 93203 | 93439 | 93671 | 93898 | 44 |
| 15 | 91439 | 91704 | 91965 | 92222 | 92475 | 92723 | 92967 | 93207 | 93443 | 93675 | 93902 | 45 |
| 30 | 91443 | 91709 | 91969 | 92226 | 92479 | 92727 | 92971 | 93211 | 93447 | 93679 | 93906 | 46 |
| 45 | 91448 | 91713 | 91974 | 92230 | 92483 | 92731 | 92975 | 93215 | 93451 | 93682 | 93910 | 47 |
| 12 0 | 91452 | 91717 | 91978 | 92235 | 92487 | 92735 | 92979 | 93219 | 93455 | 93686 | 93913 | 48 |
| 15 | 91457 | 91722 | 91982 | 92239 | 92491 | 92739 | 92983 | 93223 | 93459 | 93690 | 93917 | 49 |
| 30 | 91461 | 91726 | 91987 | 92243 | 92495 | 92744 | 92987 | 93227 | 93463 | 93694 | 93921 | 50 |
| 45 | 91466 | 91730 | 91991 | 92247 | 92500 | 92748 | 92991 | 93231 | 93466 | 93698 | 93925 | 51 |
| 13 0 | 91470 | 91735 | 91995 | 92252 | 92504 | 92752 | 92995 | 93235 | 93470 | 93702 | 93928 | 52 |
| 15 | 91474 | 91739 | 92000 | 92256 | 92508 | 92756 | 92999 | 93239 | 93474 | 93705 | 93932 | 53 |
| 30 | 91479 | 91743 | 92004 | 92260 | 92512 | 92760 | 93003 | 93243 | 93478 | 93709 | 93936 | 54 |
| 45 | 91483 | 91748 | 92008 | 92264 | 92516 | 92764 | 93008 | 93247 | 93482 | 93713 | 93940 | 55 |
| 14 0 | 91488 | 91752 | 92013 | 92269 | 92520 | 92768 | 93012 | 93251 | 93486 | 93717 | 93943 | 56 |
| 15 | 91492 | 91757 | 92017 | 92273 | 92525 | 92772 | 93016 | 93255 | 93490 | 93721 | 93947 | 57 |
| 30 | 91497 | 91761 | 92021 | 92277 | 92529 | 92776 | 93020 | 93259 | 93494 | 93724 | 93951 | 58 |
| 45 | 91501 | 91765 | 92025 | 92281 | 92533 | 92780 | 93024 | 93263 | 93498 | 93728 | 93955 | 59 |

| | Sec. | 1" | 2" | 3" | 4" | 5" | 6" | 7" | 8" | 9" | 10" | 11" | 12" | 13" | 14" | 15" |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 4. | Parts | 0 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 4 |

## LOG. SINE SQUARE

| | | 166° | | 167° | | | | 168° | | | | 169° | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | |
| | | 11ʰ 6ᵐ | 11ʰ 7ᵐ | 11ʰ 8ᵐ | 11ʰ 9ᵐ | 11ʰ 10ᵐ | 11ʰ 11ᵐ | 11ʰ 12ᵐ | 11ʰ 13ᵐ | 11ʰ 14ᵐ | 11ʰ 15ᵐ | 11ʰ 16ᵐ | s. |
| ′ | ″ | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | |
| 0 | 0 | 93958 | 94181 | 94399 | 94612 | 94822 | 95027 | 95229 | 95426 | 95619 | 95807 | 95992 | 0 |
| | 15 | 93962 | 94184 | 94402 | 94616 | 94825 | 95031 | 95232 | 95429 | 95622 | 95811 | 95995 | 1 |
| | 30 | 93966 | 94188 | 94406 | 94619 | 94829 | 95034 | 95235 | 95432 | 95625 | 95814 | 95998 | 2 |
| | 45 | 93970 | 94192 | 94409 | 94623 | 94832 | 95038 | 95239 | 95436 | 95628 | 95817 | 96001 | 3 |
| 1 | 0 | 93973 | 94195 | 94413 | 94626 | 94836 | 95041 | 95242 | 95439 | 95631 | 95820 | 96004 | 4 |
| | 15 | 93977 | 94199 | 94417 | 94630 | 94839 | 95044 | 95245 | 95442 | 95635 | 95823 | 96007 | 5 |
| | 30 | 93981 | 94202 | 94420 | 94633 | 94843 | 95048 | 95248 | 95445 | 95638 | 95826 | 96010 | 6 |
| | 45 | 93984 | 94206 | 94424 | 94637 | 94846 | 95051 | 95252 | 95448 | 95641 | 95829 | 96013 | 7 |
| 2 | 0 | 93988 | 94210 | 94427 | 94641 | 94850 | 95054 | 95255 | 95452 | 95644 | 95832 | 96016 | 8 |
| | 15 | 93992 | 94213 | 94431 | 94644 | 94853 | 95058 | 95259 | 95455 | 95647 | 95835 | 96019 | 9 |
| | 30 | 93996 | 94217 | 94434 | 94648 | 94856 | 95061 | 95262 | 95458 | 95650 | 95838 | 96022 | 10 |
| | 45 | 93999 | 94221 | 94438 | 94651 | 94860 | 95065 | 95265 | 95461 | 95654 | 95842 | 96025 | 11 |
| 3 | 0 | 94003 | 94224 | 94442 | 94655 | 94863 | 95068 | 95268 | 95465 | 95657 | 95845 | 96028 | 12 |
| | 15 | 94007 | 94228 | 94445 | 94658 | 94867 | 95071 | 95272 | 95468 | 95660 | 95848 | 96031 | 13 |
| | 30 | 94011 | 94232 | 94449 | 94662 | 94870 | 95075 | 95275 | 95471 | 95663 | 95851 | 96034 | 14 |
| | 45 | 94014 | 94235 | 94452 | 94665 | 94874 | 95078 | 95278 | 95474 | 95666 | 95854 | 96037 | 15 |
| 4 | 0 | 94018 | 94239 | 94456 | 94669 | 94877 | 95081 | 95282 | 95478 | 95669 | 95857 | 96040 | 16 |
| | 15 | 94022 | 94243 | 94460 | 94672 | 94881 | 95085 | 95285 | 95481 | 95673 | 95860 | 96043 | 17 |
| | 30 | 94025 | 94246 | 94463 | 94676 | 94884 | 95088 | 95288 | 95484 | 95676 | 95863 | 96047 | 18 |
| | 45 | 94029 | 94250 | 94467 | 94679 | 94887 | 95092 | 95292 | 95487 | 95679 | 95866 | 96050 | 19 |
| 5 | 0 | 94033 | 94254 | 94470 | 94683 | 94891 | 95095 | 95295 | 95491 | 95682 | 95869 | 96053 | 20 |
| | 15 | 94037 | 94257 | 94474 | 94686 | 94894 | 95098 | 95298 | 95494 | 95685 | 95872 | 96056 | 21 |
| | 30 | 94040 | 94261 | 94477 | 94690 | 94898 | 95102 | 95301 | 95497 | 95688 | 95876 | 96059 | 22 |
| | 45 | 94044 | 94265 | 94481 | 94693 | 94901 | 95105 | 95305 | 95500 | 95692 | 95879 | 96062 | 23 |
| 6 | 0 | 94048 | 94268 | 94485 | 94697 | 94905 | 95108 | 95308 | 95503 | 95695 | 95882 | 96065 | 24 |
| | 15 | 94051 | 94272 | 94488 | 94700 | 94908 | 95112 | 95311 | 95507 | 95698 | 95885 | 96068 | 25 |
| | 30 | 94055 | 94275 | 94492 | 94704 | 94911 | 95115 | 95315 | 95510 | 95701 | 95888 | 96071 | 26 |
| | 45 | 94059 | 94279 | 94495 | 94707 | 94915 | 95118 | 95318 | 95513 | 95704 | 95891 | 96074 | 27 |
| 7 | 0 | 94063 | 94283 | 94499 | 94711 | 94918 | 95122 | 95321 | 95516 | 95707 | 95894 | 96077 | 28 |
| | 15 | 94066 | 94286 | 94502 | 94714 | 94922 | 95125 | 95324 | 95520 | 95710 | 95897 | 96080 | 29 |
| | 30 | 94070 | 94290 | 94506 | 94718 | 94925 | 95129 | 95328 | 95523 | 95714 | 95900 | 96083 | 30 |
| | 45 | 94074 | 94294 | 94510 | 94721 | 94929 | 95132 | 95331 | 95526 | 95717 | 95903 | 96086 | 31 |
| 8 | 0 | 94077 | 94297 | 94513 | 94725 | 94932 | 95135 | 95334 | 95529 | 95720 | 95906 | 96089 | 32 |
| | 15 | 94081 | 94301 | 94517 | 94728 | 94935 | 95139 | 95338 | 95532 | 95723 | 95909 | 96092 | 33 |
| | 30 | 94085 | 94305 | 94520 | 94732 | 94939 | 95142 | 95341 | 95536 | 95726 | 95912 | 96095 | 34 |
| | 45 | 94088 | 94308 | 94524 | 94735 | 94942 | 95145 | 95344 | 95539 | 95729 | 95916 | 96098 | 35 |
| 9 | 0 | 94092 | 94312 | 94527 | 94739 | 94946 | 95149 | 95347 | 95542 | 95732 | 95919 | 96101 | 36 |
| | 15 | 94096 | 94315 | 94531 | 94742 | 94949 | 95152 | 95351 | 95545 | 95736 | 95922 | 96104 | 37 |
| | 30 | 94100 | 94319 | 94535 | 94746 | 94953 | 95155 | 95354 | 95548 | 95739 | 95925 | 96107 | 38 |
| | 45 | 94103 | 94323 | 94538 | 94749 | 94956 | 95159 | 95357 | 95552 | 95742 | 95928 | 96110 | 39 |
| 10 | 0 | 94107 | 94326 | 94542 | 94752 | 94959 | 95162 | 95361 | 95555 | 95745 | 95931 | 96113 | 40 |
| | 15 | 94111 | 94330 | 94545 | 94756 | 94963 | 95165 | 95364 | 95558 | 95748 | 95934 | 96116 | 41 |
| | 30 | 94114 | 94334 | 94549 | 94759 | 94966 | 95169 | 95367 | 95561 | 95751 | 95937 | 96119 | 42 |
| | 45 | 94118 | 94337 | 94552 | 94763 | 94970 | 95172 | 95370 | 95564 | 95754 | 95940 | 96122 | 43 |
| 11 | 0 | 94122 | 94341 | 94556 | 94766 | 94973 | 95175 | 95374 | 95568 | 95757 | 95943 | 96125 | 44 |
| | 15 | 94125 | 94344 | 94559 | 94770 | 94976 | 95179 | 95377 | 95571 | 95761 | 95946 | 96128 | 45 |
| | 30 | 94129 | 94348 | 94563 | 94773 | 94980 | 95182 | 95380 | 95574 | 95764 | 95949 | 96131 | 46 |
| | 45 | 94133 | 94352 | 94566 | 94777 | 94983 | 95185 | 95383 | 95577 | 95767 | 95952 | 96134 | 47 |
| 12 | 0 | 94136 | 94355 | 94570 | 94780 | 94987 | 95189 | 95387 | 95580 | 95770 | 95955 | 96137 | 48 |
| | 15 | 94140 | 94359 | 94573 | 94784 | 94991 | 95192 | 95390 | 95584 | 95773 | 95958 | 96140 | 49 |
| | 30 | 94144 | 94362 | 94577 | 94787 | 94993 | 95195 | 95393 | 95587 | 95776 | 95961 | 96143 | 50 |
| | 45 | 94147 | 94366 | 94581 | 94791 | 94997 | 95199 | 95396 | 95590 | 95779 | 95965 | 96146 | 51 |
| 13 | 0 | 94151 | 94370 | 94584 | 94794 | 95000 | 95202 | 95400 | 95593 | 95782 | 95968 | 96149 | 52 |
| | 15 | 94155 | 94373 | 94588 | 94798 | 95004 | 95205 | 95403 | 95596 | 95786 | 95971 | 96152 | 53 |
| | 30 | 94158 | 94377 | 94591 | 94801 | 95007 | 95209 | 95406 | 95600 | 95789 | 95974 | 96154 | 54 |
| | 45 | 94162 | 94381 | 94595 | 94805 | 95010 | 95212 | 95410 | 95603 | 95792 | 95977 | 96157 | 55 |
| 14 | 0 | 94166 | 94384 | 94598 | 94808 | 95014 | 95215 | 95413 | 95606 | 95795 | 95980 | 96160 | 56 |
| | 15 | 94170 | 94388 | 94602 | 94812 | 95017 | 95219 | 95416 | 95609 | 95798 | 95983 | 96163 | 57 |
| | 30 | 94173 | 94391 | 94605 | 94815 | 95021 | 95222 | 95419 | 95612 | 95801 | 95986 | 96166 | 58 |
| | 45 | 94177 | 94395 | 94609 | 94819 | 95024 | 95225 | 95423 | 95615 | 95805 | 95989 | 96169 | 59 |

| | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 3 | Parts | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |

## LOG. SINE SQUARE

| | 169° | | | 170° | | | | 171° | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | |
| | 11h17m | 11h18m | 11h19m | 11h20m | 11h21m | 11h22m | 11h23m | 11h24m | 11h25m | 11h26m | 11h27m | s. |
| ′ ″ | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | |
| 0 0 | 96172 | 96349 | 96521 | 96688 | 96852 | 97012 | 97167 | 97318 | 97465 | 97608 | 97747 | 0 |
| 15 | 96175 | 96351 | 96523 | 96691 | 96855 | 97014 | 97170 | 97321 | 97468 | 97611 | 97749 | 1 |
| 30 | 96178 | 96354 | 96526 | 96694 | 96858 | 97017 | 97172 | 97323 | 97470 | 97613 | 97752 | 2 |
| 45 | 96181 | 96357 | 96529 | 96697 | 96860 | 97020 | 97175 | 97326 | 97473 | 97615 | 97754 | 3 |
| 1 0 | 96184 | 96360 | 96532 | 96699 | 96863 | 97022 | 97177 | 97328 | 97475 | 97618 | 97756 | 4 |
| 15 | 96187 | 96363 | 96535 | 96702 | 96866 | 97025 | 97180 | 97331 | 97477 | 97620 | 97758 | 5 |
| 30 | 96190 | 96366 | 96538 | 96705 | 96868 | 97027 | 97182 | 97333 | 97480 | 97622 | 97761 | 6 |
| 45 | 96193 | 96369 | 96540 | 96708 | 96871 | 97030 | 97185 | 97336 | 97482 | 97625 | 97763 | 7 |
| 2 0 | 96196 | 96372 | 96543 | 96711 | 96874 | 97033 | 97187 | 97338 | 97485 | 97627 | 97765 | 8 |
| 15 | 96199 | 96375 | 96546 | 96713 | 96876 | 97035 | 97190 | 97341 | 97487 | 97629 | 97767 | 9 |
| 30 | 96202 | 96377 | 96549 | 96716 | 96879 | 97038 | 97193 | 97343 | 97489 | 97632 | 97770 | 10 |
| 45 | 96205 | 96380 | 96552 | 96719 | 96882 | 97040 | 97195 | 97346 | 97492 | 97634 | 97772 | 11 |
| 3 0 | 96208 | 96383 | 96554 | 96722 | 96884 | 97043 | 97198 | 97348 | 97494 | 97636 | 97774 | 12 |
| 15 | 96211 | 96386 | 96557 | 96724 | 96887 | 97046 | 97200 | 97351 | 97497 | 97639 | 97776 | 13 |
| 30 | 96214 | 96389 | 96560 | 96727 | 96890 | 97048 | 97203 | 97353 | 97499 | 97641 | 97779 | 14 |
| 45 | 96217 | 96392 | 96563 | 96730 | 96892 | 97051 | 97205 | 97355 | 97501 | 97643 | 97781 | 15 |
| 4 0 | 96220 | 96395 | 96566 | 96733 | 96895 | 97054 | 97208 | 97358 | 97504 | 97646 | 97783 | 16 |
| 15 | 96223 | 96398 | 96569 | 96735 | 96898 | 97056 | 97210 | 97360 | 97506 | 97648 | 97786 | 17 |
| 30 | 96226 | 96401 | 96571 | 96738 | 96900 | 97059 | 97213 | 97363 | 97509 | 97650 | 97788 | 18 |
| 45 | 96229 | 96403 | 96574 | 96741 | 96903 | 97061 | 97215 | 97365 | 97511 | 97653 | 97790 | 19 |
| 5 0 | 96232 | 96406 | 96577 | 96743 | 96906 | 97064 | 97218 | 97368 | 97513 | 97655 | 97792 | 20 |
| 15 | 96234 | 96409 | 96580 | 96746 | 96908 | 97067 | 97220 | 97370 | 97516 | 97657 | 97795 | 21 |
| 30 | 96237 | 96412 | 96583 | 96749 | 96911 | 97069 | 97223 | 97373 | 97518 | 97660 | 97797 | 22 |
| 45 | 96240 | 96415 | 96585 | 96752 | 96914 | 97072 | 97226 | 97375 | 97521 | 97662 | 97799 | 23 |
| 6 0 | 96243 | 96418 | 96588 | 96754 | 96916 | 97074 | 97228 | 97378 | 97523 | 97664 | 97801 | 24 |
| 15 | 96246 | 96421 | 96591 | 96757 | 96919 | 97077 | 97231 | 97380 | 97525 | 97667 | 97804 | 25 |
| 30 | 96249 | 96424 | 96593 | 96760 | 96922 | 97079 | 97233 | 97383 | 97528 | 97669 | 97806 | 26 |
| 45 | 96252 | 96426 | 96597 | 96763 | 96924 | 97082 | 97236 | 97385 | 97530 | 97671 | 97808 | 27 |
| 7 0 | 96255 | 96429 | 96599 | 96765 | 96927 | 97085 | 97238 | 97387 | 97532 | 97673 | 97810 | 28 |
| 15 | 96258 | 96432 | 96602 | 96768 | 96930 | 97087 | 97241 | 97390 | 97535 | 97676 | 97813 | 29 |
| 30 | 96261 | 96435 | 96605 | 96771 | 96932 | 97090 | 97243 | 97392 | 97537 | 97678 | 97815 | 30 |
| 45 | 96264 | 96438 | 96608 | 96774 | 96935 | 97092 | 97246 | 97395 | 97540 | 97680 | 97817 | 31 |
| 8 0 | 96267 | 96441 | 96611 | 96776 | 96938 | 97095 | 97248 | 97397 | 97542 | 97683 | 97819 | 32 |
| 15 | 96270 | 96444 | 96613 | 96779 | 96940 | 97098 | 97251 | 97400 | 97544 | 97685 | 97822 | 33 |
| 30 | 96273 | 96447 | 96616 | 96782 | 96943 | 97100 | 97253 | 97402 | 97547 | 97687 | 97824 | 34 |
| 45 | 96276 | 96449 | 96619 | 96784 | 96946 | 97103 | 97256 | 97405 | 97549 | 97690 | 97826 | 35 |
| 9 0 | 96279 | 96452 | 96622 | 96787 | 96948 | 97105 | 97258 | 97407 | 97552 | 97692 | 97828 | 36 |
| 15 | 96281 | 96455 | 96625 | 96790 | 96951 | 97108 | 97261 | 97409 | 97554 | 97694 | 97830 | 37 |
| 30 | 96284 | 96458 | 96627 | 96792 | 96954 | 97111 | 97263 | 97412 | 97556 | 97697 | 97833 | 38 |
| 45 | 96287 | 96461 | 96630 | 96795 | 96956 | 97113 | 97266 | 97414 | 97559 | 97699 | 97835 | 39 |
| 10 0 | 96290 | 96464 | 96633 | 96798 | 96959 | 97116 | 97268 | 97417 | 97561 | 97701 | 97837 | 40 |
| 15 | 96293 | 96467 | 96636 | 96801 | 96962 | 97118 | 97271 | 97419 | 97563 | 97703 | 97839 | 41 |
| 30 | 96296 | 96469 | 96638 | 96803 | 96964 | 97121 | 97273 | 97422 | 97566 | 97706 | 97842 | 42 |
| 45 | 96299 | 96472 | 96641 | 96806 | 96967 | 97124 | 97276 | 97424 | 97568 | 97708 | 97844 | 43 |
| 11 0 | 96302 | 96475 | 96644 | 96809 | 96970 | 97126 | 97278 | 97426 | 97570 | 97710 | 97846 | 44 |
| 15 | 96305 | 96478 | 96647 | 96812 | 96972 | 97129 | 97281 | 97429 | 97573 | 97713 | 97848 | 45 |
| 30 | 96308 | 96481 | 96650 | 96814 | 96975 | 97131 | 97283 | 97431 | 97575 | 97715 | 97850 | 46 |
| 45 | 96311 | 96484 | 96652 | 96817 | 96978 | 97134 | 97286 | 97434 | 97578 | 97717 | 97853 | 47 |
| 12 0 | 96314 | 96487 | 96655 | 96820 | 96980 | 97136 | 97288 | 97436 | 97580 | 97719 | 97855 | 48 |
| 15 | 96317 | 96489 | 96658 | 96822 | 96983 | 97139 | 97291 | 97439 | 97582 | 97722 | 97857 | 49 |
| 30 | 96319 | 96492 | 96661 | 96825 | 96985 | 97141 | 97293 | 97441 | 97585 | 97724 | 97859 | 50 |
| 45 | 96322 | 96495 | 96664 | 96828 | 96988 | 97144 | 97296 | 97444 | 97587 | 97726 | 97862 | 51 |
| 13 0 | 96325 | 96498 | 96666 | 96831 | 96991 | 97147 | 97298 | 97446 | 97589 | 97729 | 97864 | 52 |
| 15 | 96328 | 96501 | 96669 | 96833 | 96993 | 97149 | 97301 | 97448 | 97592 | 97731 | 97866 | 53 |
| 30 | 96331 | 96504 | 96672 | 96836 | 96996 | 97152 | 97303 | 97451 | 97594 | 97733 | 97868 | 54 |
| 45 | 96334 | 96506 | 96675 | 96839 | 96999 | 97154 | 97306 | 97453 | 97596 | 97736 | 97870 | 55 |
| 14 0 | 96337 | 96509 | 96677 | 96841 | 97001 | 97157 | 97308 | 97456 | 97599 | 97738 | 97873 | 56 |
| 15 | 96340 | 96512 | 96680 | 96844 | 97004 | 97159 | 97311 | 97458 | 97601 | 97740 | 97875 | 57 |
| 30 | 96343 | 96515 | 96683 | 96847 | 97006 | 97162 | 97313 | 97460 | 97603 | 97742 | 97877 | 58 |
| 45 | 96346 | 96518 | 96686 | 96849 | 97009 | 97165 | 97316 | 97463 | 97606 | 97745 | 97879 | 59 |

| | | 1′ | 2′ | 3′ | 4′ | 5′ | 6′ | 7′ | 8′ | 9′ | 10′ | 11′ | 12′ | 13′ | 14′ | 15′ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sec. | 1′ | 2′ | 3′ | 4′ | 5′ | 6′ | 7′ | 8′ | 9′ | 10′ | 11′ | 12′ | 13′ | 14′ | 15′ |
| D. 3. | Parts | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |

## LOG. SINE SQUARE

| | 172° | | | | 173° | | | | 174° | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | |
| | $11^h28^m$ | $11^h29^m$ | $11^h30^m$ | $11^h31^m$ | $11^h32^m$ | $11^h33^m$ | $11^h34^m$ | $11^h35^m$ | $11^h36^m$ | $11^h37^m$ | $11^h38^m$ | s. |
| ′ ″ | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | |
| 0 0 | 97882 | 98013 | 98138 | 98260 | 98378 | 98492 | 98602 | 98707 | 98809 | 98906 | 98999 | 0 |
| 15 | 97884 | 98014 | 98140 | 98262 | 98380 | 98494 | 98604 | 98709 | 98810 | 98908 | 99001 | 1 |
| 30 | 97886 | 98016 | 98142 | 98264 | 98382 | 98496 | 98605 | 98711 | 98812 | 98909 | 99002 | 2 |
| 45 | 97888 | 98018 | 98144 | 98266 | 98384 | 98498 | 98607 | 98713 | 98814 | 98911 | 99004 | 3 |
| 1 0 | 97890 | 98020 | 98146 | 98268 | 98386 | 98500 | 98609 | 98714 | 98815 | 98912 | 99005 | 4 |
| 15 | 97893 | 98023 | 98149 | 98270 | 98388 | 98501 | 98611 | 98716 | 98817 | 98914 | 99007 | 5 |
| 30 | 97895 | 98025 | 98151 | 98272 | 98390 | 98503 | 98613 | 98718 | 98819 | 98916 | 99008 | 6 |
| 45 | 97897 | 98027 | 98153 | 98274 | 98392 | 98505 | 98614 | 98719 | 98820 | 98917 | 99010 | 7 |
| 2 0 | 97899 | 98029 | 98155 | 98276 | 98394 | 98507 | 98616 | 98721 | 98822 | 98919 | 99011 | 8 |
| 15 | 97901 | 98031 | 98157 | 98278 | 98396 | 98509 | 98618 | 98723 | 98824 | 98920 | 99013 | 9 |
| 30 | 97904 | 98033 | 98159 | 98280 | 98398 | 98511 | 98620 | 98725 | 98825 | 98922 | 99014 | 10 |
| 45 | 97906 | 98036 | 98161 | 98282 | 98400 | 98513 | 98621 | 98726 | 98827 | 98923 | 99016 | 11 |
| 3 0 | 97908 | 98038 | 98163 | 98284 | 98402 | 98514 | 98623 | 98728 | 98829 | 98925 | 99017 | 12 |
| 15 | 97910 | 98040 | 98165 | 98286 | 98403 | 98516 | 98625 | 98730 | 98830 | 98926 | 99019 | 13 |
| 30 | 97912 | 98042 | 98167 | 98288 | 98405 | 98518 | 98627 | 98731 | 98832 | 98928 | 99020 | 14 |
| 45 | 97915 | 98044 | 98169 | 98290 | 98407 | 98520 | 98629 | 98733 | 98834 | 98930 | 99022 | 15 |
| 4 0 | 97917 | 98046 | 98171 | 98292 | 98409 | 98522 | 98630 | 98735 | 98835 | 98931 | 99023 | 16 |
| 15 | 97919 | 98048 | 98173 | 98294 | 98411 | 98524 | 98632 | 98736 | 98837 | 98933 | 99025 | 17 |
| 30 | 97921 | 98050 | 98175 | 98296 | 98413 | 98526 | 98634 | 98738 | 98838 | 98934 | 99027 | 18 |
| 45 | 97923 | 98052 | 98177 | 98298 | 98415 | 98527 | 98636 | 98740 | 98840 | 98936 | 99028 | 19 |
| 5 0 | 97926 | 98054 | 98179 | 98300 | 98417 | 98529 | 98637 | 98742 | 98842 | 98938 | 99029 | 20 |
| 15 | 97928 | 98057 | 98181 | 98302 | 98419 | 98531 | 98639 | 98743 | 98843 | 98939 | 99031 | 21 |
| 30 | 97930 | 98059 | 98183 | 98304 | 98421 | 98533 | 98641 | 98745 | 98845 | 98941 | 99032 | 22 |
| 45 | 97932 | 98061 | 98186 | 98306 | 98422 | 98535 | 98643 | 98747 | 98847 | 98942 | 99034 | 23 |
| 6 0 | 97934 | 98063 | 98188 | 98308 | 98424 | 98537 | 98644 | 98749 | 98848 | 98944 | 99035 | 24 |
| 15 | 97936 | 98065 | 98190 | 98310 | 98426 | 98539 | 98646 | 98750 | 98850 | 98945 | 99037 | 25 |
| 30 | 97939 | 98067 | 98192 | 98312 | 98428 | 98540 | 98648 | 98752 | 98851 | 98947 | 99038 | 26 |
| 45 | 97941 | 98069 | 98194 | 98314 | 98430 | 98542 | 98650 | 98753 | 98853 | 98948 | 99040 | 27 |
| 7 0 | 97943 | 98071 | 98196 | 98316 | 98432 | 98544 | 98652 | 98755 | 98855 | 98950 | 99041 | 28 |
| 15 | 97945 | 98074 | 98198 | 98318 | 98434 | 98546 | 98653 | 98757 | 98856 | 98951 | 99043 | 29 |
| 30 | 97947 | 98076 | 98200 | 98320 | 98436 | 98548 | 98655 | 98759 | 98858 | 98953 | 99044 | 30 |
| 45 | 97949 | 98078 | 98202 | 98322 | 98438 | 98549 | 98658 | 98760 | 98860 | 98955 | 99046 | 31 |
| 8 0 | 97952 | 98080 | 98204 | 98324 | 98440 | 98551 | 98659 | 98762 | 98861 | 98956 | 99047 | 32 |
| 15 | 97954 | 98082 | 98206 | 98326 | 98442 | 98553 | 98660 | 98764 | 98863 | 98958 | 99048 | 33 |
| 30 | 97956 | 98084 | 98208 | 98328 | 98443 | 98555 | 98662 | 98765 | 98864 | 98959 | 99050 | 34 |
| 45 | 97958 | 98086 | 98210 | 98330 | 98445 | 98557 | 98664 | 98767 | 98866 | 98961 | 99052 | 35 |
| 9 0 | 97960 | 98088 | 98212 | 98332 | 98447 | 98558 | 98666 | 98769 | 98868 | 98962 | 99053 | 36 |
| 15 | 97962 | 98090 | 98214 | 98334 | 98449 | 98560 | 98667 | 98770 | 98870 | 98964 | 99054 | 37 |
| 30 | 97965 | 98092 | 98216 | 98336 | 98451 | 98562 | 98669 | 98772 | 98871 | 98965 | 99056 | 38 |
| 45 | 97967 | 98094 | 98218 | 98338 | 98453 | 98564 | 98671 | 98774 | 98872 | 98967 | 99057 | 39 |
| 10 0 | 97969 | 98097 | 98220 | 98340 | 98455 | 98566 | 98673 | 98775 | 98874 | 98969 | 99059 | 40 |
| 15 | 97971 | 98099 | 98222 | 98342 | 98456 | 98568 | 98674 | 98777 | 98876 | 98970 | 99060 | 41 |
| 30 | 97973 | 98101 | 98224 | 98343 | 98458 | 98569 | 98676 | 98779 | 98877 | 98972 | 99062 | 42 |
| 45 | 97975 | 98103 | 98226 | 98345 | 98460 | 98571 | 98678 | 98781 | 98879 | 98973 | 99063 | 43 |
| 11 0 | 97977 | 98105 | 98228 | 98347 | 98462 | 98573 | 98680 | 98782 | 98881 | 98975 | 99065 | 44 |
| 15 | 97980 | 98108 | 98230 | 98349 | 98464 | 98575 | 98681 | 98784 | 98882 | 98976 | 99066 | 45 |
| 30 | 97982 | 98109 | 98232 | 98351 | 98466 | 98577 | 98683 | 98786 | 98884 | 98978 | 99068 | 46 |
| 45 | 97984 | 98111 | 98234 | 98353 | 98468 | 98579 | 98685 | 98787 | 98885 | 98979 | 99069 | 47 |
| 12 0 | 97986 | 98113 | 98236 | 98355 | 98470 | 98580 | 98687 | 98789 | 98887 | 98981 | 99071 | 48 |
| 15 | 97988 | 98115 | 98238 | 98357 | 98472 | 98582 | 98688 | 98791 | 98888 | 98982 | 99072 | 49 |
| 30 | 97990 | 98117 | 98240 | 98359 | 98473 | 98584 | 98690 | 98792 | 98890 | 98984 | 99074 | 50 |
| 45 | 97993 | 98120 | 98242 | 98361 | 98475 | 98586 | 98692 | 98794 | 98892 | 98985 | 99075 | 51 |
| 13 0 | 97995 | 98122 | 98244 | 98363 | 98477 | 98588 | 98694 | 98796 | 98893 | 98987 | 99076 | 52 |
| 15 | 97997 | 98124 | 98246 | 98365 | 98479 | 98589 | 98695 | 98797 | 98895 | 98989 | 99078 | 53 |
| 30 | 97999 | 98126 | 98248 | 98367 | 98481 | 98591 | 98697 | 98799 | 98896 | 98990 | 99079 | 54 |
| 45 | 98001 | 98128 | 98250 | 98369 | 98483 | 98593 | 98699 | 98800 | 98898 | 98992 | 99081 | 55 |
| 14 0 | 98003 | 98130 | 98252 | 98371 | 98485 | 98595 | 98701 | 98802 | 98900 | 98993 | 99082 | 56 |
| 15 | 98006 | 98132 | 98254 | 98373 | 98487 | 98596 | 98702 | 98804 | 98901 | 98995 | 99084 | 57 |
| 30 | 98008 | 98134 | 98256 | 98375 | 98488 | 98598 | 98704 | 98805 | 98903 | 98996 | 99085 | 58 |
| 45 | 98010 | 98136 | 98258 | 98376 | 98490 | 98600 | 98706 | 98807 | 98904 | 98998 | 99087 | 59 |

| Sec. | 1′ | 2′ | 3′ | 4′ | 5′ | 6′ | 7′ | 8′ | 9′ | 10′ | 11′ | 12′ | 13′ | 14′ | 15′ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P. P. Parts | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 |

## LOG. SINE SQUARE

| | 174° | 175° | | | | 176° | | | | 177° | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | |
| | 11h39m | 11h40m | 11h41m | 11h42m | 11h43m | 11h44m | 11h45m | 11h46m | 11h47m | 11h48m | 11h49m | s. |
| ′ ″ | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | |
| 0 0 | 99088 | 99173 | 99254 | 99330 | 99402 | 99471 | 99535 | 99595 | 99651 | 99702 | 99750 | 0 |
| 15 | 99089 | 99174 | 99255 | 99331 | 99404 | 99472 | 99536 | 99596 | 99651 | 99703 | 99751 | 1 |
| 30 | 99091 | 99176 | 99256 | 99333 | 99405 | 99473 | 99537 | 99597 | 99652 | 99704 | 99751 | 2 |
| 45 | 99092 | 99177 | 99257 | 99334 | 99406 | 99474 | 99538 | 99598 | 99653 | 99705 | 99752 | 3 |
| 1 0 | 99094 | 99178 | 99259 | 99335 | 99407 | 99475 | 99539 | 99599 | 99654 | 99706 | 99753 | 4 |
| 15 | 99095 | 99180 | 99260 | 99336 | 99408 | 99476 | 99540 | 99600 | 99655 | 99706 | 99754 | 5 |
| 30 | 99097 | 99181 | 99261 | 99337 | 99409 | 99477 | 99541 | 99600 | 99656 | 99707 | 99754 | 6 |
| 45 | 99098 | 99183 | 99263 | 99339 | 99411 | 99478 | 99542 | 99601 | 99657 | 99708 | 99755 | 7 |
| 2 0 | 99100 | 99184 | 99264 | 99340 | 99412 | 99479 | 99543 | 99602 | 99658 | 99709 | 99756 | 8 |
| 15 | 99101 | 99185 | 99265 | 99341 | 99413 | 99481 | 99544 | 99603 | 99659 | 99710 | 99757 | 9 |
| 30 | 99103 | 99187 | 99267 | 99342 | 99414 | 99482 | 99545 | 99604 | 99659 | 99711 | 99757 | 10 |
| 45 | 99104 | 99188 | 99268 | 99344 | 99415 | 99483 | 99546 | 99605 | 99660 | 99711 | 99758 | 11 |
| 3 0 | 99105 | 99189 | 99269 | 99345 | 99416 | 99484 | 99547 | 99606 | 99661 | 99712 | 99759 | 12 |
| 15 | 99107 | 99191 | 99270 | 99346 | 99418 | 99485 | 99548 | 99607 | 99662 | 99713 | 99760 | 13 |
| 30 | 99108 | 99192 | 99272 | 99347 | 99419 | 99486 | 99549 | 99608 | 99664 | 99714 | 99760 | 14 |
| 45 | 99110 | 99193 | 99273 | 99349 | 99420 | 99487 | 99550 | 99609 | 99664 | 99715 | 99761 | 15 |
| 4 0 | 99111 | 99195 | 99274 | 99350 | 99421 | 99488 | 99551 | 99610 | 99665 | 99715 | 99762 | 16 |
| 15 | 99113 | 99196 | 99276 | 99351 | 99422 | 99489 | 99552 | 99611 | 99666 | 99716 | 99763 | 17 |
| 30 | 99114 | 99197 | 99277 | 99352 | 99423 | 99490 | 99553 | 99612 | 99666 | 99717 | 99763 | 18 |
| 45 | 99115 | 99199 | 99279 | 99353 | 99424 | 99491 | 99554 | 99613 | 99667 | 99718 | 99764 | 19 |
| 5 0 | 99117 | 99200 | 99280 | 99355 | 99426 | 99492 | 99555 | 99614 | 99668 | 99719 | 99765 | 20 |
| 15 | 99118 | 99202 | 99281 | 99356 | 99427 | 99494 | 99556 | 99615 | 99669 | 99719 | 99765 | 21 |
| 30 | 99120 | 99203 | 99282 | 99357 | 99428 | 99495 | 99557 | 99616 | 99670 | 99720 | 99766 | 22 |
| 45 | 99121 | 99204 | 99283 | 99358 | 99429 | 99496 | 99558 | 99617 | 99671 | 99721 | 99767 | 23 |
| 6 0 | 99123 | 99206 | 99285 | 99360 | 99430 | 99497 | 99559 | 99618 | 99672 | 99722 | 99768 | 24 |
| 15 | 99124 | 99207 | 99286 | 99361 | 99431 | 99498 | 99560 | 99618 | 99673 | 99723 | 99768 | 25 |
| 30 | 99125 | 99208 | 99287 | 99362 | 99433 | 99499 | 99561 | 99619 | 99673 | 99723 | 99769 | 26 |
| 45 | 99127 | 99210 | 99288 | 99363 | 99434 | 99500 | 99562 | 99620 | 99674 | 99724 | 99770 | 27 |
| 7 0 | 99128 | 99211 | 99290 | 99364 | 99435 | 99501 | 99563 | 99621 | 99675 | 99725 | 99771 | 28 |
| 15 | 99130 | 99212 | 99291 | 99366 | 99436 | 99502 | 99564 | 99622 | 99676 | 99726 | 99771 | 29 |
| 30 | 99131 | 99214 | 99292 | 99367 | 99437 | 99503 | 99565 | 99623 | 99677 | 99727 | 99772 | 30 |
| 45 | 99132 | 99215 | 99294 | 99368 | 99438 | 99504 | 99566 | 99624 | 99678 | 99727 | 99773 | 31 |
| 8 0 | 99134 | 99216 | 99295 | 99369 | 99439 | 99505 | 99567 | 99625 | 99679 | 99728 | 99773 | 32 |
| 15 | 99135 | 99218 | 99296 | 99370 | 99440 | 99506 | 99568 | 99626 | 99680 | 99729 | 99774 | 33 |
| 30 | 99137 | 99219 | 99297 | 99372 | 99442 | 99507 | 99569 | 99627 | 99680 | 99730 | 99775 | 34 |
| 45 | 99139 | 99220 | 99298 | 99373 | 99443 | 99509 | 99570 | 99628 | 99681 | 99731 | 99776 | 35 |
| 9 0 | 99140 | 99222 | 99300 | 99374 | 99444 | 99510 | 99571 | 99629 | 99682 | 99731 | 99776 | 36 |
| 15 | 99141 | 99223 | 99301 | 99375 | 99445 | 99511 | 99572 | 99630 | 99683 | 99732 | 99777 | 37 |
| 30 | 99142 | 99224 | 99303 | 99376 | 99446 | 99512 | 99573 | 99631 | 99684 | 99733 | 99778 | 38 |
| 45 | 99144 | 99226 | 99304 | 99378 | 99447 | 99513 | 99574 | 99631 | 99685 | 99734 | 99779 | 39 |
| 10 0 | 99145 | 99227 | 99305 | 99379 | 99448 | 99514 | 99575 | 99632 | 99686 | 99734 | 99779 | 40 |
| 15 | 99146 | 99228 | 99306 | 99380 | 99450 | 99515 | 99576 | 99633 | 99686 | 99735 | 99780 | 41 |
| 30 | 99148 | 99230 | 99308 | 99381 | 99451 | 99516 | 99577 | 99634 | 99687 | 99736 | 99781 | 42 |
| 45 | 99149 | 99231 | 99309 | 99382 | 99452 | 99517 | 99578 | 99635 | 99688 | 99737 | 99781 | 43 |
| 11 0 | 99151 | 99232 | 99310 | 99384 | 99453 | 99518 | 99579 | 99636 | 99689 | 99737 | 99782 | 44 |
| 15 | 99152 | 99234 | 99311 | 99385 | 99454 | 99519 | 99580 | 99637 | 99690 | 99738 | 99783 | 45 |
| 30 | 99153 | 99235 | 99312 | 99386 | 99455 | 99520 | 99581 | 99638 | 99691 | 99739 | 99784 | 46 |
| 45 | 99155 | 99236 | 99314 | 99387 | 99456 | 99521 | 99582 | 99639 | 99692 | 99740 | 99784 | 47 |
| 12 0 | 99156 | 99238 | 99315 | 99388 | 99457 | 99522 | 99583 | 99640 | 99692 | 99741 | 99785 | 48 |
| 15 | 99158 | 99239 | 99316 | 99389 | 99459 | 99523 | 99584 | 99641 | 99693 | 99741 | 99786 | 49 |
| 30 | 99159 | 99240 | 99318 | 99391 | 99460 | 99524 | 99585 | 99642 | 99694 | 99742 | 99786 | 50 |
| 45 | 99160 | 99242 | 99319 | 99392 | 99461 | 99525 | 99586 | 99642 | 99695 | 99743 | 99787 | 51 |
| 13 0 | 99162 | 99243 | 99320 | 99393 | 99462 | 99526 | 99587 | 99643 | 99696 | 99744 | 99788 | 52 |
| 15 | 99163 | 99244 | 99321 | 99394 | 99463 | 99527 | 99588 | 99644 | 99697 | 99744 | 99788 | 53 |
| 30 | 99165 | 99246 | 99323 | 99395 | 99464 | 99529 | 99589 | 99645 | 99697 | 99745 | 99789 | 54 |
| 45 | 99166 | 99247 | 99324 | 99397 | 99465 | 99530 | 99590 | 99646 | 99698 | 99746 | 99790 | 55 |
| 14 0 | 99167 | 99248 | 99325 | 99398 | 99466 | 99531 | 99591 | 99647 | 99699 | 99747 | 99790 | 56 |
| 15 | 99169 | 99250 | 99326 | 99399 | 99467 | 99532 | 99592 | 99648 | 99700 | 99748 | 99791 | 57 |
| 30 | 99170 | 99251 | 99328 | 99400 | 99469 | 99533 | 99593 | 99649 | 99701 | 99748 | 99792 | 58 |
| 45 | 99172 | 99252 | 99329 | 99401 | 99470 | 99534 | 99594 | 99650 | 99702 | 99749 | 99793 | 59 |

| | Sec. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D. 1. | Parts | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

## LOG. SINE SQUARE

| | 177° | | 178° | | | | 179° | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | 0′ | 15′ | 30′ | 45′ | |
| ′ ″ | 11h 50m | 11h 51m | 11h 52m | 11h 53m | 11h 54m | 11h 55m | 11h 56m | 11h 57m | 11h 58m | 11h 59m | s. |
| | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | 9·9 | | |
| 0 0 | 99793 | 99833 | 99868 | 99899 | 99926 | 99948 | 99967 | 99981 | 99992 | 9·999998 | 0 |
| 15 | 99794 | 99833 | 99868 | 99899 | 99926 | 99949 | 99967 | 99982 | 99992 | 9·999998 | 1 |
| 30 | 99795 | 99834 | 99869 | 99900 | 99926 | 99949 | 99967 | 99982 | 99992 | 9·999998 | 2 |
| 45 | 99795 | 99834 | 99869 | 99900 | 99927 | 99949 | 99968 | 99982 | 99992 | 9·999998 | 3 |
| 1 0 | 99796 | 99835 | 99870 | 99901 | 99927 | 99950 | 99968 | 99982 | 99992 | 9·999998 | 4 |
| 15 | 99797 | 99836 | 99870 | 99901 | 99928 | 99950 | 99968 | 99982 | 99992 | 9·999998 | 5 |
| 30 | 99797 | 99836 | 99871 | 99902 | 99928 | 99950 | 99969 | 99983 | 99993 | 9·999998 | 6 |
| 45 | 99798 | 99837 | 99871 | 99902 | 99928 | 99951 | 99969 | 99983 | 99993 | 9·999998 | 7 |
| 2 0 | 99799 | 99838 | 99872 | 99903 | 99929 | 99951 | 99969 | 99983 | 99993 | 9·999998 | 8 |
| 15 | 99799 | 99838 | 99873 | 99903 | 99929 | 99951 | 99969 | 99983 | 99993 | 9·999998 | 9 |
| 30 | 99800 | 99839 | 99873 | 99903 | 99930 | 99952 | 99970 | 99983 | 99993 | 9·999998 | 10 |
| 45 | 99801 | 99839 | 99874 | 99904 | 99930 | 99952 | 99970 | 99984 | 99993 | 9·999998 | 11 |
| 3 0 | 99801 | 99840 | 99874 | 99904 | 99930 | 99952 | 99970 | 99984 | 99993 | 9·999999 | 12 |
| 15 | 99802 | 99841 | 99875 | 99905 | 99931 | 99953 | 99970 | 99984 | 99993 | 9·999999 | 13 |
| 30 | 99803 | 99841 | 99875 | 99905 | 99931 | 99953 | 99971 | 99984 | 99994 | 9·999999 | 14 |
| 45 | 99804 | 99842 | 99876 | 99906 | 99932 | 99953 | 99971 | 99984 | 99994 | 9·999999 | 15 |
| 4 0 | 99804 | 99842 | 99876 | 99906 | 99932 | 99954 | 99971 | 99985 | 99994 | 9·999999 | 16 |
| 15 | 99805 | 99843 | 99877 | 99907 | 99932 | 99954 | 99971 | 99985 | 99994 | 9·999999 | 17 |
| 30 | 99806 | 99844 | 99877 | 99907 | 99933 | 99954 | 99972 | 99985 | 99994 | 9·999999 | 18 |
| 45 | 99806 | 99844 | 99878 | 99908 | 99933 | 99955 | 99972 | 99985 | 99994 | 9·999999 | 19 |
| 5 0 | 99807 | 99845 | 99878 | 99908 | 99934 | 99955 | 99972 | 99985 | 99994 | 9·999999 | 20 |
| 15 | 99808 | 99845 | 99879 | 99908 | 99934 | 99955 | 99972 | 99985 | 99994 | 9·999999 | 21 |
| 30 | 99808 | 99846 | 99880 | 99909 | 99934 | 99956 | 99973 | 99986 | 99994 | 9·999999 | 22 |
| 45 | 99809 | 99846 | 99880 | 99909 | 99935 | 99956 | 99973 | 99986 | 99994 | 9·999999 | 23 |
| 6 0 | 99810 | 99847 | 99881 | 99910 | 99935 | 99956 | 99973 | 99986 | 99995 | 9·999999 | 24 |
| 15 | 99810 | 99848 | 99881 | 99910 | 99936 | 99957 | 99973 | 99986 | 99995 | 9·999999 | 25 |
| 30 | 99811 | 99848 | 99882 | 99911 | 99936 | 99957 | 99974 | 99986 | 99995 | 9·999999 | 26 |
| 45 | 99811 | 99849 | 99882 | 99911 | 99936 | 99957 | 99974 | 99987 | 99995 | 9·999999 | 27 |
| 7 0 | 99812 | 99849 | 99883 | 99912 | 99937 | 99958 | 99974 | 99987 | 99995 | 9·999999 | 28 |
| 15 | 99813 | 99850 | 99883 | 99912 | 99937 | 99958 | 99974 | 99987 | 99995 | 9·999999 | 29 |
| 30 | 99813 | 99851 | 99884 | 99913 | 99937 | 99958 | 99975 | 99987 | 99995 | 9·999999 | 30 |
| 45 | 99814 | 99851 | 99884 | 99913 | 99938 | 99958 | 99975 | 99987 | 99995 | 9·999999 | 31 |
| 8 0 | 99815 | 99852 | 99885 | 99914 | 99938 | 99959 | 99975 | 99987 | 99996 | 9·999999 | 32 |
| 15 | 99815 | 99852 | 99885 | 99914 | 99939 | 99959 | 99975 | 99988 | 99996 | 9·999999 | 33 |
| 30 | 99816 | 99853 | 99886 | 99914 | 99939 | 99959 | 99976 | 99988 | 99996 | 9·999999 | 34 |
| 45 | 99817 | 99854 | 99886 | 99915 | 99939 | 99960 | 99976 | 99988 | 99996 | 10·000000 | 35 |
| 9 0 | 99817 | 99854 | 99887 | 99915 | 99940 | 99960 | 99976 | 99988 | 99996 | 10·000000 | 36 |
| 15 | 99818 | 99855 | 99887 | 99916 | 99940 | 99960 | 99976 | 99988 | 99996 | 10·000000 | 37 |
| 30 | 99819 | 99855 | 99888 | 99916 | 99940 | 99961 | 99977 | 99988 | 99996 | 10·000000 | 38 |
| 45 | 99819 | 99856 | 99888 | 99917 | 99941 | 99961 | 99977 | 99989 | 99996 | 10·000000 | 39 |
| 10 0 | 99820 | 99856 | 99889 | 99917 | 99941 | 99961 | 99977 | 99989 | 99996 | 10·000000 | 40 |
| 15 | 99821 | 99857 | 99889 | 99918 | 99942 | 99961 | 99977 | 99989 | 99996 | 10·000000 | 41 |
| 30 | 99821 | 99858 | 99890 | 99918 | 99942 | 99962 | 99977 | 99989 | 99996 | 10·000000 | 42 |
| 45 | 99822 | 99858 | 99890 | 99918 | 99942 | 99962 | 99978 | 99989 | 99997 | 10·000000 | 43 |
| 11 0 | 99822 | 99859 | 99891 | 99919 | 99943 | 99962 | 99978 | 99989 | 99997 | 10·000000 | 44 |
| 15 | 99823 | 99859 | 99891 | 99919 | 99943 | 99963 | 99978 | 99990 | 99997 | 10·000000 | 45 |
| 30 | 99824 | 99860 | 99892 | 99920 | 99943 | 99963 | 99978 | 99990 | 99997 | 10·000000 | 46 |
| 45 | 99824 | 99860 | 99892 | 99920 | 99944 | 99963 | 99979 | 99990 | 99997 | 10·000000 | 47 |
| 12 0 | 99825 | 99861 | 99893 | 99920 | 99944 | 99964 | 99979 | 99990 | 99997 | 10·000000 | 48 |
| 15 | 99826 | 99862 | 99893 | 99921 | 99944 | 99964 | 99979 | 99990 | 99997 | 10·000000 | 49 |
| 30 | 99826 | 99862 | 99894 | 99921 | 99945 | 99964 | 99979 | 99990 | 99997 | 10·000000 | 50 |
| 45 | 99827 | 99863 | 99894 | 99922 | 99945 | 99964 | 99979 | 99990 | 99997 | 10·000000 | 51 |
| 13 0 | 99827 | 99863 | 99895 | 99922 | 99946 | 99965 | 99980 | 99991 | 99997 | 10·000000 | 52 |
| 15 | 99828 | 99864 | 99895 | 99923 | 99946 | 99965 | 99980 | 99991 | 99997 | 10·000000 | 53 |
| 30 | 99829 | 99864 | 99896 | 99923 | 99946 | 99965 | 99980 | 99991 | 99997 | 10·000000 | 54 |
| 45 | 99829 | 99865 | 99896 | 99923 | 99947 | 99966 | 99980 | 99991 | 99998 | 10·000000 | 55 |
| 14 0 | 99830 | 99865 | 99897 | 99924 | 99947 | 99966 | 99981 | 99991 | 99998 | 10·000000 | 56 |
| 15 | 99831 | 99866 | 99897 | 99924 | 99947 | 99966 | 99981 | 99991 | 99998 | 10·000000 | 57 |
| 30 | 99831 | 99866 | 99898 | 99925 | 99948 | 99966 | 99981 | 99991 | 99998 | 10·000000 | 58 |
| 45 | 99832 | 99867 | 99868 | 99925 | 99948 | 99967 | 99981 | 99992 | 99998 | 10·000000 | 59 |

## LOGARITHMS
## FOR COMPUTING THE REDUCTION TO THE MERIDIAN, AT SEA.
### PART I. Latitude and Declination of the *same* name.

| Lat. | DECLINATION. 0° | 1° | 2° | 3° | 4° | 5° | 6° | 7° | 8° | 9° | 10° | 11° | Lat. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0° | | | | | | 1·359 | 1·279 | 1·212 | 1·153 | 1·101 | 1·055 | 1·012 | 0° |
| 1 | | | | | | | 1·358 | 1·278 | 1·211 | 1·152 | 1·100 | 1·053 | 1 |
| 2 | | | | | | | | 1·357 | 1·277 | 1·209 | 1·151 | 1·098 | 2 |
| 3 | | | | | | | | | 1·356 | 1·276 | 1·208 | 1·149 | 3 |
| 4 | | | | | | | | | | 1·354 | 1·274 | 1·206 | 4 |
| 5 | 1·359 | | | | | | | | | | 1·352 | 1·272 | 5 |
| 6 | 1·279 | 1·358 | | | | | | | | | | 1·350 | 6 |
| 7 | 1·212 | 1·278 | 1·357 | | | | | | | | | | 7 |
| 8 | 1·153 | 1·211 | 1·277 | 1·356 | | | | | | | | | 8 |
| 9 | 1·101 | 1·152 | 1·209 | 1·276 | 1·354 | | | | | | | | 9 |
| 10 | 1·055 | 1·100 | 1·151 | 1·208 | 1·274 | 1·352 | | | | | | | 10 |
| 11 | 1·012 | 1·053 | 1·098 | 1·149 | 1·206 | 1·272 | 1·350 | | | | | | 11 |
| 12 | 0·974 | 1·011 | 1·051 | 1·097 | 1·147 | 1·204 | 1·270 | 1·348 | | | | | 12 |
| 13 | 0·938 | 0·972 | 1·009 | 1·049 | 1·094 | 1·145 | 1·201 | 1·267 | 1·345 | | | | 13 |
| 14 | 0·904 | 0·936 | 0·970 | 1·007 | 1·047 | 1·092 | 1·142 | 1·199 | 1·264 | 1·342 | | | 14 |
| 15 | 0·873 | 0·902 | 0·934 | 0·967 | 1·004 | 1·045 | 1·089 | 1·139 | 1·196 | 1·261 | 1·339 | | 15 |
| 16 | 0·844 | 0·871 | 0·900 | 0·931 | 0·965 | 1·002 | 1·042 | 1·086 | 1·136 | 1·193 | 1·258 | 1·336 | 16 |
| 17 | 0·816 | 0·841 | 0·868 | 0·897 | 0·928 | 0·962 | 0·999 | 1·039 | 1·083 | 1·133 | 1·189 | 1·254 | 17 |
| 18 | 0·789 | 0·813 | 0·839 | 0·866 | 0·895 | 0·925 | 0·959 | 0·995 | 1·035 | 1·080 | 1·129 | 1·185 | 18 |
| 19 | 0·764 | 0·787 | 0·811 | 0·836 | 0·863 | 0·891 | 0·922 | 0·956 | 0·992 | 1·032 | 1·076 | 1·125 | 19 |
| 20 | 0·740 | 0·761 | 0·784 | 0·807 | 0·833 | 0·859 | 0·888 | 0·919 | 0·952 | 0·988 | 1·028 | 1·072 | 20 |
| 21 | 0·717 | 0·737 | 0·758 | 0·781 | 0·804 | 0·829 | 0·856 | 0·884 | 0·915 | 0·948 | 0·984 | 1·023 | 21 |
| 22 | 0·695 | 0·714 | 0·734 | 0·755 | 0·777 | 0·801 | 0·825 | 0·852 | 0·880 | 0·911 | 0·944 | 0·980 | 22 |
| 23 | 0·673 | 0·691 | 0·710 | 0·730 | 0·751 | 0·773 | 0·797 | 0·821 | 0·848 | 0·876 | 0·906 | 0·939 | 23 |
| 24 | 0·652 | 0·670 | 0·688 | 0·707 | 0·727 | 0·747 | 0·769 | 0·793 | 0·817 | 0·844 | 0·871 | 0·902 | 24 |
| 25 | 0·632 | 0·649 | 0·666 | 0·684 | 0·703 | 0·723 | 0·743 | 0·765 | 0·788 | 0·813 | 0·839 | 0·867 | 25 |
| 26 | 0·613 | 0·629 | 0·645 | 0·662 | 0·680 | 0·699 | 0·718 | 0·739 | 0·760 | 0·783 | 0·808 | 0·834 | 26 |
| 27 | 0·594 | 0·609 | 0·625 | 0·641 | 0·658 | 0·676 | 0·694 | 0·714 | 0·734 | 0·756 | 0·778 | 0·803 | 27 |
| 28 | 0·575 | 0·590 | 0·605 | 0·620 | 0·637 | 0·653 | 0·671 | 0·689 | 0·709 | 0·729 | 0·750 | 0·773 | 28 |
| 29 | 0·557 | 0·571 | 0·586 | 0·600 | 0·616 | 0·632 | 0·649 | 0·666 | 0·684 | 0·703 | 0·724 | 0·745 | 29 |
| 30 | 0·540 | 0·553 | 0·567 | 0·581 | 0·596 | 0·611 | 0·627 | 0·643 | 0·661 | 0·679 | 0·698 | 0·718 | 30 |
| 31 | 0·522 | 0·535 | 0·548 | 0·562 | 0·576 | 0·591 | 0·606 | 0·622 | 0·638 | 0·655 | 0·673 | 0·692 | 31 |
| 32 | 0·505 | 0·518 | 0·530 | 0·543 | 0·557 | 0·571 | 0·585 | 0·600 | 0·616 | 0·632 | 0·649 | 0·667 | 32 |
| 33 | 0·489 | 0·500 | 0·513 | 0·525 | 0·538 | 0·551 | 0·565 | 0·580 | 0·594 | 0·610 | 0·626 | 0·643 | 33 |
| 34 | 0·472 | 0·483 | 0·495 | 0·507 | 0·519 | 0·532 | 0·546 | 0·559 | 0·574 | 0·588 | 0·604 | 0·620 | 34 |
| 35 | 0·456 | 0·467 | 0·478 | 0·489 | 0·501 | 0·514 | 0·526 | 0·540 | 0·553 | 0·567 | 0·582 | 0·597 | 35 |
| 36 | 0·440 | 0·450 | 0·461 | 0·472 | 0·484 | 0·495 | 0·508 | 0·520 | 0·533 | 0·548 | 0·560 | 0·575 | 36 |
| 37 | 0·424 | 0·434 | 0·445 | 0·455 | 0·466 | 0·478 | 0·489 | 0·501 | 0·514 | 0·526 | 0·540 | 0·553 | 37 |
| 38 | 0·408 | 0·418 | 0·428 | 0·438 | 0·449 | 0·460 | 0·471 | 0·482 | 0·494 | 0·507 | 0·519 | 0·532 | 38 |
| 39 | 0·393 | 0·402 | 0·412 | 0·422 | 0·432 | 0·442 | 0·453 | 0·464 | 0·475 | 0·487 | 0·499 | 0·512 | 39 |
| 40 | 0·377 | 0·386 | 0·396 | 0·405 | 0·415 | 0·425 | 0·435 | 0·447 | 0·457 | 0·468 | 0·480 | 0·492 | 40 |
| 41 | 0·362 | 0·371 | 0·380 | 0·389 | 0·398 | 0·408 | 0·418 | 0·428 | 0·438 | 0·449 | 0·460 | 0·472 | 41 |
| 42 | 0·347 | 0·355 | 0·364 | 0·373 | 0·382 | 0·391 | 0·400 | 0·410 | 0·420 | 0·431 | 0·441 | 0·452 | 42 |
| 43 | 0·331 | 0·340 | 0·348 | 0·356 | 0·365 | 0·374 | 0·383 | 0·393 | 0·402 | 0·412 | 0·422 | 0·433 | 43 |
| 44 | 0·316 | 0·324 | 0·332 | 0·340 | 0·349 | 0·357 | 0·366 | 0·375 | 0·384 | 0·394 | 0·404 | 0·414 | 44 |
| 45 | 0·301 | 0·309 | 0·316 | 0·324 | 0·333 | 0·341 | 0·349 | 0·358 | 0·367 | 0·376 | 0·385 | 0·395 | 45 |
| 46 | 0·286 | 0·293 | 0·301 | 0·308 | 0·316 | 0·324 | 0·332 | 0·341 | 0·349 | 0·358 | 0·36[illegible] | 0·376 | 46 |
| 47 | 0·271 | 0·278 | 0·285 | 0·292 | 0·300 | 0·308 | 0·315 | 0·323 | 0·331 | 0·340 | 0·349 | 0·358 | 47 |
| 48 | 0·255 | 0·262 | 0·269 | 0·276 | 0·284 | 0·291 | 0·299 | 0·306 | 0·314 | 0·322 | 0·331 | 0·339 | 48 |
| 49 | 0·240 | 0·247 | 0·254 | 0·260 | 0·267 | 0·275 | 0·282 | 0·289 | 0·297 | 0·305 | 0·312 | 0·321 | 49 |
| 50 | 0·225 | 0·231 | 0·238 | 0·244 | 0·251 | 0·258 | 0·265 | 0·272 | 0·279 | 0·287 | 0·294 | 0·302 | 50 |
| 51 | 0·209 | 0·216 | 0·222 | 0·228 | 0·235 | 0·241 | 0·248 | 0·255 | 0·262 | 0·269 | 0·276 | 0·284 | 51 |
| 52 | 0·194 | 0·200 | 0·206 | 0·212 | 0·218 | 0·225 | 0·231 | 0·238 | 0·244 | 0·251 | 0·258 | 0·265 | 52 |
| 53 | 0·178 | 0·184 | 0·190 | 0·196 | 0·202 | 0·208 | 0·214 | 0·220 | 0·227 | 0·233 | 0·240 | 0·247 | 53 |
| 54 | 0·162 | 0·168 | 0·173 | 0·179 | 0·185 | 0·191 | 0·197 | 0·203 | 0·209 | 0·215 | 0·222 | 0·228 | 54 |
| 55 | 0·146 | 0·152 | 0·157 | 0·162 | 0·168 | 0·174 | 0·179 | 0·185 | 0·191 | 0·197 | 0·204 | 0·210 | 55 |
| 56 | 0·130 | 0·135 | 0·140 | 0·146 | 0·151 | 0·156 | 0·162 | 0·168 | 0·173 | 0·179 | 0·185 | 0·191 | 56 |
| 57 | 0·114 | 0·118 | 0·124 | 0·129 | 0·134 | 0·139 | 0·144 | 0·150 | 0·155 | 0·160 | 0·166 | 0·172 | 57 |
| 58 | 0·097 | 0·100 | 0·106 | 0·111 | 0·116 | 0·121 | 0·126 | 0·131 | 0·137 | 0·142 | 0·148 | 0·153 | 58 |
| 59 | 0·080 | 0·084 | 0·089 | 0·094 | 0·098 | 0·103 | 0·108 | 0·113 | 0·118 | 0·123 | 0·128 | 0·134 | 59 |
| 60 | 0·062 | 0·067 | 0·071 | 0·076 | 0·080 | 0·085 | 0·090 | 0·094 | 0·099 | 0·104 | 0·109 | 0·114 | 60 |
| 61 | 0·045 | 0·049 | 0·053 | 0·058 | 0·062 | 0·066 | 0·071 | 0·075 | 0·080 | 0·085 | 0·089 | 0·094 | 61 |
| 62 | 0·027 | 0·031 | 0·035 | 0·039 | 0·043 | 0·047 | 0·052 | 0·056 | 0·060 | 0·065 | 0·069 | 0·074 | 62 |

## LOGARITHMS
## FOR COMPUTING THE REDUCTION TO THE MERIDIAN, AT SEA.
### PART I. Latitude and Declination of the *same* name.

| Lat. | Declination. 12° | 13° | 14° | 15° | 16° | 17° | 18° | 19° | 20° | 21° | 22° | 23° | Lat. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0° | 0·974 | 0·938 | 0·904 | 0·873 | 0·844 | 0·816 | 0·789 | 0·764 | 0·740 | 0·717 | 0·695 | 0·673 | 0° |
| 1 | 1·011 | 0·972 | 0·936 | 0·902 | 0·871 | 0·841 | 0·813 | 0·787 | 0·761 | 0·737 | 0·714 | 0·691 | 1 |
| 2 | 1·051 | 1·009 | 0·970 | 0·934 | 0·900 | 0·868 | 0·839 | 0·811 | 0·784 | 0·758 | 0·734 | 0·710 | 2 |
| 3 | 1·097 | 1·049 | 1·007 | 0·967 | 0·931 | 0·897 | 0·866 | 0·836 | 0·807 | 0·781 | 0·755 | 0·730 | 3 |
| 4 | 1·147 | 1·094 | 1·047 | 1·004 | 0·965 | 0·928 | 0·895 | 0·863 | 0·833 | 0·804 | 0·777 | 0·751 | 4 |
| 5 | 1·204 | 1·145 | 1·092 | 1·045 | 1·002 | 0·962 | 0·925 | 0·891 | 0·859 | 0·829 | 0·801 | 0·773 | 5 |
| 6 | 1·270 | 1·201 | 1·142 | 1·089 | 1·042 | 0·999 | 0·959 | 0·922 | 0·888 | 0·856 | 0·825 | 0·797 | 6 |
| 7 | 1·348 | 1·267 | 1·199 | 1·139 | 1·086 | 1·039 | 0·995 | 0·956 | 0·919 | 0·884 | 0·852 | 0·821 | 7 |
| 8 | | 1·345 | 1·264 | 1·196 | 1·136 | 1·083 | 1·035 | 0·992 | 0·952 | 0·915 | 0·880 | 0·848 | 8 |
| 9 | | | 1·342 | 1·261 | 1·193 | 1·133 | 1·080 | 1·032 | 0·988 | 0·948 | 0·911 | 0·876 | 9 |
| 10 | | | | 1·339 | 1·258 | 1·189 | 1·129 | 1·076 | 1·028 | 0·984 | 0·944 | 0·906 | 10 |
| 11 | | | | | 1·336 | 1·254 | 1·185 | 1·125 | 1·072 | 1·023 | 0·980 | 0·939 | 11 |
| 12 | | | | | | 1·332 | 1·250 | 1·181 | 1·121 | 1·067 | 1·019 | 0·975 | 12 |
| 13 | | | | | | | 1·328 | 1·246 | 1·177 | 1·116 | 1·063 | 1·014 | 13 |
| 14 | | | | | | | | 1·323 | 1·242 | 1·172 | 1·112 | 1·058 | 14 |
| 15 | | | | | | | | | 1·319 | 1·237 | 1·167 | 1·106 | 15 |
| 16 | | | | | | | | | | 1·314 | 1·232 | 1·162 | 16 |
| 17 | 1·332 | | | | | | | | | | 1·308 | 1·226 | 17 |
| 18 | 1·250 | 1·328 | | | | | | | | | | 1·303 | 18 |
| 19 | 1·181 | 1·246 | 1·323 | | | | | | | | | | 19 |
| 20 | 1·121 | 1·177 | 1·242 | 1·319 | | | | | | | | | 20 |
| 21 | 1·067 | 1·116 | 1·172 | 1·237 | 1·314 | | | | | | | | 21 |
| 22 | 1·019 | 1·063 | 1·112 | 1·167 | 1·232 | 1·308 | | | | | | | 22 |
| 23 | 0·975 | 1·014 | 1·058 | 1·106 | 1·162 | 1·226 | 1·303 | | | | | | 23 |
| 24 | 0·934 | 0·970 | 1·009 | 1·052 | 1·101 | 1·156 | 1·221 | 1·297 | | | | | 24 |
| 25 | 0·897 | 0·929 | 0·965 | 1·004 | 1·047 | 1·095 | 1·151 | 1·215 | 1·291 | | | | 25 |
| 26 | 0·861 | 0·890 | 0·924 | 0·959 | 0·998 | 1·041 | 1·090 | 1·144 | 1·208 | 1·285 | | | 26 |
| 27 | 0·828 | 0·856 | 0·886 | 0·918 | 0·953 | 0·992 | 1·035 | 1·083 | 1·138 | 1·202 | 1·278 | | 27 |
| 28 | 0·797 | 0·823 | 0·850 | 0·880 | 0·912 | 0·947 | 0·986 | 1·028 | 1·076 | 1·131 | 1·195 | 1·271 | 28 |
| 29 | 0·767 | 0·791 | 0·817 | 0·844 | 0·874 | 0·906 | 0·940 | 0·979 | 1·021 | 1·069 | 1·124 | 1·188 | 29 |
| 30 | 0·739 | 0·761 | 0·785 | 0·811 | 0·838 | 0·867 | 0·899 | 0·934 | 0·972 | 1·014 | 1·062 | 1·117 | 30 |
| 31 | 0·712 | 0·733 | 0·755 | 0·779 | 0·804 | 0·831 | 0·860 | 0·892 | 0·926 | 0·965 | 1·007 | 1·055 | 31 |
| 32 | 0·686 | 0·706 | 0·726 | 0·748 | 0·772 | 0·797 | 0·824 | 0·853 | 0·885 | 0·919 | 0·957 | 0·999 | 32 |
| 33 | 0·661 | 0·679 | 0·699 | 0·720 | 0·742 | 0·765 | 0·790 | 0·817 | 0·846 | 0·877 | 0·911 | 0·949 | 33 |
| 34 | 0·636 | 0·654 | 0·672 | 0·692 | 0·712 | 0·734 | 0·757 | 0·782 | 0·809 | 0·838 | 0·869 | 0·903 | 34 |
| 35 | 0·612 | 0·630 | 0·647 | 0·665 | 0·685 | 0·705 | 0·727 | 0·750 | 0·774 | 0·801 | 0·829 | 0·861 | 35 |
| 36 | 0·590 | 0·606 | 0·622 | 0·640 | 0·658 | 0·677 | 0·697 | 0·719 | 0·742 | 0·766 | 0·792 | 0·821 | 36 |
| 37 | 0·568 | 0·583 | 0·598 | 0·615 | 0·632 | 0·650 | 0·669 | 0·689 | 0·710 | 0·733 | 0·758 | 0·784 | 37 |
| 38 | 0·546 | 0·560 | 0·575 | 0·591 | 0·607 | 0·624 | 0·642 | 0·661 | 0·681 | 0·702 | 0·724 | 0·749 | 38 |
| 39 | 0·525 | 0·538 | 0·552 | 0·567 | 0·582 | 0·599 | 0·615 | 0·633 | 0·652 | 0·672 | 0·693 | 0·715 | 39 |
| 40 | 0·504 | 0·517 | 0·530 | 0·544 | 0·559 | 0·574 | 0·590 | 0·607 | 0·624 | 0·643 | 0·662 | 0·683 | 40 |
| 41 | 0·484 | 0·496 | 0·509 | 0·522 | 0·536 | 0·550 | 0·565 | 0·581 | 0·597 | 0·615 | 0·623 | 0·653 | 41 |
| 42 | 0·464 | 0·475 | 0·487 | 0·500 | 0·513 | 0·527 | 0·541 | 0·556 | 0·572 | 0·588 | 0·605 | 0·623 | 42 |
| 43 | 0·444 | 0·455 | 0·466 | 0·478 | 0·491 | 0·504 | 0·517 | 0·532 | 0·546 | 0·562 | 0·578 | 0·595 | 43 |
| 44 | 0·424 | 0·435 | 0·446 | 0·457 | 0·469 | 0·482 | 0·494 | 0·508 | 0·522 | 0·536 | 0·552 | 0·568 | 44 |
| 45 | 0·405 | 0·415 | 0·426 | 0·436 | 0·448 | 0·460 | 0·472 | 0·484 | 0·498 | 0·511 | 0·526 | 0·541 | 45 |
| 46 | 0·386 | 0·395 | 0·405 | 0·416 | 0·427 | 0·438 | 0·449 | 0·461 | 0·474 | 0·487 | 0·501 | 0·515 | 46 |
| 47 | 0·367 | 0·376 | 0·386 | 0·396 | 0·406 | 0·416 | 0·427 | 0·439 | 0·451 | 0·463 | 0·476 | 0·490 | 47 |
| 48 | 0·348 | 0·357 | 0·366 | 0·375 | 0·385 | 0·395 | 0·406 | 0·417 | 0·428 | 0·440 | 0·452 | 0·465 | 48 |
| 49 | 0·329 | 0·337 | 0·346 | 0·355 | 0·365 | 0·374 | 0·384 | 0·395 | 0·405 | 0·417 | 0·428 | 0·440 | 49 |
| 50 | 0·310 | 0·318 | 0·327 | 0·335 | 0·344 | 0·354 | 0·363 | 0·373 | 0·383 | 0·394 | 0·405 | 0·416 | 50 |
| 51 | 0·291 | 0·299 | 0·307 | 0·316 | 0·324 | 0·333 | 0·342 | 0·351 | 0·361 | 0·371 | 0·381 | 0·392 | 51 |
| 52 | 0·273 | 0·280 | 0·288 | 0·296 | 0·304 | 0·312 | 0·321 | 0·330 | 0·339 | 0·349 | 0·359 | 0·369 | 52 |
| 53 | 0·254 | 0·261 | 0·269 | 0·276 | 0·284 | 0·292 | 0·300 | 0·309 | 0·317 | 0·326 | 0·336 | 0·346 | 53 |
| 54 | 0·235 | 0·242 | 0·249 | 0·257 | 0·264 | 0·271 | 0·279 | 0·287 | 0·296 | 0·304 | 0·313 | 0·322 | 54 |
| 55 | 0·216 | 0·223 | 0·230 | 0·236 | 0·244 | 0·251 | 0·258 | 0·266 | 0·274 | 0·282 | 0·291 | 0·299 | 55 |
| 56 | 0·197 | 0·204 | 0·210 | 0·217 | 0·223 | 0·230 | 0·237 | 0·245 | 0·252 | 0·260 | 0·268 | 0·277 | 56 |
| 57 | 0·178 | 0·184 | 0·190 | 0·197 | 0·203 | 0·210 | 0·216 | 0·223 | 0·231 | 0·238 | 0·246 | 0·254 | 57 |
| 58 | 0·159 | 0·164 | 0·170 | 0·176 | 0·183 | 0·189 | 0·195 | 0·202 | 0·209 | 0·216 | 0·223 | 0·231 | 58 |
| 59 | 0·139 | 0·145 | 0·150 | 0·156 | 0·162 | 0·168 | 0·174 | 0·180 | 0·187 | 0·194 | 0·201 | 0·208 | 59 |
| 60 | 0·119 | 0·125 | 0·130 | 0·135 | 0·141 | 0·147 | 0·153 | 0·159 | 0·165 | 0·171 | 0·178 | 0·185 | 60 |
| 61 | 0·099 | 0·104 | 0·109 | 0·115 | 0·120 | 0·125 | 0·131 | 0·137 | 0·143 | 0·149 | 0·155 | 0·161 | 61 |
| 62 | 0·079 | 0·084 | 0·088 | 0·093 | 0·099 | 0·104 | 0·110 | 0·115 | 0·120 | 0·126 | 0·132 | 0·138 | 62 |

## LOGARITHMS
## FOR COMPUTING THE REDUCTION TO THE MERIDIAN, AT SEA.
### Part I. Latitude and Declination of the *same* name.

| Lat. | Declination. 24° | 25° | 26° | 27° | 28° | 29° | 30° | 31° | 32° | 33° | 34° | 35° | Lat. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0° | 0·652 | 0·632 | 0·613 | 0·594 | 0·575 | 0·557 | 0·539 | 0·522 | 0·505 | 0·489 | 0·472 | 0·456 | 0° |
| 1 | 0·670 | 0·649 | 0·629 | 0·609 | 0·590 | 0·571 | 0·553 | 0·535 | 0·518 | 0·501 | 0·484 | 0·467 | 1 |
| 2 | 0·688 | 0·666 | 0·645 | 0·625 | 0·605 | 0·586 | 0·567 | 0·548 | 0·530 | 0·513 | 0·496 | 0·478 | 2 |
| 3 | 0·707 | 0·684 | 0·662 | 0·641 | 0·621 | 0·601 | 0·581 | 0·562 | 0·543 | 0·525 | 0·508 | 0·490 | 3 |
| 4 | 0·727 | 0·703 | 0·680 | 0·658 | 0·637 | 0·616 | 0·596 | 0·576 | 0·557 | 0·538 | 0·520 | 0·502 | 4 |
| 5 | 0·747 | 0·723 | 0·699 | 0·676 | 0·654 | 0·632 | 0·611 | 0·591 | 0·571 | 0·551 | 0·532 | 0·514 | 5 |
| 6 | 0·769 | 0·743 | 0·718 | 0·694 | 0·671 | 0·649 | 0·627 | 0·606 | 0·585 | 0·565 | 0·545 | 0·526 | 6 |
| 7 | 0·793 | 0·765 | 0·739 | 0·714 | 0·689 | 0·666 | 0·644 | 0·622 | 0·601 | 0·580 | 0·559 | 0·539 | 7 |
| 8 | 0·817 | 0·788 | 0·760 | 0·734 | 0·709 | 0·684 | 0·661 | 0·638 | 0·616 | 0·595 | 0·574 | 0·553 | 8 |
| 9 | 0·844 | 0·813 | 0·783 | 0·755 | 0·729 | 0·704 | 0·679 | 0·655 | 0·632 | 0·610 | 0·589 | 0·567 | 9 |
| 10 | 0·872 | 0·839 | 0·808 | 0·778 | 0·750 | 0·724 | 0·6[illegible]8 | 0·673 | 0·649 | 0·626 | 0·604 | 0·582 | 10 |
| 11 | 0·902 | 0·867 | 0·834 | 0·803 | 0·773 | 0·745 | 0·718 | 0·692 | 0·667 | 0·643 | 0·620 | 0·597 | 11 |
| 12 | 0·935 | 0·897 | 0·862 | 0·829 | 0·797 | 0·767 | 0·739 | 0·712 | 0·686 | 0·661 | 0·637 | 0·613 | 12 |
| 13 | 0·970 | 0·930 | 0·892 | 0·857 | 0·823 | 0·791 | 0·761 | 0·733 | 0·706 | 0·680 | 0·654 | 0·630 | 13 |
| 14 | 1·010 | 0·965 | 0·924 | 0·886 | 0·850 | 0·817 | 0·785 | 0·755 | 0·726 | 0·699 | 0·673 | 0·647 | 14 |
| 15 | 1·053 | 1·004 | 0·959 | 0·918 | 0·880 | 0·844 | 0·811 | 0·779 | 0·749 | 0·720 | 0·692 | 0·665 | 15 |
| 16 | 1·101 | 1·047 | 0·998 | 0·953 | 0·911 | 0·874 | 0·838 | 0·804 | 0·772 | 0·742 | 0·713 | 0·685 | 16 |
| 17 | 1·157 | 1·096 | 1·041 | 0·992 | 0·947 | 0·905 | 0·867 | 0·831 | 0·797 | 0·765 | 0·735 | 0·705 | 17 |
| 18 | 1·222 | 1·151 | 1·089 | 1·035 | 0·986 | 0·940 | 0·898 | 0·860 | 0·824 | 0·790 | 0·758 | 0·727 | 18 |
| 19 | 1·297 | 1·216 | 1·145 | 1·083 | 1·029 | 0·980 | 0·934 | 0·891 | 0·853 | 0·817 | 0·782 | 0·750 | 19 |
| 20 | | 1·291 | 1·210 | 1·138 | 1·076 | 1·022 | 0·973 | 0·927 | 0·884 | 0·846 | 0·809 | 0·774 | 20 |
| 21 | | | 1·285 | 1·203 | 1·131 | 1·069 | 1·015 | 0·965 | 0·919 | 0·877 | 0·838 | 0·800 | 21 |
| 22 | | | | 1·278 | 1·196 | 1·124 | 1·061 | 1·007 | 0·957 | 0·911 | 0·868 | 0·829 | 22 |
| 23 | | | | | 1·271 | 1·189 | 1·117 | 1·054 | 0·999 | 0·949 | 0·903 | 0·860 | 23 |
| 24 | | | | | | 1·264 | 1·182 | 1·109 | 1·046 | 0·991 | 0·941 | 0·894 | 24 |
| 25 | | | | | | | 1·256 | 1·173 | 1·101 | 1·038 | 0·983 | 0·933 | 25 |
| 26 | | | | | | | | 1·248 | 1·165 | 1·092 | 1·029 | 0·974 | 26 |
| 27 | | | | | | | | | 1·239 | 1·156 | 1·083 | 1·020 | 27 |
| 28 | | | | | | | | | | 1·230 | 1·147 | 1·074 | 28 |
| 29 | 1·264 | | | | | | | | | | 1·221 | 1·138 | 29 |
| 30 | 1·1[illegible]2 | 1·256 | | | | | | | | | | 1·212 | 30 |
| 31 | 1·109 | 1·174 | 1·248 | | | | | | | | | | 31 |
| 32 | 1·046 | 1·101 | 1·166 | 1·2[illegible]9 | | | | | | | | | 32 |
| 33 | 0·991 | 1·038 | 1·093 | 1·157 | 1·230 | | | | | | | | 33 |
| 34 | 0·941 | 0·983 | 1·030 | 1·0[illegible]4 | 1·147 | 1·221 | | | | | | | 34 |
| 35 | 0·895 | 0·933 | 0·974 | 1·021 | 1·075 | 1·138 | 1·212 | | | | | | 35 |
| 36 | 0·852 | 0·886 | 0·924 | 0·965 | 1·012 | 1·065 | 1·128 | 1·202 | | | | | 36 |
| 37 | 0·812 | 0·843 | 0·877 | 0·914 | 0·955 | 1·002 | 1·055 | 1·118 | 1·191 | | | | 37 |
| 38 | 0·775 | 0·803 | 0·834 | 0·867 | 0·904 | 0·945 | 0·992 | 1·045 | 1·107 | 1·181 | | | 38 |
| 39 | 0·740 | 0·765 | 0·793 | 0·823 | 0·857 | 0·894 | 0·935 | 0·982 | 1·034 | 1·097 | 1·170 | | 39 |
| 40 | 0·706 | 0·730 | 0·755 | 0·783 | 0·814 | 0·847 | 0·883 | 0·924 | 0·970 | 1·023 | 1·086 | 1·158 | 40 |
| 41 | 0·673 | 0·696 | 0·719 | 0·745 | 0·773 | 0·803 | 0·836 | 0·872 | 0·914 | 0·958 | 1·012 | 1·075 | 41 |
| 42 | 0·642 | 0·663 | 0·685 | 0·709 | 0·734 | 0·762 | 0·792 | 0·825 | 0·861 | 0·901 | 0·947 | 1·000 | 42 |
| 43 | 0·613 | 0·632 | 0·653 | 0·675 | 0·698 | 0·723 | 0·751 | 0·781 | 0·813 | 0·849 | 0·889 | 0·934 | 43 |
| 44 | 0·585 | 0·602 | 0·621 | 0·642 | 0·664 | 0·687 | 0·712 | 0·739 | 0·769 | 0·801 | 0·837 | 0·877 | 44 |
| 45 | 0·557 | 0·574 | 0·591 | 0·610 | 0·631 | 0·652 | 0·675 | 0·700 | 0·727 | 0·756 | 0·789 | 0·825 | 45 |
| 46 | 0·530 | 0·546 | 0·562 | 0·580 | 0·599 | 0·619 | 0·640 | 0·663 | 0·687 | 0·714 | 0·744 | 0·776 | 46 |
| 47 | 0·504 | 0·519 | 0·534 | 0·551 | 0·568 | 0·587 | 0·607 | 0·628 | 0·650 | 0·675 | 0·701 | 0·731 | 47 |
| 48 | 0·478 | 0·492 | 0·507 | 0·522 | 0·539 | 0·556 | 0·575 | 0·594 | 0·615 | 0·637 | 0·662 | 0·688 | 48 |
| 49 | 0·453 | 0·466 | 0·480 | 0·494 | 0·510 | 0·526 | 0·543 | 0·561 | 0·581 | 0·601 | 0·624 | 0·648 | 49 |
| 50 | 0·428 | 0·440 | 0·453 | 0·467 | 0·482 | 0·497 | 0·513 | 0·530 | 0·548 | 0·567 | 0·588 | 0·610 | 50 |
| 51 | 0·403 | 0·415 | 0·427 | 0·440 | 0·454 | 0·468 | 0·483 | 0·499 | 0·516 | 0·534 | 0·553 | 0·573 | 51 |
| 52 | 0·379 | 0·390 | 0·402 | 0·414 | 0·427 | 0·440 | 0·454 | 0·469 | 0·485 | 0·501 | 0·519 | 0·538 | 52 |
| 53 | 0·356 | 0·366 | 0·377 | 0·388 | 0·400 | 0·413 | 0·426 | 0·440 | 0·454 | 0·470 | 0·486 | 0·504 | 53 |
| 54 | 0·332 | 0·342 | 0·352 | 0·363 | 0·374 | 0·386 | 0·398 | 0·411 | 0·425 | 0·439 | 0·455 | 0·471 | 54 |
| 55 | 0·308 | 0·318 | 0·328 | 0·338 | 0·348 | 0·359 | 0·371 | 0·383 | 0·396 | 0·410 | 0·424 | 0·438 | 55 |
| 56 | 0·285 | 0·294 | 0·303 | 0·313 | 0·322 | 0·333 | 0·344 | 0·356 | 0·368 | 0·380 | 0·394 | 0·408 | 56 |
| 57 | 0·262 | 0·270 | 0·279 | 0·288 | 0·297 | 0·307 | 0·317 | 0·328 | 0·340 | 0·352 | 0·364 | 0·377 | 57 |
| 58 | 0·238 | 0·246 | 0·254 | 0·263 | 0·272 | 0·281 | 0·291 | 0·301 | 0·312 | 0·323 | 0·335 | 0·347 | 58 |
| 59 | 0·215 | 0·222 | 0·230 | 0·238 | 0·247 | 0·255 | 0·264 | 0·274 | 0·284 | 0·295 | 0·306 | 0·317 | 59 |
| 60 | 0·191 | 0·198 | 0·205 | 0·213 | 0·221 | 0·230 | 0·238 | 0·247 | 0·257 | 0·267 | 0·277 | 0·288 | 60 |
| 61 | 0·168 | 0·174 | 0·181 | 0·188 | 0·196 | 0·204 | 0·212 | 0·220 | 0·229 | 0·238 | 0·248 | 0·258 | 61 |
| 62 | 0·144 | 0·150 | 0·157 | 0·164 | 0·171 | 0·178 | 0·186 | 0·194 | 0·202 | 0·211 | 0·220 | 0·229 | 62 |

## LOGARITHMS
## FOR COMPUTING THE REDUCTION TO THE MERIDIAN, AT SEA.
### PART II. Latitude and Declination of *contrary* Names.

| Lat. | Declination. 0° | 1° | 2° | 3° | 4° | 5° | 6° | 7° | 8° | 9° | 10° | 11° | Lat. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0° | | | | | | 1·359 | 1·279 | 1·212 | 1·153 | 1·101 | 1·055 | 1·012 | 0 |
| 1 | | | | | 1·360 | 1·280 | 1·213 | 1·154 | 1·102 | 1·056 | 1·014 | 0·975 | 1 |
| 2 | | | | 1·360 | 1·281 | 1·213 | 1·155 | 1·103 | 1·057 | 1·015 | 0·976 | 0·941 | 2 |
| 3 | | | 1·360 | 1·281 | 1·213 | 1·155 | 1·104 | 1·058 | 1·016 | 0·977 | 0·942 | 0·909 | 3 |
| 4 | | 1·360 | 1·280 | 1·213 | 1·155 | 1·104 | 1·058 | 1·016 | 0·978 | 0·943 | 0·910 | 0·879 | 4 |
| 5 | 1·359 | 1·280 | 1·213 | 1·155 | 1·104 | 1·058 | 1·016 | 0·978 | 0·943 | 0·910 | 0·880 | 0·851 | 5 |
| 6 | 1·279 | 1·213 | 1·155 | 1·104 | 1·058 | 1·016 | 0·979 | 0·943 | 0·911 | 0·880 | 0·852 | 0·825 | 6 |
| 7 | 1·212 | 1·154 | 1·103 | 1·058 | 1·016 | 0·978 | 0·943 | 0·911 | 0·881 | 0·851 | 0·825 | 0·800 | 7 |
| 8 | 1·153 | 1·102 | 1·057 | 1·016 | 0·978 | 0·943 | 0·911 | 0·881 | 0·852 | 0·825 | 0·800 | 0·776 | 8 |
| 9 | 1·101 | 1·056 | 1·015 | 0·977 | 0·943 | 0·910 | 0·880 | 0·852 | 0·825 | 0·800 | 0·776 | 0·754 | 9 |
| 10 | 1·055 | 1·014 | 0·976 | 0·942 | 0·910 | 0·880 | 0·852 | 0·825 | 0·800 | 0·776 | 0·754 | 0·732 | 10 |
| 11 | 1·012 | 0·975 | 0·941 | 0·909 | 0·879 | 0·851 | 0·825 | 0·800 | 0·776 | 0·754 | 0·732 | 0·711 | 11 |
| 12 | 0·974 | 0·939 | 0·907 | 0·878 | 0·850 | 0·824 | 0·799 | 0·775 | 0·753 | 0·732 | 0·711 | 0·692 | 12 |
| 13 | 0·938 | 0·906 | 0·876 | 0·849 | 0·823 | 0·798 | 0·775 | 0·752 | 0·731 | 0·711 | 0·691 | 0·672 | 13 |
| 14 | 0·904 | 0·875 | 0·847 | 0·821 | 0·797 | 0·774 | 0·751 | 0·730 | 0·710 | 0·691 | 0·672 | 0·654 | 14 |
| 15 | 0·873 | 0·846 | 0·820 | 0·795 | 0·772 | 0·750 | 0·729 | 0·709 | 0·690 | 0·671 | 0·653 | 0·636 | 15 |
| 16 | 0·844 | 0·818 | 0·794 | 0·771 | 0·749 | 0·728 | 0·708 | 0·689 | 0·670 | 0·653 | 0·635 | 0·619 | 16 |
| 17 | 0·816 | 0·792 | 0·769 | 0·747 | 0·726 | 0·706 | 0·687 | 0·669 | 0·651 | 0·634 | 0·617 | 0·602 | 17 |
| 18 | 0·789 | 0·767 | 0·745 | 0·724 | 0·705 | 0·686 | 0·668 | 0·650 | 0·633 | 0·617 | 0·601 | 0·586 | 18 |
| 19 | 0·764 | 0·743 | 0·722 | 0·703 | 0·684 | 0·666 | 0·648 | 0·632 | 0·615 | 0·600 | 0·584 | 0·570 | 19 |
| 20 | 0·740 | 0·720 | 0·700 | 0·682 | 0·664 | 0·646 | 0·630 | 0·614 | 0·598 | 0·583 | 0·568 | 0·554 | 20 |
| 21 | 0·717 | 0·698 | 0·679 | 0·661 | 0·644 | 0·628 | 0·612 | 0·596 | 0·581 | 0·567 | 0·553 | 0·539 | 21 |
| 22 | 0·695 | 0·676 | 0·659 | 0·642 | 0·625 | 0·609 | 0·594 | 0·579 | 0·565 | 0·551 | 0·537 | 0·524 | 22 |
| 23 | 0·673 | 0·656 | 0·639 | 0·623 | 0·607 | 0·592 | 0·577 | 0·563 | 0·549 | 0·535 | 0·522 | 0·509 | 23 |
| 24 | 0·652 | 0·636 | 0·621 | 0·604 | 0·589 | 0·575 | 0·560 | 0·547 | 0·533 | 0·520 | 0·508 | 0·495 | 24 |
| 25 | 0·632 | 0·616 | 0·601 | 0·586 | 0·572 | 0·558 | 0·544 | 0·531 | 0·518 | 0·505 | 0·493 | 0·481 | 25 |
| 26 | 0·613 | 0·598 | 0·583 | 0·569 | 0·555 | 0·541 | 0·528 | 0·515 | 0·503 | 0·491 | 0·479 | 0·467 | 26 |
| 27 | 0·594 | 0·579 | 0·565 | 0·551 | 0·538 | 0·525 | 0·512 | 0·500 | 0·488 | 0·476 | 0·465 | 0·454 | 27 |
| 28 | 0·575 | 0·561 | 0·548 | 0·535 | 0·522 | 0·509 | 0·497 | 0·485 | 0·473 | 0·462 | 0·451 | 0·440 | 28 |
| 29 | 0·557 | 0·544 | 0·531 | 0·518 | 0·506 | 0·494 | 0·482 | 0·470 | 0·459 | 0·448 | 0·437 | 0·427 | 29 |
| 30 | 0·540 | 0·527 | 0·514 | 0·502 | 0·490 | 0·478 | 0·467 | 0·456 | 0·445 | 0·434 | 0·425 | 0·414 | 30 |
| 31 | 0·522 | 0·510 | 0·498 | 0·486 | 0·474 | 0·463 | 0·452 | 0·442 | 0·431 | 0·421 | 0·411 | 0·401 | 31 |
| 32 | 0·505 | 0·493 | 0·482 | 0·470 | 0·459 | 0·448 | 0·438 | 0·427 | 0·417 | 0·407 | 0·397 | 0·388 | 32 |
| 33 | 0·489 | 0·477 | 0·466 | 0·455 | 0·444 | 0·434 | 0·423 | 0·413 | 0·403 | 0·394 | 0·384 | 0·375 | 33 |
| 34 | 0·472 | 0·461 | 0·450 | 0·440 | 0·429 | 0·419 | 0·409 | 0·399 | 0·390 | 0·380 | 0·371 | 0·362 | 34 |
| 35 | 0·456 | 0·445 | 0·435 | 0·424 | 0·414 | 0·405 | 0·395 | 0·386 | 0·376 | 0·367 | 0·358 | 0·349 | 35 |
| 36 | 0·440 | 0·429 | 0·419 | 0·410 | 0·400 | 0·390 | 0·381 | 0·372 | 0·363 | 0·354 | 0·345 | 0·337 | 36 |
| 37 | 0·424 | 0·414 | 0·404 | 0·395 | 0·385 | 0·376 | 0·367 | 0·358 | 0·350 | 0·341 | 0·333 | 0·324 | 37 |
| 38 | 0·408 | 0·399 | 0·389 | 0·380 | 0·371 | 0·362 | 0·353 | 0·345 | 0·336 | 0·328 | 0·320 | 0·312 | 38 |
| 39 | 0·393 | 0·384 | 0·374 | 0·365 | 0·357 | 0·348 | 0·340 | 0·331 | 0·323 | 0·315 | 0·307 | 0·299 | 39 |
| 40 | 0·377 | 0·368 | 0·360 | 0·351 | 0·342 | 0·334 | 0·326 | 0·318 | 0·310 | 0·302 | 0·294 | 0·287 | 40 |
| 41 | 0·362 | 0·353 | 0·345 | 0·336 | 0·328 | 0·320 | 0·312 | 0·304 | 0·297 | 0·289 | 0·282 | 0·274 | 41 |
| 42 | 0·347 | 0·338 | 0·330 | 0·322 | 0·314 | 0·306 | 0·299 | 0·291 | 0·284 | 0·276 | 0·269 | 0·262 | 42 |
| 43 | 0·331 | 0·323 | 0·315 | 0·308 | 0·300 | 0·292 | 0·285 | 0·278 | 0·270 | 0·263 | 0·256 | 0·249 | 43 |
| 44 | 0·316 | 0·308 | 0·301 | 0·293 | 0·286 | 0·279 | 0·271 | 0·264 | 0·257 | 0·250 | 0·243 | 0·237 | 44 |
| 45 | 0·301 | 0·294 | 0·286 | 0·279 | 0·272 | 0·265 | 0·258 | 0·251 | 0·244 | 0·237 | 0·231 | 0·224 | 45 |
| 46 | 0·286 | 0·279 | 0·271 | 0·264 | 0·257 | 0·251 | 0·244 | 0·237 | 0·231 | 0·224 | 0·218 | 0·211 | 46 |
| 47 | 0·271 | 0·264 | 0·257 | 0·250 | 0·243 | 0·237 | 0·230 | 0·224 | 0·217 | 0·211 | 0·205 | 0·198 | 47 |
| 48 | 0·255 | 0·249 | 0·242 | 0·235 | 0·229 | 0·223 | 0·216 | 0·210 | 0·204 | 0·198 | 0·191 | 0·185 | 48 |
| 49 | 0·240 | 0·234 | 0·227 | 0·221 | 0·215 | 0·208 | 0·202 | 0·196 | 0·190 | 0·184 | 0·178 | 0·172 | 49 |
| 50 | 0·225 | 0·219 | 0·212 | 0·206 | 0·200 | 0·194 | 0·188 | 0·182 | 0·176 | 0·171 | 0·165 | 0·159 | 50 |
| 51 | 0·209 | 0·203 | 0·197 | 0·191 | 0·185 | 0·180 | 0·174 | 0·168 | 0·163 | 0·157 | 0·151 | 0·145 | 51 |
| 52 | 0·194 | 0·188 | 0·182 | 0·176 | 0·171 | 0·165 | 0·160 | 0·154 | 0·149 | 0·143 | 0·138 | 0·132 | 52 |
| 53 | 0·178 | 0·172 | 0·167 | 0·161 | 0·156 | 0·150 | 0·145 | 0·140 | 0·134 | 0·129 | 0·124 | 0·119 | 53 |
| 54 | 0·162 | 0·157 | 0·151 | 0·146 | 0·141 | 0·136 | 0·130 | 0·125 | 0·120 | 0·115 | 0·110 | 0·105 | 54 |
| 55 | 0·146 | 0·141 | 0·136 | 0·131 | 0·125 | 0·120 | 0·115 | 0·110 | 0·105 | 0·101 | 0·096 | 0·091 | 55 |
| 56 | 0·130 | 0·125 | 0·120 | 0·115 | 0·110 | 0·105 | 0·100 | 0·095 | 0·091 | 0·086 | 0·081 | 0·077 | 56 |
| 57 | 0·114 | 0·109 | 0·104 | 0·099 | 0·094 | 0·090 | 0·085 | 0·080 | 0·076 | 0·071 | 0·066 | 0·062 | 57 |
| 58 | 0·097 | 0·092 | 0·087 | 0·083 | 0·078 | 0·074 | 0·069 | 0·065 | 0·060 | 0·056 | 0·051 | 0·047 | 58 |
| 59 | 0·080 | 0·075 | 0·071 | 0·066 | 0·062 | 0·058 | 0·053 | 0·049 | 0·045 | 0·040 | 0·036 | 0·032 | 59 |
| 60 | 0·062 | 0·058 | 0·054 | 0·050 | 0·045 | 0·041 | 0·037 | 0·033 | 0·029 | 0·024 | 0·020 | 0·016 | 60 |
| 61 | 0·045 | 0·041 | 0·036 | 0·032 | 0·028 | 0·024 | 0·020 | 0·016 | 0·012 | 0·008 | 0·004 | 0·000 | 61 |
| 62 | 0·027 | 0·023 | 0·019 | 0·015 | 0·011 | 0·007 | 0·003 | 9·999 | 9·995 | 9·992 | 9·988 | 9·984 | 62 |

# LOGARITHMS

## FOR COMPUTING THE REDUCTION TO THE MERIDIAN, AT SEA

### Part II. Latitude and Declination of *contrary* Names.

| Lat. | DECLINATION. | | | | | | | | | | | | Lat. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 12° | 13° | 14° | 15° | 16° | 17° | 18° | 19° | 20° | 21° | 22° | 23° | |
| 0° | 0·974 | 0·938 | 0·904 | 0·873 | 0·844 | 0·816 | 0·789 | 0·764 | 0·740 | 0·717 | 0·695 | 0·673 | 0° |
| 1 | 0·939 | 0·906 | 0·875 | 0·846 | 0·818 | 0·792 | 0·767 | 0·743 | 0·720 | 0·698 | 0·676 | 0·656 | 1 |
| 2 | 0·907 | 0·876 | 0·847 | 0·820 | 0·794 | 0·769 | 0·745 | 0·722 | 0·700 | 0·679 | 0·659 | 0·639 | 2 |
| 3 | 0·878 | 0·849 | 0·821 | 0·795 | 0·771 | 0·747 | 0·724 | 0·703 | 0·682 | 0·661 | 0·642 | 0·623 | 3 |
| 4 | 0·850 | 0·823 | 0·797 | 0·772 | 0·749 | 0·726 | 0·705 | 0·684 | 0·664 | 0·644 | 0·625 | 0·607 | 4 |
| 5 | 0·824 | 0·798 | 0·774 | 0·750 | 0·728 | 0·706 | 0·686 | 0·666 | 0·646 | 0·628 | 0·609 | 0·592 | 5 |
| 6 | 0·799 | 0·775 | 0·751 | 0·729 | 0·708 | 0·687 | 0·668 | 0·648 | 0·630 | 0·612 | 0·594 | 0·577 | 6 |
| 7 | 0·776 | 0·752 | 0·730 | 0·709 | 0·689 | 0·669 | 0·650 | 0·632 | 0·614 | 0·596 | 0·579 | 0·563 | 7 |
| 8 | 0·753 | 0·731 | 0·710 | 0·690 | 0·670 | 0·651 | 0·633 | 0·615 | 0·598 | 0·581 | 0·565 | 0·549 | 8 |
| 9 | 0·732 | 0·711 | 0·691 | 0·671 | 0·653 | 0·634 | 0·617 | 0·600 | 0·583 | 0·567 | 0·551 | 0·535 | 9 |
| 10 | 0·711 | 0·691 | 0·672 | 0·653 | 0·635 | 0·618 | 0·601 | 0·584 | 0·568 | 0·553 | 0·537 | 0·522 | 10 |
| 11 | 0·692 | 0·672 | 0·654 | 0·636 | 0·619 | 0·602 | 0·586 | 0·570 | 0·554 | 0·539 | 0·524 | 0·509 | 11 |
| 12 | 0·673 | 0·654 | 0·636 | 0·619 | 0·603 | 0·586 | 0·571 | 0·555 | 0·540 | 0·525 | 0·511 | 0·497 | 12 |
| 13 | 0·654 | 0·637 | 0·620 | 0·603 | 0·587 | 0·571 | 0·556 | 0·541 | 0·527 | 0·512 | 0·498 | 0·485 | 13 |
| 14 | 0·636 | 0·620 | 0·603 | 0·587 | 0·572 | 0·557 | 0·542 | 0·527 | 0·513 | 0·499 | 0·486 | 0·473 | 14 |
| 15 | 0·619 | 0·602 | 0·587 | 0·572 | 0·557 | 0·542 | 0·528 | 0·514 | 0·500 | 0·487 | 0·474 | 0·461 | 15 |
| 16 | 0·603 | 0·587 | 0·572 | 0·557 | 0·542 | 0·528 | 0·515 | 0·501 | 0·488 | 0·475 | 0·462 | 0·449 | 16 |
| 17 | 0·586 | 0·571 | 0·557 | 0·542 | 0·528 | 0·515 | 0·501 | 0·488 | 0·475 | 0·463 | 0·450 | 0·438 | 17 |
| 18 | 0·571 | 0·556 | 0·542 | 0·528 | 0·515 | 0·501 | 0·488 | 0·475 | 0·463 | 0·451 | 0·438 | 0·426 | 18 |
| 19 | 0·555 | 0·541 | 0·527 | 0·514 | 0·501 | 0·488 | 0·475 | 0·463 | 0·451 | 0·439 | 0·427 | 0·415 | 19 |
| 20 | 0·540 | 0·527 | 0·513 | 0·500 | 0·488 | 0·475 | 0·463 | 0·451 | 0·439 | 0·427 | 0·416 | 0·404 | 20 |
| 21 | 0·525 | 0·512 | 0·499 | 0·487 | 0·475 | 0·462 | 0·451 | 0·439 | 0·427 | 0·416 | 0·405 | 0·393 | 21 |
| 22 | 0·511 | 0·498 | 0·486 | 0·474 | 0·462 | 0·450 | 0·438 | 0·427 | 0·416 | 0·405 | 0·394 | 0·383 | 22 |
| 23 | 0·497 | 0·485 | 0·472 | 0·461 | 0·449 | 0·438 | 0·426 | 0·415 | 0·404 | 0·393 | 0·383 | 0·372 | 23 |
| 24 | 0·483 | 0·471 | 0·459 | 0·448 | 0·437 | 0·425 | 0·414 | 0·404 | 0·393 | 0·382 | 0·372 | 0·362 | 24 |
| 25 | 0·469 | 0·458 | 0·446 | 0·435 | 0·424 | 0·413 | 0·403 | 0·392 | 0·382 | 0·372 | 0·361 | 0·351 | 25 |
| 26 | 0·456 | 0·445 | 0·434 | 0·423 | 0·412 | 0·402 | 0·391 | 0·381 | 0·371 | 0·361 | 0·351 | 0·341 | 26 |
| 27 | 0·442 | 0·432 | 0·421 | 0·410 | 0·400 | 0·390 | 0·380 | 0·370 | 0·360 | 0·350 | 0·340 | 0·331 | 27 |
| 28 | 0·429 | 0·419 | 0·408 | 0·398 | 0·388 | 0·378 | 0·368 | 0·359 | 0·349 | 0·339 | 0·330 | 0·320 | 28 |
| 29 | 0·416 | 0·406 | 0·396 | 0·386 | 0·376 | 0·367 | 0·357 | 0·347 | 0·338 | 0·329 | 0·320 | 0·310 | 29 |
| 30 | 0·403 | 0·394 | 0·384 | 0·374 | 0·364 | 0·355 | 0·346 | 0·336 | 0·327 | 0·318 | 0·309 | 0·300 | 30 |
| 31 | 0·391 | 0·381 | 0·372 | 0·362 | 0·353 | 0·344 | 0·335 | 0·326 | 0·317 | 0·308 | 0·299 | 0·290 | 31 |
| 32 | 0·378 | 0·369 | 0·359 | 0·350 | 0·341 | 0·332 | 0·323 | 0·315 | 0·306 | 0·297 | 0·289 | 0·280 | 32 |
| 33 | 0·366 | 0·356 | 0·347 | 0·338 | 0·330 | 0·321 | 0·312 | 0·304 | 0·295 | 0·287 | 0·278 | 0·270 | 33 |
| 34 | 0·353 | 0·344 | 0·335 | 0·327 | 0·318 | 0·310 | 0·301 | 0·293 | 0·285 | 0·276 | 0·268 | 0·260 | 34 |
| 35 | 0·341 | 0·332 | 0·324 | 0·315 | 0·307 | 0·298 | 0·290 | 0·282 | 0·274 | 0·266 | 0·258 | 0·250 | 35 |
| 36 | 0·328 | 0·320 | 0·312 | 0·303 | 0·295 | 0·287 | 0·279 | 0·271 | 0·263 | 0·256 | 0·248 | 0·240 | 36 |
| 37 | 0·316 | 0·308 | 0·300 | 0·292 | 0·284 | 0·276 | 0·268 | 0·260 | 0·253 | 0·245 | 0·237 | 0·230 | 37 |
| 38 | 0·304 | 0·296 | 0·288 | 0·280 | 0·272 | 0·265 | 0·257 | 0·250 | 0·242 | 0·235 | 0·227 | 0·220 | 38 |
| 39 | 0·291 | 0·284 | 0·276 | 0·269 | 0·261 | 0·254 | 0·246 | 0·239 | 0·231 | 0·224 | 0·217 | 0·210 | 39 |
| 40 | 0·279 | 0·272 | 0·264 | 0·257 | 0·250 | 0·242 | 0·235 | 0·228 | 0·221 | 0·214 | 0·207 | 0·199 | 40 |
| 41 | 0·267 | 0·260 | 0·252 | 0·245 | 0·238 | 0·231 | 0·224 | 0·217 | 0·210 | 0·203 | 0·196 | 0·188 | 41 |
| 42 | 0·255 | 0·247 | 0·240 | 0·233 | 0·227 | 0·220 | 0·213 | 0·206 | 0·199 | 0·192 | 0·186 | 0·178 | 42 |
| 43 | 0·242 | 0·235 | 0·228 | 0·222 | 0·215 | 0·208 | 0·202 | 0·195 | 0·188 | 0·182 | 0·175 | 0·168 | 43 |
| 44 | 0·230 | 0·223 | 0·216 | 0·210 | 0·203 | 0·197 | 0·190 | 0·184 | 0·177 | 0·171 | 0·164 | 0·158 | 44 |
| 45 | 0·217 | 0·211 | 0·204 | 0·198 | 0·192 | 0·185 | 0·179 | 0·173 | 0·166 | 0·160 | 0·154 | 0·147 | 45 |
| 46 | 0·205 | 0·198 | 0·192 | 0·186 | 0·180 | 0·174 | 0·167 | 0·161 | 0·155 | 0·149 | 0·143 | 0·136 | 46 |
| 47 | 0·192 | 0·186 | 0·180 | 0·174 | 0·168 | 0·162 | 0·156 | 0·150 | 0·144 | 0·138 | 0·132 | 0·126 | 47 |
| 48 | 0·179 | 0·173 | 0·168 | 0·162 | 0·156 | 0·150 | 0·144 | 0·138 | 0·132 | 0·127 | 0·121 | 0·115 | 48 |
| 49 | 0·167 | 0·161 | 0·155 | 0·149 | 0·144 | 0·138 | 0·132 | 0·126 | 0·121 | 0·115 | 0·109 | 0·104 | 49 |
| 50 | 0·154 | 0·148 | 0·142 | 0·137 | 0·131 | 0·126 | 0·120 | 0·115 | 0·109 | 0·104 | 0·098 | 0·093 | 50 |
| 51 | 0·140 | 0·135 | 0·130 | 0·124 | 0·119 | 0·113 | 0·108 | 0·103 | 0·097 | 0·092 | 0·086 | 0·081 | 51 |
| 52 | 0·127 | 0·122 | 0·117 | 0·111 | 0·106 | 0·101 | 0·096 | 0·090 | 0·085 | 0·080 | 0·075 | 0·069 | 52 |
| 53 | 0·114 | 0·108 | 0·103 | 0·098 | 0·093 | 0·088 | 0·083 | 0·078 | 0·073 | 0·068 | 0·063 | 0·058 | 53 |
| 54 | 0·100 | 0·095 | 0·090 | 0·085 | 0·080 | 0·075 | 0·070 | 0·065 | 0·060 | 0·055 | 0·051 | 0·046 | 54 |
| 55 | 0·086 | 0·081 | 0·076 | 0·072 | 0·067 | 0·062 | 0·057 | 0·052 | 0·048 | 0·043 | 0·038 | 0·033 | 55 |
| 56 | 0·072 | 0·067 | 0·063 | 0·058 | 0·053 | 0·049 | 0·044 | 0·039 | 0·035 | 0·030 | 0·025 | 0·021 | 56 |
| 57 | 0·057 | 0·053 | 0·048 | 0·044 | 0·039 | 0·035 | 0·030 | 0·026 | 0·021 | 0·017 | 0·012 | 0·008 | 57 |
| 58 | 0·043 | 0·038 | 0·034 | 0·030 | 0·025 | 0·021 | 0·017 | 0·013 | 0·008 | 0·003 | 9·999 | 9·995 | 58 |
| 59 | 0·028 | 0·023 | 0·019 | 0·015 | 0·011 | 0·007 | 0·002 | 9·998 | 9·994 | 9·990 | 9·985 | 9·981 | 59 |
| 60 | 0·012 | 0·008 | 0·004 | 0·000 | 9·996 | 9·992 | 9·988 | 9·984 | 9·980 | 9·976 | 9·971 | 9·967 | 60 |
| 61 | 9·996 | 9·992 | 9·989 | 9·985 | 9·981 | 9·977 | 9·973 | 9·969 | 9·965 | 9·961 | 9·957 | 9·953 | 61 |
| 62 | 9·980 | 9·976 | 9·973 | 9·909 | 9·965 | 9·961 | 9·957 | 9·954 | 9·950 | 9·946 | 9·942 | 9·938 | 62 |

## LOGARITHMS
## FOR COMPUTING THE REDUCTION TO THE MERIDIAN, AT SEA.
### PART II. Latitude and Declination of *contrary* Names.

| Lat. | Declination. | | | | | | | | | | | | Lat. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 24° | 25° | 26° | 27° | 28° | 29° | 30° | 31° | 32° | 33° | 34° | 35° | |
| 0° | 0·652 | 0·632 | 0·613 | 0·594 | 0·575 | 0·557 | 0·539 | 0·522 | 0·505 | 0·489 | 0·472 | 0·456 | 0° |
| 1 | 0·636 | 0·617 | 0·598 | 0·579 | 0·561 | 0·544 | 0·526 | 0·510 | 0·493 | 0·477 | 0·461 | 0·445 | 1 |
| 2 | 0·620 | 0·601 | 0·583 | 0·565 | 0·548 | 0·531 | 0·514 | 0·498 | 0·482 | 0·466 | 0·450 | 0·435 | 2 |
| 3 | 0·605 | 0·587 | 0·569 | 0·551 | 0·535 | 0·518 | 0·502 | 0·486 | 0·470 | 0·455 | 0·439 | 0·424 | 3 |
| 4 | 0·589 | 0·572 | 0·555 | 0·538 | 0·522 | 0·506 | 0·490 | 0·474 | 0·459 | 0·444 | 0·429 | 0·414 | 4 |
| 5 | 0·574 | 0·558 | 0·541 | 0·525 | 0·509 | 0·494 | 0·478 | 0·463 | 0·448 | 0·433 | 0·419 | 0·404 | 5 |
| 6 | 0·560 | 0·544 | 0·528 | 0·512 | 0·497 | 0·482 | 0·467 | 0·452 | 0·437 | 0·423 | 0·409 | 0·395 | 6 |
| 7 | 0·546 | 0·531 | 0·515 | 0·500 | 0·485 | 0·470 | 0·456 | 0·441 | 0·427 | 0·413 | 0·399 | 0·385 | 7 |
| 8 | 0·533 | 0·518 | 0·503 | 0·488 | 0·473 | 0·459 | 0·445 | 0·431 | 0·417 | 0·404 | 0·390 | 0·376 | 8 |
| 9 | 0·520 | 0·506 | 0·491 | 0·476 | 0·462 | 0·448 | 0·434 | 0·421 | 0·407 | 0·394 | 0·380 | 0·367 | 9 |
| 10 | 0·507 | 0·493 | 0·479 | 0·465 | 0·451 | 0·437 | 0·424 | 0·411 | 0·397 | 0·384 | 0·371 | 0·358 | 10 |
| 11 | 0·495 | 0·481 | 0·467 | 0·453 | 0·440 | 0·426 | 0·413 | 0·401 | 0·387 | 0·375 | 0·362 | 0·349 | 11 |
| 12 | 0·483 | 0·469 | 0·455 | 0·442 | 0·429 | 0·416 | 0·403 | 0·391 | 0·378 | 0·366 | 0·353 | 0·341 | 12 |
| 13 | 0·471 | 0·457 | 0·444 | 0·431 | 0·418 | 0·406 | 0·393 | 0·381 | 0·368 | 0·356 | 0·344 | 0·332 | 13 |
| 14 | 0·459 | 0·446 | 0·433 | 0·421 | 0·408 | 0·396 | 0·384 | 0·372 | 0·359 | 0·347 | 0·335 | 0·323 | 14 |
| 15 | 0·448 | 0·435 | 0·422 | 0·410 | 0·398 | 0·386 | 0·374 | 0·362 | 0·349 | 0·338 | 0·326 | 0·315 | 15 |
| 16 | 0·436 | 0·424 | 0·412 | 0·400 | 0·388 | 0·376 | 0·364 | 0·353 | 0·341 | 0·330 | 0·318 | 0·307 | 16 |
| 17 | 0·425 | 0·413 | 0·402 | 0·390 | 0·378 | 0·366 | 0·355 | 0·344 | 0·332 | 0·321 | 0·309 | 0·298 | 17 |
| 18 | 0·414 | 0·403 | 0·391 | 0·380 | 0·368 | 0·357 | 0·346 | 0·335 | 0·323 | 0·312 | 0·301 | 0·290 | 18 |
| 19 | 0·404 | 0·392 | 0·381 | 0·370 | 0·358 | 0·347 | 0·336 | 0·326 | 0·314 | 0·303 | 0·292 | 0·282 | 19 |
| 20 | 0·393 | 0·382 | 0·371 | 0·360 | 0·349 | 0·338 | 0·327 | 0·317 | 0·306 | 0·295 | 0·284 | 0·274 | 20 |
| 21 | 0·383 | 0·371 | 0·361 | 0·350 | 0·339 | 0·329 | 0·318 | 0·308 | 0·297 | 0·286 | 0·276 | 0·266 | 21 |
| 22 | 0·372 | 0·361 | 0·351 | 0·340 | 0·330 | 0·320 | 0·309 | 0·299 | 0·288 | 0·278 | 0·268 | 0·258 | 22 |
| 23 | 0·362 | 0·351 | 0·341 | 0·330 | 0·320 | 0·310 | 0·300 | 0·289 | 0·279 | 0·270 | 0·260 | 0·250 | 23 |
| 24 | 0·351 | 0·341 | 0·331 | 0·321 | 0·311 | 0·301 | 0·291 | 0·281 | 0·271 | 0·262 | 0·252 | 0·242 | 24 |
| 25 | 0·341 | 0·331 | 0·321 | 0·311 | 0·301 | 0·292 | 0·282 | 0·272 | 0;262 | 0·253 | 0·243 | 0·234 | 25 |
| 26 | 0·331 | 0·322 | 0·312 | 0·302 | 0·292 | 0·283 | 0·273 | 0·264 | 0·254 | 0·245 | 0·235 | 0·226 | 26 |
| 27 | 0·321 | 0·312 | 0·302 | 0·292 | 0·283 | 0·274 | 0·264 | 0·256 | 0·246 | 0·237 | 0·227 | 0·218 | 27 |
| 28 | 0·311 | 0·302 | 0·292 | 0·283 | 0·274 | 0·265 | 0·256 | 0·248 | 0·238 | 0·229 | 0·219 | 0·210 | 28 |
| 29 | 0·301 | 0·292 | 0·282 | 0·274 | 0·265 | 0·256 | 0·247 | 0·239 | 0·229 | 0·221 | 0·211 | 0·202 | 29 |
| 30 | 0·291 | 0·282 | 0·273 | 0·265 | 0·256 | 0·247 | 0·238 | 0·230 | 0·221 | 0·213 | 0·204 | 0·195 | 30 |
| 31 | 0·281 | 0·272 | 0·263 | 0·255 | 0·246 | 0·238 | 0·229 | 0·221 | 0·212 | 0·204 | 0·196 | 0·187 | 31 |
| 32 | 0·271 | 0·263 | 0·254 | 0·246 | 0·237 | 0·229 | 0·221 | 0·213 | 0·204 | 0·196 | 0·187 | 0·179 | 32 |
| 33 | 0·261 | 0·253 | 0·245 | 0·237 | 0·228 | 0·220 | 0·212 | 0·204 | 0·195 | 0·187 | 0·179 | 0·171 | 33 |
| 34 | 0·252 | 0·244 | 0·236 | 0·228 | 0·220 | 0·212 | 0·203 | 0·195 | 0·187 | 0·179 | 0·171 | 0·163 | 34 |
| 35 | 0·242 | 0·234 | 0·226 | 0·218 | 0·210 | 0·203 | 0·194 | 0·186 | 0·178 | 0·170 | 0·162 | 0·155 | 35 |
| 36 | 0·232 | 0·225 | 0·217 | 0·209 | 0·201 | 0·194 | 0·186 | 0·178 | 0·170 | 0·162 | 0·154 | 0·147 | 36 |
| 37 | 0·222 | 0·215 | 0·207 | 0·199 | 0·191 | 0·184 | 0·176 | 0·169 | 0·161 | 0·153 | 0·145 | 0·138 | 37 |
| 38 | 0·212 | 0·205 | 0·197 | 0·190 | 0·182 | 0·175 | 0·167 | 0·160 | 0·152 | 0·145 | 0·137 | 0·130 | 38 |
| 39 | 0·202 | 0·195 | 0·187 | 0·180 | 0·173 | 0·166 | 0·158 | 0·152 | 0·143 | 0·136 | 0·129 | 0·122 | 39 |
| 40 | 0·192 | 0·185 | 0·178 | 0·171 | 0·164 | 0·157 | 0·150 | 0·143 | 0·135 | 0·128 | 0·121 | 0·114 | 40 |
| 41 | 0·182 | 0·175 | 0·168 | 0·162 | 0·155 | 0·148 | 0·141 | 0·134 | 0·127 | 0·120 | 0·113 | 0·106 | 41 |
| 42 | 0·172 | 0·165 | 0·158 | 0·152 | 0·145 | 0·138 | 0·131 | 0·125 | 0·118 | 0·111 | 0·104 | 0·097 | 42 |
| 43 | 0·161 | 0·155 | 0·148 | 0·142 | 0·135 | 0·129 | 0·122 | 0·116 | 0·109 | 0·102 | 0·095 | 0·088 | 43 |
| 44 | 0·151 | 0·144 | 0·138 | 0·132 | 0·126 | 0·119 | 0·113 | 0·106 | 0·100 | 0·093 | 0·086 | 0·079 | 44 |
| 45 | 0·141 | 0·134 | 0·128 | 0·122 | 0·116 | 0·110 | 0·103 | 0·097 | 0·090 | 0·084 | 0·077 | 0·071 | 45 |
| 46 | 0·131 | 0·124 | 0·118 | 0·112 | 0·106 | 0·100 | 0·094 | 0·087 | 0·081 | 0·074 | 0·068 | 0·062 | 46 |
| 47 | 0·120 | 0·114 | 0·108 | 0·102 | 0·096 | 0·090 | 0·084 | 0·078 | 0·071 | 0·065 | 0·058 | 0·053 | 47 |
| 48 | 0·109 | 0·103 | 0·098 | 0·092 | 0·086 | 0·080 | 0·074 | 0·068 | 0·062 | 0·056 | 0·049 | 0·043 | 48 |
| 49 | 0·098 | 0·092 | 0·087 | 0·082 | 0·075 | 0·070 | 0·064 | 0·058 | 0·052 | 0·046 | 0·040 | 0·034 | 49 |
| 50 | 0·087 | 0·081 | 0·076 | 0·071 | 0·064 | 0·059 | 0·054 | 0·048 | 0·042 | 0·036 | 0·030 | 0·024 | 50 |
| 51 | 0·076 | 0·070 | 0·064 | 0·060 | 0·054 | 0·049 | 0·043 | 0·037 | 0·032 | 0·026 | 0·020 | 0·014 | 51 |
| 52 | 0·064 | 0·059 | 0·053 | 0·048 | 0·043 | 0·038 | 0·032 | 0·027 | 0·021 | 0·016 | 0·010 | 0·004 | 52 |
| 53 | 0·052 | 0·048 | 0·042 | 0·037 | 0·031 | 0·027 | 0·021 | 0·016 | 0·010 | 0·005 | 0·000 | 9·994 | 53 |
| 54 | 0·040 | 0·036 | 0·031 | 0·026 | 0·020 | 0·015 | 0·010 | 0·005 | 9·999 | 9·994 | 9·989 | 9·984 | 54 |
| 55 | 0·028 | 0·024 | 0·019 | 0·014 | 0·009 | 0·003 | 9·998 | 9·994 | 9·988 | 9·983 | 9·978 | 9·973 | 55 |
| 56 | 0·016 | 0·011 | 0·006 | 0·002 | 9·997 | 9·992 | 9·987 | 9·982 | 9·977 | 9·972 | 9·967 | 9·962 | 56 |
| 57 | 0·003 | 9·999 | 9·994 | 9·990 | 9·985 | 9·980 | 9·975 | 9·970 | 9·965 | 9·961 | 9·955 | 9·951 | 57 |
| 58 | 9·990 | 9·986 | 9·981 | 9·977 | 9·973 | 9·968 | 9·963 | 9·958 | 9·953 | 9·949 | 9·944 | 9·939 | 58 |
| 59 | 9·977 | 9·973 | 9·968 | 9·964 | 9·960 | 9·956 | 9·950 | 9·946 | 9·941 | 9·937 | 9·932 | 9·927 | 59 |
| 60 | 9·963 | 9·959 | 9·955 | 9·951 | 9·946 | 9·943 | 9·937 | 9·933 | 9·928 | 9·924 | 9·920 | 9·915 | 60 |
| 61 | 9·948 | 9·945 | 9·941 | 9·937 | 9·932 | 9·929 | 9·924 | 9·920 | 9·915 | 9·911 | 9·907 | 9·902 | 61 |
| 62 | 9·934 | 9·930 | 9·926 | 9·923 | 9·918 | 9·914 | 9·910 | 9·906 | 9·902 | 9·898 | 9·894 | 9·889 | 62 |

## LOGARITHMS
## FOR COMPUTING THE CORRECTION OF THE LATITUDE BY ACCOUNT.

### PART I. Observations on the *same* side both of the Meridian and of the Prime Vertical.

AZIMUTHS.

| | 8° | 10° | 12° | 14° | 16° | 18° | 20° | 22° | 24° | 26° | 28° | 30° | 32° | 34° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12° | 9·206 | | | | | | | | | | | | | |
| 14 | 9·316 | | | | | | | | | | | | | |
| 16 | 9·384 | 9·163 | | | | | | | | | | | | |
| 18 | 9·430 | 9·238 | 9·035 | | | | | | | | | | | |
| 20 | 9·464 | 9·290 | 9·116 | 8·925 | | | | | | | | | | |
| 22 | 9·490 | 9·329 | 9·172 | 9·010 | 8·829 | | | | | | | | | |
| 24 | 9·511 | 9·359 | 9·215 | 9·071 | 8·918 | 8·744 | | | | | | | | |
| 26 | 9·528 | 9·383 | 9·248 | 9·116 | 8·981 | 8·836 | | | | | | | | |
| 28 | 9·543 | 9·403 | 9·275 | 9·152 | 9·029 | 8·902 | 8·762 | | | | | | | |
| 30 | 9·555 | 9·419 | 9·297 | 9·182 | 9·068 | 8·953 | 8·831 | 8·695 | | | | | | |
| 32 | 9·565 | 9·435 | 9·316 | 9·206 | 9·100 | 8·993 | 8·884 | 8·766 | | | | | | |
| 34 | 9·575 | 9·446 | 9·332 | 9·227 | 9·126 | 9·027 | 8·926 | 8·821 | 8·707 | | | | | |
| 36 | 9·583 | 9·457 | 9·346 | 9·245 | 9·148 | 9·055 | 8·961 | 8·865 | 8·763 | 8·653 | | | | |
| 38 | 9·590 | 9·467 | 9·359 | 9·260 | 9·168 | 9·079 | 8·991 | 8·901 | 8·809 | 8·711 | | | | |
| 40 | 9·596 | 9·475 | 9·370 | 9·274 | 9·185 | 9·099 | 9·016 | 8·932 | 8·847 | 8·758 | 8·662 | | | |
| 42 | 9·602 | 9·483 | 9·379 | 9·286 | 9·200 | 9·118 | 9·038 | 8·959 | 8·879 | 8·797 | 8·710 | 8·617 | | |
| 44 | 9·608 | 9·490 | 9·389 | 9·297 | 9·214 | 9·134 | 9·057 | 8·982 | 8·907 | 8·830 | 8·751 | 8·667 | 8·576 | |
| 46 | 9·613 | 9·497 | 9·397 | 9·308 | 9·226 | 9·149 | 9·075 | 9·003 | 8·931 | 8·859 | 8·785 | 8·708 | 8·626 | 8·537 |
| 48 | 9·617 | 9·503 | 9·404 | 9·317 | 9·237 | 9·162 | 9·090 | 9·021 | 8·953 | 8·885 | 8·815 | 8·744 | 8·668 | 8·589 |
| 50 | 9·622 | 9·508 | 9·411 | 9·325 | 9·247 | 9·174 | 9·105 | 9·038 | 8·972 | 8·907 | 8·842 | 8·775 | 8·705 | 8·632 |
| 52 | 9·626 | 9·513 | 9·418 | 9·333 | 9·256 | 9·185 | 9·118 | 9·053 | 8·990 | 8·927 | 8·865 | 8·802 | 8·737 | 8·670 |
| 54 | 9·629 | 9·518 | 9·424 | 9·340 | 9·265 | 9·195 | 9·129 | 9·067 | 9·006 | 8·946 | 8·886 | 8·826 | 8·765 | 8·702 |
| 56 | 9·633 | 9·523 | 9·429 | 9·347 | 9·273 | 9·205 | 9·141 | 9·079 | 9·020 | 8·962 | 8·905 | 8·848 | 8·790 | 8·731 |
| 58 | 9·636 | 9·527 | 9·435 | 9·354 | 9·281 | 9·214 | 9·151 | 9·091 | 9·034 | 8·978 | 8·923 | 8·868 | 8·813 | 8·757 |
| 60 | 9·639 | 9·531 | 9·440 | 9·360 | 9·288 | 9·222 | 9·160 | 9·102 | 9·046 | 8·992 | 8·939 | 8·886 | 8·834 | 8·781 |
| 62 | 9·642 | 9·535 | 9·444 | 9·365 | 9·295 | 9·230 | 9·169 | 9·112 | 9·058 | 9·005 | 8·954 | 8·903 | 8·853 | 8·802 |
| 64 | 9·645 | 9·539 | 9·449 | 9·371 | 9·301 | 9·237 | 9·178 | 9·122 | 9·069 | 9·018 | 8·968 | 8·919 | 8·870 | 8·822 |
| 66 | 9·648 | 9·542 | 9·453 | 9·376 | 9·307 | 9·244 | 9·186 | 9·131 | 9·079 | 9·029 | 8·981 | 8·933 | 8·887 | 8·840 |
| 68 | 9·651 | 9·545 | 9·457 | 9·381 | 9·313 | 9·251 | 9·194 | 9·140 | 9·089 | 9·040 | 8·993 | 8·947 | 8·902 | 8·857 |
| 70 | 9·653 | 9·549 | 9·461 | 9·386 | 9·319 | 9·258 | 9·201 | 9·148 | 9·099 | 9·051 | 9·005 | 8·960 | 8·916 | 8·873 |
| 72 | 9·656 | 9·552 | 9·465 | 9·390 | 9·324 | 9·264 | 9·208 | 9·156 | 9·107 | 9·061 | 9·016 | 8·972 | 8·930 | 8·887 |
| 74 | 9·658 | 9·555 | 9·469 | 9·395 | 9·329 | 9·270 | 9·215 | 9·164 | 9·116 | 9·070 | 9·026 | 8·984 | 8·942 | 8·902 |
| 76 | 9·661 | 9·558 | 9·473 | 9·399 | 9·334 | 9·275 | 9·222 | 9·171 | 9·124 | 9·079 | 9·036 | 8·995 | 8·959 | 8·915 |
| 78 | 9·663 | 9·561 | 9·476 | 9·403 | 9·339 | 9·281 | 9·228 | 9·178 | 9·132 | 9·088 | 9·046 | 9·006 | 8·966 | 8·928 |
| 80 | 9·665 | 9·564 | 9·480 | 9·408 | 9·344 | 9·287 | 9·234 | 9·185 | 9·140 | 9·097 | 9·055 | 9·016 | 8·977 | 8·940 |
| 82 | 9·667 | 9·567 | 9·483 | 9·412 | 9·349 | 9·292 | 9·240 | 9·192 | 9·147 | 9·105 | 9·065 | 9·026 | 8·988 | 8·952 |
| 84 | 9·670 | 9·569 | 9·487 | 9·416 | 9·353 | 9·297 | 9·246 | 9·199 | 9·155 | 9·113 | 9·073 | 9·035 | 8·999 | 8·963 |
| 86 | 9·672 | 9·572 | 9·490 | 9·420 | 9·358 | 9·302 | 9·252 | 9·205 | 9·162 | 9·121 | 9·082 | 9·045 | 9·009 | 8·974 |
| 88 | 9·674 | 9·575 | 9·493 | 9·423 | 9·362 | 9·307 | 9·257 | 9·211 | 9·169 | 9·128 | 9·090 | 9·054 | 9·019 | 8·985 |
| 90 | 9·676 | 9·578 | 9·496 | 9·427 | 9·366 | 9·312 | 9·263 | 9·218 | 9·175 | 9·136 | 9·098 | 9·062 | 9·028 | 8·995 |

| | 36° | 38° | 40° | 42° | 44° | 46° | 48° | 50° | 52° | 54° | 56° | 58° | 60° | 62° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 54° | 8·637 | 8·567 | 8·492 | 8·408 | 8·314 | | | | | | | | | |
| 56 | 8·670 | 8·606 | 8·538 | 8·464 | 8·381 | 8·288 | | | | | | | | |
| 58 | 8·700 | 8·640 | 8·577 | 8·510 | 8·437 | 8·356 | 8·264 | | | | | | | |
| 60 | 8·726 | 8·671 | 8·612 | 8·551 | 8·485 | 8·413 | 8·333 | 8·242 | | | | | | |
| 62 | 8·750 | 8·698 | 8·643 | 8·587 | 8·526 | 8·461 | 8·391 | 8·312 | 8·221 | | | | | |
| 64 | 8·773 | 8·723 | 8·671 | 8·618 | 8·563 | 8·503 | 8·440 | 8·370 | 8·292 | | | | | |
| 66 | 8·793 | 8·745 | 8·697 | 8·647 | 8·595 | 8·540 | 8·482 | 8·419 | 8·350 | 8·273 | | | | |
| 68 | 8·812 | 8·766 | 8·720 | 8·673 | 8·624 | 8·573 | 8·520 | 8·462 | 8·401 | 8·332 | 8·256 | | | |
| 70 | 8·829 | 8·786 | 8·742 | 8·697 | 8·651 | 8·603 | 8·553 | 8·501 | 8·444 | 8·383 | 8·316 | 8·240 | | |
| 72 | 8·846 | 8·804 | 8·762 | 8·719 | 8·676 | 8·631 | 8·584 | 8·535 | 8·483 | 8·428 | 8·367 | 8·301 | 8·226 | |
| 74 | 8·861 | 8·821 | 8·781 | 8·740 | 8·698 | 8·656 | 8·612 | 8·566 | 8·518 | 8·467 | 8·412 | 8·353 | 8·287 | |
| 76 | 8·876 | 8·837 | 8·798 | 8·759 | 8·719 | 8·679 | 8·638 | 8·595 | 8·550 | 8·503 | 8·453 | 8·398 | 8·346 | 8·275 |
| 78 | 8·890 | 8·852 | 8·815 | 8·777 | 8·739 | 8·701 | 8·661 | 8·621 | 8·579 | 8·535 | 8·489 | 8·439 | 8·386 | 8·328 |
| 80 | 8·903 | 8·867 | 8·831 | 8·794 | 8·758 | 8·721 | 8·684 | 8·645 | 8·606 | 8·564 | 8·521 | 8·476 | 8·427 | 8·375 |
| 82 | 8·916 | 8·881 | 8·846 | 8·811 | 8·776 | 8·740 | 8·705 | 8·668 | 8·631 | 8·591 | 8·551 | 8·509 | 8·464 | 8·416 |
| 84 | 8·928 | 8·894 | 8·860 | 8·826 | 8·793 | 8·759 | 8·724 | 8·690 | 8·654 | 8·617 | 8·579 | 8·540 | 8·498 | 8·454 |
| 86 | 8·940 | 8·907 | 8·874 | 8·841 | 8·809 | 8·776 | 8·743 | 8·710 | 8·676 | 8·641 | 8·605 | 8·568 | 8·529 | 8·488 |
| 88 | 8·951 | 8·919 | 8·887 | 8·856 | 8·824 | 8·793 | 8·761 | 8·729 | 8·697 | 8·664 | 8·630 | 8·595 | 8·558 | 8·520 |
| 90 | 8·963 | 8·931 | 8·900 | 8·869 | 8·839 | 8·809 | 8·778 | 8·748 | 8·717 | 8·685 | 8·653 | 8·620 | 8·585 | 8·550 |

## LOGARITHMS
## FOR COMPUTING THE CORRECTION OF THE LATITUDE BY ACCOUNT.

### PART II. Observations on *different* sides either of the Meridian or of the Prime Vertical.

AZIMUTHS.

| | 8° | 10° | 12° | 14° | 16° | 18° | 20° | 22° | 24° | 26° | 28° | 30° | 32° | 34° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8° | 9·977 | | | | | | | | | | | | | |
| 10 | 9·931 | 9·879 | | | | | | | | | | | | |
| 12 | 9·897 | 9·840 | 9·797 | | | | | | | | | | | |
| 14 | 9·870 | 9·810 | 9·764 | 9·728 | | | | | | | | | | |
| 16 | 9·849 | 9·786 | 9·737 | 9·699 | 9·667 | | | | | | | | | |
| 18 | 9·832 | 9·766 | 9·715 | 9·674 | 9·641 | 9·613 | | | | | | | | |
| 20 | 9·818 | 9·749 | 9·696 | 9·654 | 9·619 | 9·589 | 9·564 | | | | | | | |
| 22 | 9·806 | 9·735 | 9·680 | 9·636 | 9·599 | 9·568 | 9·542 | 9·519 | | | | | | |
| 24 | 9·795 | 9·722 | 9·666 | 9·620 | 9·582 | 9·550 | 9·522 | 9·498 | 9·476 | | | | | |
| 26 | 9·786 | 9·712 | 9·654 | 9·606 | 9·567 | 9·534 | 9·505 | 9·480 | 9·457 | 9·437 | | | | |
| 28 | 9·778 | 9·702 | 9·643 | 9·594 | 9·554 | 9·519 | 9·489 | 9·463 | 9·440 | 9·418 | 9·399 | | | |
| 30 | 9·771 | 9·693 | 9·633 | 9·583 | 9·542 | 9·506 | 9·475 | 9·448 | 9·424 | 9·402 | 9·382 | 9·364 | | |
| 32 | 9·764 | 9·686 | 9·624 | 9·573 | 9·530 | 9·494 | 9·462 | 9·434 | 9·409 | 9·386 | 9·366 | 9·347 | 9·329 | |
| 34 | 9·758 | 9·678 | 9·616 | 9·564 | 9·520 | 9·483 | 9·450 | 9·421 | 9·395 | 9·372 | 9·351 | 9·331 | 9·313 | 9·296 |
| 36 | 9·753 | 9·672 | 9·608 | 9·555 | 9·511 | 9·473 | 9·439 | 9·410 | 9·383 | 9·359 | 9·337 | 9·316 | 9·298 | 9·280 |
| 38 | 9·748 | 9·666 | 9·601 | 9·547 | 9·502 | 9·463 | 9·429 | 9·397 | 9·371 | 9·346 | 9·324 | 9·303 | 9·283 | 9·265 |
| 40 | 9·743 | 9·660 | 9·594 | 9·540 | 9·494 | 9·454 | 9·419 | 9·388 | 9·360 | 9·335 | 9·311 | 9·290 | 9·270 | 9·251 |
| 42 | 9·739 | 9·655 | 9·588 | 9·533 | 9·486 | 9·446 | 9·410 | 9·378 | 9·350 | 9·324 | 9·300 | 9·278 | 9·257 | 9·238 |
| 44 | 9·735 | 9·650 | 9·583 | 9·527 | 9·479 | 9·438 | 9·402 | 9·369 | 9·340 | 9·313 | 9·28[illegible] | 9·266 | 9·245 | 9·225 |
| 46 | 9·731 | 9·646 | 9·578 | 9·521 | 9·473 | 9·431 | 9·394 | 9·361 | 9·331 | 9·303 | 9·278 | 9·255 | 9·233 | 9·213 |
| 48 | 9·728 | 9·642 | 9·573 | 9·515 | 9·466 | 9·424 | 9·386 | 9·352 | 9·322 | 9·294 | 9·268 | 9·244 | 9·222 | 9·201 |
| 50 | 9·725 | 9·638 | 9·568 | 9·510 | 9·460 | 9·417 | 9·379 | 9·344 | 9·313 | 9·285 | 9·258 | 9·234 | 9·211 | 9·190 |
| 52 | 9·721 | 9·634 | 9·563 | 9·504 | 9·454 | 9·410 | 9·372 | 9·337 | 9·305 | 9·276 | 9·249 | 9·224 | 9·201 | 9·179 |
| 54 | 9·718 | 9·630 | 9·559 | 9·499 | 9·449 | 9·404 | 9·365 | 9·329 | 9·297 | 9·267 | 9·240 | 9·215 | 9·191 | 9·168 |
| 56 | 9·715 | 9·626 | 9·555 | 9·495 | 9·443 | 9·398 | 9·358 | 9·322 | 9·289 | 9·259 | 9·231 | 9·205 | 9·181 | 9·158 |
| 58 | 9·713 | 9·623 | 9·551 | 9·490 | 9·438 | 9·392 | 9·352 | 9·315 | 9·282 | 9·251 | 9·223 | 9·196 | 9·171 | 9·148 |
| 60 | 9·710 | 9·620 | 9·547 | 9·486 | 9·433 | 9·387 | 9·346 | 9·309 | 9·275 | 9·243 | 9·215 | 9·187 | 9·162 | 9·138 |
| 62 | 9·707 | 9·617 | 9·543 | 9·481 | 9·428 | 9·381 | 9·340 | 9·302 | 9·268 | 9·236 | 9·206 | 9·179 | 9·153 | 9·128 |
| 64 | 9·705 | 9·613 | 9·539 | 9·477 | 9·423 | 9·376 | 9·334 | 9·296 | 9·261 | 9·228 | 9·198 | 9·170 | 9·144 | 9·118 |
| 66 | 9·702 | 9·610 | 9·536 | 9·473 | 9·419 | 9·371 | 9·328 | 9·289 | 9·254 | 9·221 | 9·191 | 9·162 | 9·135 | 9·109 |
| 68 | 9·700 | 9·607 | 9·532 | 9·469 | 9·414 | 9·366 | 9·322 | 9·283 | 9·247 | 9·214 | 9·183 | 9·154 | 9·126 | 9·100 |
| 70 | 9·698 | 9·605 | 9·529 | 9·465 | 9·410 | 9·361 | 9·317 | 9·277 | 9·241 | 9·207 | 9·175 | 9·145 | 9·117 | 9·090 |
| 72 | 9·695 | 9·602 | 9·525 | 9·461 | 9·405 | 9·356 | 9·311 | 9·271 | 9·234 | 9·200 | 9·167 | 9·137 | 9·108 | 9·081 |
| 74 | 9·693 | 9·599 | 9·522 | 9·457 | 9·401 | 9·351 | 9·306 | 9·265 | 9·228 | 9·193 | 9·160 | 9·129 | 9·100 | 9·072 |
| 76 | 9·691 | 9·596 | 9·519 | 9·453 | 9·396 | 9·346 | 9·301 | 9·259 | 9·221 | 9·186 | 9·152 | 9·121 | 9·091 | 9·062 |
| 78 | 9·689 | 9·594 | 9·516 | 9·450 | 9·392 | 9·341 | 9·295 | 9·253 | 9·215 | 9·179 | 9·145 | 9·113 | 9·082 | 9·053 |
| 80 | 9·687 | 9·591 | 9·512 | 9·446 | 9·388 | 9·336 | 9·290 | 9·247 | 9·208 | 9·172 | 9·137 | 9·105 | 9·074 | 9·044 |
| 82 | 9·685 | 9·588 | 9·509 | 9·442 | 9·384 | 9·332 | 9·285 | 9·241 | 9·202 | 9·165 | 9·130 | 9·096 | 9·065 | 9·034 |
| 84 | 9·682 | 9·586 | 9·506 | 9·438 | 9·379 | 9·327 | 9·279 | 9·236 | 9·195 | 9·157 | 9·122 | 9·088 | 9·056 | 9·025 |
| 86 | 9·680 | 9·583 | 9·503 | 9·435 | 9·375 | 9·322 | 9·274 | 9·230 | 9·189 | 9·150 | 9·114 | 9·080 | 9·047 | 9·015 |
| 88 | 9·678 | 9·580 | 9·500 | 9·431 | 9·371 | 9·317 | 9·268 | 9·224 | 9·182 | 9·143 | 9·106 | 9·071 | 9·037 | 9·005 |
| 90 | 9·676 | 9·578 | 9·496 | 9·427 | 9·366 | 9·312 | 9·263 | 9·218 | 9·175 | 9·136 | 9·098 | 9·062 | 9·028 | 8·995 |

| | 36° | 38° | 40° | 42° | 44° | 46° | 48° | 50° | 52° | 54° | 56° | 58° | 60° | 62° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 36° | 9·264 | | | | | | | | | | | | | |
| 38 | 9·248 | 9·232 | | | | | | | | | | | | |
| 40 | 9·234 | 9·217 | 9·201 | | | | | | | | | | | |
| 42 | 9·220 | 9·202 | 9·186 | 9·171 | | | | | | | | | | |
| 44 | 9·206 | 9·189 | 9·172 | 9·156 | 9·140 | | | | | | | | | |
| 46 | 9·193 | 9·175 | 9·158 | 9·141 | 9·125 | 9·110 | | | | | | | | |
| 48 | 9·181 | 9·162 | 9·145 | 9·127 | 9·111 | 9·095 | 9·079 | | | | | | | |
| 50 | 9·169 | 9·150 | 9·132 | 9·114 | 9·097 | 9·080 | 9·064 | 9·049 | | | | | | |
| 52 | 9·158 | 9·138 | 9·119 | 9·101 | 9·083 | 9·066 | 9·050 | 9·034 | 9·018 | | | | | |
| 54 | 9·147 | 9·126 | 9·107 | 9·088 | 9·070 | 9·052 | 9·035 | 9·019 | 9·002 | 8·986 | | | | |
| 56 | 9·136 | 9·115 | 9·095 | 9·076 | 9·057 | 9·039 | 9·021 | 9·004 | 8·987 | 8·970 | 8·954 | | | |
| 58 | 9·125 | 9·104 | 9·083 | 9·063 | 9·044 | 9·025 | 9·007 | 8·989 | 8·972 | 8·955 | 8·938 | 8·921 | | |
| 60 | 9·115 | 9·093 | 9·072 | 9·051 | 9·032 | 9·012 | 8·994 | 8·975 | 8·957 | 8·939 | 8·921 | 8·904 | 8·886 | |
| 62 | 9·105 | 9·083 | 9·060 | 9·039 | 9·019 | 8·999 | 8·980 | 8·961 | 8·942 | 8·924 | 8·905 | 8·887 | 8·869 | 8·851 |
| 64 | 9·094 | 9·071 | 9·049 | 9·028 | 9·007 | 8·986 | 8·966 | 8·947 | 8·927 | 8·908 | 8·889 | 8·870 | 8·851 | 8·832 |
| 66 | 9·084 | 9·061 | 9·038 | 9·016 | 8·994 | 8·973 | 8·953 | 8·933 | 8·913 | 8·893 | 8·873 | 8·853 | 8·834 | 8·814 |
| 68 | 9·074 | 9·050 | 9·027 | 9·004 | 8·982 | 8·960 | 8·939 | 8·918 | 8·898 | 8·877 | 8·857 | 8·836 | 8·816 | 8·795 |

LOGARITHMS
FOR COMPUTING THE CORRECTION OF THE LATITUDE BY ACCOUNT
PART II. (continued.) Observations on *different* sides
either of the Meridian or of the Prime Vertical.

| | AZIMUTHS. | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 36° | 38° | 40° | 42° | 44° | 46° | 48° | 50° | 52° | 54° | 56° | 58° | 60° | 62° |
| 70° | 9·065 | 9·040 | 9·016 | 8·993 | 8·970 | 8·948 | 8·926 | 8·904 | 8·883 | 8·862 | 8·848 | 8·819 | 8·798 | 8·776 |
| 72 | 9·055 | 9·029 | 9·005 | 8·981 | 8·958 | 8·935 | 8·912 | 8·890 | 8·868 | 8·846 | 8·824 | 8·802 | 8·779 | 8·757 |
| 74 | 9·045 | 9·019 | 8·994 | 8·969 | 8·945 | 8·922 | 8·898 | 8·875 | 8·853 | 8·830 | 8·807 | 8·784 | 8·760 | 8·737 |
| 76 | 9·035 | 9·008 | 8·983 | 8·957 | 8·933 | 8·909 | 8·885 | 8·861 | 8·837 | 8·813 | 8·790 | 8·766 | 8·741 | 8·717 |
| 78 | 9·025 | 8·998 | 8·971 | 8·946 | 8·920 | 8·895 | 8·870 | 8·846 | 8·821 | 8·797 | 8·772 | 8·747 | 8·721 | 8·696 |
| 80 | 9·015 | 8·987 | 8·960 | 8·933 | 8·907 | 8·882 | 8·856 | 8·831 | 8·805 | 8·780 | 8·754 | 8·728 | 8·701 | 8·674 |
| 82 | 9·005 | 8·976 | 8·948 | 8·921 | 8·894 | 8·868 | 8·841 | 8·815 | 8·789 | 8·762 | 8·725 | 8·708 | 8·680 | 8·651 |
| 84 | 8·995 | 8·965 | 8·937 | 8·909 | 8·881 | 8·854 | 8·826 | 8·799 | 8·772 | 8·744 | 8·716 | 8·687 | 8·658 | 8·628 |
| 86 | 8·984 | 8·954 | 8·925 | 8·896 | 8·867 | 8·839 | 8·811 | 8·782 | 8·754 | 8·725 | 8·696 | 8·666 | 8·635 | 8·603 |
| 88 | 8·974 | 8·943 | 8·913 | 8·883 | 8·853 | 8·824 | 8·795 | 8·765 | 8·736 | 8·706 | 8·675 | 8·643 | 8·611 | 8·577 |
| 90 | 8·963 | 8·931 | 8·900 | 8·869 | 8·839 | 8·809 | 8·778 | 8·748 | 8·717 | 8·685 | 8·653 | 8·620 | 8·585 | 8·550 |

TABLE 72

LOGARITHMS
FOR COMPUTING THE EQUATION OF EQUAL ALTITUDES

| Interval. | Log. A. | Log. B. | Interval. | Log. A. | Log. B. | Interval. | Log. A. | Log. B |
|---|---|---|---|---|---|---|---|---|
| 1h 30m | 2·2725 | 2·2809 | 4h 30m | 2·2499 | 2·3300 | 7h 30m | 2·2032 | 2·4584 |
| 1 35 | 2·2722 | 2·2816 | 4 35 | 2·2489 | 2·3323 | 7 35 | 2·2015 | 2·4645 |
| 1 40 | 2·2719 | 2·2823 | 4 40 | 2·2479 | 2·3346 | 7 40 | 2·1998 | 2·4696 |
| 1 45 | 2·2715 | 2·2831 | 4 45 | 2·2469 | 2·3370 | 7 45 | 2·1980 | 2·4755 |
| 1 50 | 2·2711 | 2·2838 | 4 50 | 2·2459 | 2·3394 | 7 50 | 2·1963 | 2·4814 |
| 1 55 | 2·2707 | 2·2846 | 4 55 | 2·2449 | 2·3418 | 7 55 | 2·1945 | 2·4876 |
| 2 0 | 2·2703 | 2·2854 | 5 0 | 2·2438 | 2·3444 | 8 0 | 2·1928 | 2·4938 |
| 2 5 | 2·2699 | 2·2863 | 5 5 | 2·2428 | 2·3470 | 8 5 | 2·1910 | 2·5004 |
| 2 10 | 2·2695 | 2·2872 | 5 10 | 2·2417 | 2·3495 | 8 10 | 2·1892 | 2·5070 |
| 2 15 | 2·2690 | 2·2882 | 5 15 | 2·2406 | 2·3524 | 8 15 | 2·1874 | 2·5141 |
| 2 20 | 2·2685 | 2·2891 | 5 20 | 2·2394 | 2·3552 | 8 20 | 2·1855 | 2·5211 |
| 2 25 | 2·2680 | 2·2902 | 5 25 | 2·2383 | 2·3581 | 8 25 | 2·1836 | 2·5286 |
| 2 30 | 2·2675 | 2·2912 | 5 30 | 2·2371 | 2·3610 | 8 30 | 2·1817 | 2·5360 |
| 2 35 | 2·2669 | 2·2924 | 5 35 | 2·2359 | 2·3641 | 8 35 | 2·1798 | 2·5439 |
| 2 40 | 2·2664 | 2·2935 | 5 40 | 2·2347 | 2·3671 | 8 40 | 2·1778 | 2·5518 |
| 2 45 | 2·2658 | 2·2947 | 5 45 | 2·2334 | 2·3703 | 8 45 | 2·1758 | 2·5602 |
| 2 50 | 2·2652 | 2·2950 | 5 50 | 2·2322 | 2·3735 | 8 50 | 2·1738 | 2·5685 |
| 2 55 | 2·2646 | 2·2972 | 5 55 | 2·2309 | 2·3768 | 8 55 | 2·1718 | 2·5776 |
| 3 0 | 2·2641 | 2·2985 | 6 0 | 2·2297 | 2·3802 | 9 0 | 2·1697 | 2·5868 |
| 3 5 | 2·2634 | 2·2998 | 6 5 | 2·2283 | 2·3837 | 9 5 | 2·1677 | 2·5963 |
| 3 10 | 2·2628 | 2·3012 | 6 10 | 2·2271 | 2·3873 | 9 10 | 2·1656 | 2·6063 |
| 3 15 | 2·2621 | 2·3027 | 6 15 | 2·2257 | 2·3910 | 9 15 | 2·1635 | 2·6164 |
| 3 20 | 2·2614 | 2·3042 | 6 20 | 2·2244 | 2·3947 | 9 20 | 2·1613 | 2·6273 |
| 3 25 | 2·2607 | 2·3058 | 6 25 | 2·2230 | 2·3986 | 9 25 | 2·1592 | 2·6384 |
| 3 30 | 2·2600 | 2·3073 | 6 30 | 2·2216 | 2·4024 | 9 30 | 2·1570 | 2·6499 |
| 3 35 | 2·2592 | 2·3090 | 6 35 | 2·2202 | 2·4065 | 9 35 | 2·1547 | 2·6619 |
| 3 40 | 2·2585 | 2·3106 | 6 40 | 2·2187 | 2·4106 | 9 40 | 2·1525 | 2·6744 |
| 3 45 | 2·2577 | 2·3124 | 6 45 | 2·2173 | 2·4149 | 9 45 | 2·1502 | 2·6874 |
| 3 50 | 2·2569 | 2·3141 | 6 50 | 2·2158 | 2·4192 | 9 50 | 2·1480 | 2·7011 |
| 3 55 | 2·2561 | 2·3159 | 6 55 | 2·2143 | 2·4237 | 9 55 | 2·1457 | 2·7154 |
| 4 0 | 2·2553 | 2·3177 | 7 0 | 2·2127 | 2·4283 | 10 0 | 2·1433 | 2·7303 |
| 4 5 | 2·2544 | 2·3196 | 7 5 | 2·2112 | 2·4330 | 10 5 | 2·1409 | 2·7460 |
| 4 10 | 2·2536 | 2·3216 | 7 10 | 2·2096 | 2·4378 | 10 10 | 2·1386 | 2·7626 |
| 4 15 | 2·2527 | 2·3236 | 7 15 | 2·2080 | 2·4426 | 10 15 | 2·1361 | 2·7801 |
| 4 20 | 2·2518 | 2·3257 | 7 20 | 2·2064 | 2·4478 | 10 20 | 2·1337 | 2·7984 |
| 4 25 | 2·2509 | 2·3278 | 7 25 | 2·2048 | 2·4531 | 10 25 | 2·1312 | 2·8076 |

## THE LOGARITHMIC DIFFERENCE

(Barometer, 30 inches. Fahrenheit's Thermometer, 50°.)

| ☽ App. Alt. | Horizontal Parallax. 53' | 54' | 55' | 56' | 57' | 58' | 59' | 60' | 61' | ' of Par. | Corr. for ' of Par. 0' | 2' | 4' | 6' | 8' | 10' | Cor. for ' of Alt. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° ' | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | | | | | | | | | |
| 3 0 | 9841 | 9833 | 9825 | 9817 | 9809 | 9800 | 9792 | 9784 | 9776 | 0 | 0 | 0 | 0 | 1 | 2 | 2 | | |
| 10 | 9822 | 9814 | 9806 | 9797 | 9789 | 9780 | 9771 | 9763 | 9754 | 10 | 2 | 2 | 2 | 3 | 3 | 3 | | |
| 20 | 9804 | 9795 | 9786 | 9777 | 9769 | 9760 | 9751 | 9742 | 9732 | 20 | 3 | 3 | 4 | 4 | 5 | 5 | | |
| 30 | 9785 | 9776 | 9767 | 9758 | 9748 | 9739 | 9730 | 9720 | 9711 | 30 | 5 | 5 | 5 | 6 | 6 | 6 | | |
| 40 | 9767 | 9757 | 9747 | 9738 | 9728 | 9718 | 9709 | 9699 | 9689 | 40 | 6 | 7 | 7 | 8 | 8 | 8 | | |
| 50 | 9748 | 9738 | 9728 | 9718 | 9708 | 9698 | 9687 | 9677 | 9667 | 50 | 8 | 8 | 9 | 9 | 10 | 11 | sub. | |
| 4 0 | 9729 | 9718 | 9708 | 9698 | 9687 | 9677 | 9666 | 9656 | 9645 | 0. | 0 | 0 | 0 | 1 | 2 | 2 | H P. | |
| 10 | 9710 | 9699 | 9689 | 9678 | 9667 | 9656 | 9645 | 9634 | 9623 | 10 | 2 | 2 | 2 | 3 | 4 | 4 | 53 | |
| 20 | 9691 | 9680 | 9669 | 9658 | 9646 | 9635 | 9624 | 9613 | 9601 | 20 | 4 | 4 | 5 | 5 | 6 | 6 | | |
| 30 | 9672 | 9660 | 9649 | 9637 | 9626 | 9614 | 9603 | 9591 | 9579 | 30 | 6 | 6 | 7 | 7 | 8 | 8 | 1' | 2 |
| 40 | 9653 | 9641 | 9629 | 9617 | 9605 | 9593 | 9581 | 9569 | 9557 | 40 | 8 | 8 | 9 | 9 | 10 | 10 | 2 | 4 |
| 50 | 9634 | 9622 | 9609 | 9597 | 9585 | 9572 | 9560 | 9547 | 9535 | 50 | 10 | 10 | 11 | 11 | 12 | 12 | 3 | 6 |
| 5 0 | 9614 | 9602 | 9589 | 9576 | 9563 | 9551 | 9538 | 9525 | 9512 | 0 | 0 | 0 | 1 | 1 | 2 | 2 | 4 | 8 |
| 10 | 9595 | 9582 | 9569 | 9556 | 9543 | 9530 | 9516 | 9503 | 9490 | 10 | 2 | 3 | 3 | 3 | 4 | 4 | 5 | 9 |
| 20 | 9576 | 9562 | 9549 | 9535 | 9522 | 9509 | 9495 | 9481 | 9468 | 20 | 4 | 5 | 5 | 6 | 6 | 7 | 6 | 11 |
| 30 | 9557 | 9543 | 9529 | 9515 | 9501 | 9487 | 9474 | 9460 | 9446 | 30 | 7 | 7 | 8 | 8 | 9 | 9 | 7 | 13 |
| 40 | 9538 | 9523 | 9509 | 9495 | 9481 | 9466 | 9452 | 9438 | 9424 | 40 | 9 | 10 | 10 | 11 | 11 | 12 | 8 | 15 |
| 50 | 9518 | 9504 | 9489 | 9474 | 9460 | 9445 | 9431 | 9416 | 9401 | 50 | 12 | 13 | 13 | 14 | 14 | 14 | 9 | 17 |
| 6 0 | 9499 | 9484 | 9469 | 9454 | 9439 | 9424 | 9409 | 9394 | 9379 | 0 | 0 | 0 | 1 | 1 | 2 | 3 | | |
| 10 | 9480 | 9465 | 9449 | 9434 | 9418 | 9403 | 9388 | 9372 | 9357 | 10 | 3 | 3 | 4 | 4 | 5 | 5 | | |
| 20 | 9461 | 9445 | 9429 | 9413 | 9398 | 9382 | 9366 | 9350 | 9334 | 20 | 5 | 6 | 6 | 7 | 7 | 8 | | |
| 30 | 9441 | 9425 | 9409 | 9393 | 9377 | 9361 | 9345 | 9329 | 9312 | 30 | 8 | 8 | 9 | 10 | 10 | 11 | | |
| 40 | 9422 | 9406 | 9389 | 9373 | 9356 | 9340 | 9323 | 9307 | 9290 | 40 | 11 | 11 | 12 | 13 | 13 | 1 | | |
| 50 | 9403 | 9386 | 9369 | 9352 | 9335 | 9319 | 9301 | 9285 | 9268 | 50 | 14 | 15 | 15 | 16 | 16 | 16 | | |
| 7 0 | 9383 | 9366 | 9349 | 9332 | 9314 | 9297 | 9280 | 9263 | 9246 | 0 | 0 | 1 | 1 | 2 | 2 | 3 | | |
| 10 | 9364 | 9347 | 9329 | 9311 | 9294 | 9276 | 9258 | 9241 | 9223 | 10 | 3 | 3 | 4 | 5 | 5 | 6 | | |
| 20 | 9345 | 9327 | 9309 | 9291 | 9273 | 9255 | 9237 | 9219 | 9201 | 20 | 6 | 7 | 7 | 8 | 8 | 9 | | |
| 30 | 9326 | 9307 | 9289 | 9271 | 9252 | 9234 | 9216 | 9197 | 9179 | 30 | 9 | 10 | 10 | 11 | 12 | 12 | | |
| 40 | 9306 | 9288 | 9269 | 9250 | 9232 | 9213 | 9194 | 9175 | 9157 | 40 | 12 | 13 | 14 | 14 | 15 | 16 | H.P. | |
| 50 | 9287 | 9268 | 9249 | 9230 | 9211 | 9192 | 9173 | 9154 | 9134 | 50 | 16 | 16 | 17 | 18 | 18 | 19 | 61' | |
| 8 0 | 9268 | 9248 | 9229 | 9209 | 9190 | 9170 | 9151 | 9132 | 9112 | 0 | 0 | 1 | 1 | 2 | 3 | 3 | | |
| 10 | 9249 | 9229 | 9209 | 9189 | 9169 | 9149 | 9130 | 9110 | 9090 | 10 | 3 | 4 | 5 | 5 | 6 | 7 | 1' | 2 |
| 20 | 9229 | 9209 | 9189 | 9169 | 9149 | 9128 | 9108 | 9088 | 9068 | 20 | 7 | 7 | 8 | 9 | 9 | 10 | 2 | 4 |
| 30 | 9210 | 9189 | 9169 | 9148 | 9128 | 9107 | 9087 | 9066 | 9046 | 30 | 10 | 11 | 12 | 12 | 13 | 14 | 3 | 7 |
| 40 | 9191 | 9170 | 9149 | 9128 | 9107 | 9086 | 9065 | 9044 | 9023 | 40 | 14 | 15 | 15 | 16 | 17 | 18 | 4 | 9 |
| 50 | 9172 | 9150 | 9129 | 9108 | 9086 | 9065 | 9044 | 9022 | 9001 | 50 | 18 | 19 | 19 | 20 | 21 | 21 | 5 | 11 |
| 9 0 | 9152 | 9131 | 9109 | 9087 | 9066 | 9044 | 9022 | 9001 | 8979 | 0 | 0 | 1 | 1 | 2 | 3 | 4 | 6 | 13 |
| 10 | 9133 | 9111 | 9089 | 9067 | 9045 | 9023 | 9001 | 8979 | 8957 | 10 | 4 | 4 | 5 | 6 | [illegible] | 7 | 7 | 15 |
| 20 | 9114 | 9091 | 9069 | 9047 | 9024 | 9002 | 8979 | 8957 | 8935 | 20 | 7 | 8 | 9 | 10 | 10 | 11 | 8 | 18 |
| 30 | 9095 | 9072 | 9049 | 9026 | 9004 | 8981 | 8958 | 8935 | 8912 | 30 | 11 | 12 | 13 | 14 | 14 | 15 | 9 | 20 |
| 40 | 9075 | 9052 | 9029 | 9006 | 8983 | 8960 | 8937 | 8913 | 8890 | 40 | 15 | 16 | 17 | 18 | 18 | 20 | | |
| 50 | 9·56 | 9032 | 9009 | 8986 | 8962 | 8939 | 8915 | 8892 | 8868 | 50 | 20 | 20 | 21 | 22 | 23 | 23 | | |

| Sun's Alt. | 5° | 6° | 7° | 8° | 14° | 25° | 34° | 42° | 51° | 64° | 90° |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Sub* | 17 | 13 | 11 | 9 | 7 | 9 | 11 | 13 | 15 | 17 | 18 |

| Star's Alt. | 5° | 6° | 7° | 8° | 9° | 11° | 12° | 14° | 18° | 30° |
|---|---|---|---|---|---|---|---|---|---|---|
| *Sub.* | 15 | 11 | 9 | 7 | 5 | 4 | 3 | 2 | 1 | 0 |

The Logarithmic Difference is not given in this Table for altitudes less than 3°, because the lunar observation ought not to be employed with very low altitudes.

## THE LOGARITHMIC DIFFERENCE

(Barometer, 30 inches. Fahrenheit's Thermometer, 50°.)

| ☽ App. Alt | Horizontal Parallax. 53′ | 54′ | 55′ | 56′ | 57′ | 58′ | 59′ | 60′ | 61′ | ″ of Par. | Corr. for ″ of Par. *sub.* 0″ | 2″ | 4″ | 6″ | 8″ | 10″ | Cor. for ′ of Alt. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° ′ | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | | | | | | | | |
| 10 0 | 9037 | 9013 | 8989 | 8965 | 8941 | 8917 | 8894 | 8870 | 8846 | 0 | 0 | 1 | 2 | 2 | 3 | 4 | |
| 10 | 9018 | 8993 | 8969 | 8945 | 8921 | 8896 | 8872 | 8848 | 8824 | 10 | 4 | 5 | 6 | 6 | 7 | 8 | |
| 20 | 8998 | 8974 | 8949 | 8925 | 8900 | 8875 | 8851 | 8826 | 8802 | 20 | 8 | 9 | 10 | 11 | 11 | 12 | |
| 30 | 8979 | 8954 | 8929 | 8904 | 8879 | 8854 | 8830 | 8805 | 8780 | 30 | 12 | 13 | 14 | 15 | 16 | 17 | |
| 40 | 8960 | 8935 | 8909 | 8884 | 8859 | 8833 | 8808 | 8783 | 8758 | 40 | 17 | 18 | 18 | 19 | 20 | 21 | |
| 50 | 8941 | 8915 | 8889 | 8864 | 8838 | 8812 | 8787 | 8761 | 8735 | 50 | 21 | 22 | 23 | 24 | 25 | 26 | *sub.* |
| 11 0 | 8922 | 8895 | 8869 | 8843 | 8817 | 8791 | 8765 | 8739 | 8713 | 0 | 0 | 1 | 2 | 3 | 3 | 4 | |
| 10 | 8903 | 8876 | 8850 | 8823 | 8797 | 8771 | 8744 | 8718 | 8691 | 10 | 4 | 5 | 6 | 7 | 8 | 9 | |
| 20 | 8883 | 8857 | 8830 | 8803 | 8776 | 8750 | 8723 | 8696 | 8669 | 20 | 9 | 10 | 11 | 12 | 13 | 13 | |
| 30 | 8864 | 8837 | 8810 | 8783 | 8756 | 8729 | 8702 | 8675 | 8647 | 30 | 13 | 14 | 15 | 16 | 17 | 18 | H.P. |
| 40 | 8845 | 8818 | 8790 | 8763 | 8735 | 8708 | 8680 | 8653 | 8625 | 40 | 18 | 19 | 20 | 21 | 22 | 23 | 53′ |
| 50 | 8826 | 8799 | 8771 | 8743 | 8715 | 8687 | 8659 | 8631 | 8604 | 50 | 23 | 24 | 25 | 26 | 27 | 28 | |
| 12 0 | 8807 | 8779 | 8751 | 8723 | 8694 | 8666 | 8638 | 8610 | 8582 | 0 | 0 | 1 | 2 | 3 | 4 | 5 | 1′ \| 2 |
| 10 | 8788 | 8760 | 8731 | 8703 | 8674 | 8645 | 8617 | 8588 | 8560 | 10 | 5 | 6 | 7 | 8 | 8 | 10 | 2 \| 4 |
| 20 | 8769 | 8740 | 8711 | 8682 | 8653 | 8624 | 8595 | 8566 | 8538 | 20 | 10 | 11 | 12 | 12 | 13 | 15 | 3 \| 6 |
| 30 | 8750 | 8721 | 8691 | 8662 | 8633 | 8603 | 8574 | 8545 | 8516 | 30 | 15 | 16 | 17 | 17 | 18 | 20 | 4 \| 8 |
| 40 | 8731 | 8701 | 8672 | 8642 | 8612 | 8582 | 8553 | 8523 | 8494 | 40 | 20 | 21 | 22 | 23 | 24 | 25 | 5 \| 9 |
| 50 | 8712 | 8682 | 8652 | 8622 | 8592 | 8562 | 8532 | 8502 | 8472 | 50 | 25 | 26 | 27 | 28 | 29 | 29 | 6 \| 11 |
| 13 0 | 8693 | 8662 | 8632 | 8601 | 8571 | 8541 | 8510 | 8480 | 8450 | 0 | 0 | 1 | 2 | 3 | 4 | 5 | 7 \| 13 |
| 10 | 8674 | 8643 | 8612 | 8581 | 8551 | 8520 | 8489 | 8458 | 8428 | 10 | 5 | 6 | 7 | 8 | 9 | 10 | 8 \| 15 |
| 20 | 8655 | 8624 | 8592 | 8561 | 8530 | 8499 | 8468 | 8437 | 8406 | 20 | 10 | 11 | 12 | 13 | 14 | 16 | 9 \| 17 |
| 30 | 8636 | 8604 | 8573 | 8541 | 8510 | 8478 | 8447 | 8416 | 8384 | 30 | 16 | 17 | 18 | 19 | 20 | 21 | |
| 40 | 8617 | 8585 | 8553 | 8521 | 8490 | 8458 | 8426 | 8394 | 8362 | 40 | 21 | 22 | 23 | 24 | 25 | 27 | |
| 50 | 8598 | 8566 | 8533 | 8501 | 8469 | 8437 | 8405 | 8373 | 8340 | 50 | 27 | 28 | 29 | 30 | 31 | 32 | |
| 14 0 | 8579 | 8546 | 8514 | 8481 | 8449 | 8416 | 8384 | 8351 | 8318 | 0 | 0 | 1 | 2 | 3 | 4 | 5 | |
| 10 | 8560 | 8527 | 8494 | 8461 | 8428 | 8395 | 8363 | 8330 | 8297 | 10 | 5 | 7 | 8 | 9 | 10 | 11 | |
| 20 | 8541 | 8508 | 8474 | 8441 | 8408 | 8375 | 8341 | 8308 | 8275 | 20 | 11 | 12 | 13 | 14 | 15 | 17 | |
| 30 | 8522 | 8489 | 8455 | 8421 | 8388 | 8354 | 8320 | 8287 | 8253 | 30 | 17 | 18 | 19 | 20 | 21 | 23 | |
| 40 | 8503 | 8469 | 8435 | 8401 | 8367 | 8333 | 8299 | 8266 | 8232 | 40 | 23 | 24 | 25 | 26 | 27 | 28 | |
| 50 | 8484 | 8450 | 8416 | 8381 | 8347 | 8313 | 8278 | 8244 | 8210 | 50 | 28 | 30 | 31 | 32 | 33 | 34 | |
| 15 0 | 8465 | 8431 | 8396 | 8361 | 8327 | 8292 | 8257 | 8223 | 8188 | 0 | 0 | 1 | 2 | 3 | 5 | 6 | |
| 10 | 8447 | 8412 | 8377 | 8342 | 8307 | 8271 | 8236 | 8201 | 8166 | 10 | 6 | 7 | 8 | 9 | 10 | 12 | |
| 20 | 8428 | 8392 | 8357 | 8322 | 8286 | 8251 | 8215 | 8180 | 8145 | 20 | 12 | 13 | 14 | 15 | 16 | 18 | |
| 30 | 8409 | 8373 | 8338 | 8302 | 8266 | 8230 | 8195 | 8159 | 8123 | 30 | 18 | 19 | 20 | 22 | 23 | 24 | |
| 40 | 8390 | 8354 | 8318 | 8282 | 8246 | 8210 | 8174 | 8138 | 8101 | 40 | 24 | 25 | 26 | 28 | 29 | 30 | |
| 50 | 8371 | 8335 | 8299 | 8262 | 8226 | 8189 | 8153 | 8116 | 8080 | 50 | 30 | 31 | 33 | 34 | 35 | 36 | |
| 16 0 | 8353 | 8316 | 8279 | 8242 | 8205 | 8169 | 8132 | 8095 | 8058 | 0 | 0 | 1 | 2 | 4 | 5 | 6 | |
| 10 | 8334 | 8297 | 8260 | 8222 | 8185 | 8148 | 8111 | 8074 | 8037 | 10 | 6 | 7 | 9 | 10 | 11 | 12 | |
| 20 | 8315 | 8278 | 8240 | 8203 | 8165 | 8128 | 8090 | 8053 | 8015 | 20 | 12 | 14 | 15 | 16 | 17 | 19 | |
| 30 | 8297 | 8259 | 8221 | 8183 | 8145 | 8107 | 8069 | 8031 | 7994 | 30 | 19 | 20 | 21 | 23 | 24 | 24 | |
| 40 | 8278 | 8240 | 8201 | 8163 | 8125 | 8087 | 8048 | 8010 | 7972 | 40 | 25 | 27 | 28 | 29 | 31 | 32 | |
| 50 | 8259 | 8221 | 8182 | 8143 | 8105 | 8066 | 8028 | 7989 | 7950 | 50 | 32 | 33 | 35 | 36 | 37 | 38 | |
| 17 0 | 8240 | 8201 | 8162 | 8124 | 8085 | 8046 | 8007 | 7968 | 7929 | 0 | 0 | 1 | 3 | 4 | 5 | 7 | H.P. |
| 10 | 8222 | 8183 | 8143 | 8104 | 8065 | 8025 | 7986 | 7947 | 7907 | 10 | 7 | 8 | 9 | 10 | 12 | 13 | 61′ |
| 20 | 8203 | 8164 | 8124 | 8084 | 8045 | 8005 | 7965 | 7926 | 7886 | 20 | 13 | 14 | 16 | 17 | 18 | 20 | |
| 30 | 8185 | 8145 | 8105 | 8065 | 8025 | 7985 | 7945 | 7905 | 7865 | 30 | 20 | 21 | 23 | 24 | 25 | 27 | |
| 40 | 8166 | 8126 | 8085 | 8045 | 8005 | 7964 | 7924 | 7884 | 7843 | 40 | 27 | 28 | 30 | 34 | 32 | 34 | 1′ \| 2 |
| 50 | 8147 | 8107 | 8066 | 8025 | 7985 | 7944 | 7903 | 7863 | 7822 | 50 | 34 | 35 | 37 | 38 | 39 | 40 | 2 \| 4 |
| 18 0 | 8129 | 8088 | 8047 | 8006 | 7965 | 7924 | 7882 | 7841 | 7800 | 0 | 0 | 1 | 3 | 4 | 5 | 7 | 3 \| 7 |
| 10 | 8110 | 8069 | 8027 | 7986 | 7945 | 7903 | 7862 | 7820 | 7779 | 10 | 7 | 8 | 10 | 11 | 12 | 14 | 4 \| 9 |
| 20 | 8092 | 8050 | 8008 | 7967 | 7925 | 7883 | 7841 | 7800 | 7758 | 20 | 14 | 15 | 17 | 18 | 19 | 21 | 5 \| 11 |
| 30 | 8073 | 8031 | 7989 | 7947 | 7905 | 7863 | 7821 | 7779 | 7736 | 30 | 21 | 22 | 24 | 25 | 27 | 28 | 6 \| 13 |
| 40 | 8055 | 8012 | 7970 | 7927 | 7885 | 7842 | 7800 | 7758 | 7715 | 40 | 28 | 30 | 31 | 32 | 34 | 36 | 7 \| 15 |
| 50 | 8036 | 7993 | 7950 | 7908 | 7865 | 7822 | 7779 | 7737 | 7694 | 50 | 36 | 37 | 39 | 40 | 41 | 42 | 8 \| 18 |
| 19 0 | 8018 | 7974 | 7931 | 7888 | 7845 | 7802 | 7759 | 7715 | 7672 | 0 | 0 | 1 | 3 | 4 | 6 | 7 | 9 \| 20 |
| 10 | 7999 | 7956 | 7912 | 7869 | 7825 | 7782 | 7738 | 7695 | 7651 | 10 | 7 | 9 | 10 | 12 | 13 | 15 | |
| 20 | 7981 | 7937 | 7893 | 7849 | 7805 | 7762 | 7718 | 7674 | 7630 | 20 | 15 | 16 | 17 | 19 | 20 | 22 | |
| 30 | 7962 | 7918 | 7874 | 7830 | 7786 | 7741 | 7697 | 7653 | 7609 | 30 | 22 | 24 | 25 | 27 | 28 | 30 | |
| 40 | 7944 | 7899 | 7855 | 7810 | 7766 | 7721 | 7677 | 7632 | 7588 | 40 | 30 | 31 | 33 | 34 | 36 | 37 | |
| 50 | 7926 | 7881 | 7836 | 7791 | 7746 | 7701 | 7656 | 7611 | 7567 | 50 | 37 | 39 | 40 | 42 | 43 | 44 | |

| Sun's Alt. | 5° | 6° | 7° | 8° | 14° | 25° | 34° | 42° | 51° | 64° | 90° |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *sub.* | 17 | 13 | 11 | 9 | 7 | 9 | 11 | 13 | 15 | 17 | 18 |

| Star's Alt. | 5° | 6° | 7° | 8° | 9° | 11° | 12° | 14° | 18° | 30° |
|---|---|---|---|---|---|---|---|---|---|---|
| *sub.* | 15 | 11 | 9 | 7 | 5 | 4 | 3 | 2 | 1 | 0 |

## THE LOGARITHMIC DIFFERENCE

(Barometer, 30 inches. Fahrenheit's Thermometer, 50°)

| ☽ App. Alt. | | Horizontal Parallax. 53′ | 54′ | 55′ | 56′ | 57′ | 58′ | 59′ | 60′ | 61′ | ″ of Par. | Corr. for ″ of Par. sub 0″ | 2″ | 4″ | 6″ | 8″ | 10″ | Cor. for ′ of Alt. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° | ′ | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | | | | | | | | |
| 20 | 0 | 7907 | 7862 | 7817 | 7772 | 7726 | 7681 | 7636 | 7591 | 7545 | 0 | 0 | 1 | 3 | 4 | 6 | 8 | |
| | 10 | 7889 | 7843 | 7798 | 7752 | 7707 | 7661 | 7615 | 7570 | 7524 | 10 | 8 | 9 | 11 | 12 | 14 | 15 | |
| | 20 | 7871 | 7825 | 7779 | 7733 | 7687 | 7641 | 7595 | 7549 | 7503 | 20 | 15 | 17 | 18 | 20 | 21 | 23 | sub. |
| | 30 | 7852 | 7806 | 7760 | 7714 | 7667 | 7621 | 7575 | 7529 | 7482 | 30 | 23 | 25 | 26 | 28 | 29 | 34 | |
| | 40 | 7834 | 7788 | 7741 | 7694 | 7648 | 7601 | 7554 | 7508 | 7461 | 40 | 31 | 33 | 34 | 36 | 37 | 39 | |
| | 50 | 7816 | 7769 | 7722 | 7674 | 7628 | 7581 | 7534 | 7487 | 7440 | 50 | 39 | 41 | 42 | 44 | 45 | 46 | |
| 21 | 0 | 7798 | 7750 | 7703 | 7656 | 7608 | 7561 | 7514 | 7466 | 7419 | 0 | 0 | 2 | 3 | 5 | 6 | 8 | |
| | 10 | 7779 | 7732 | 7684 | 7636 | 7589 | 7541 | 7493 | 7446 | 7398 | 10 | 8 | 9 | 11 | 12 | 14 | 16 | H.P. |
| | 20 | 7761 | 7713 | 7665 | 7617 | 7569 | 7521 | 7473 | 7425 | 7377 | 20 | 16 | 18 | 19 | 21 | 22 | 24 | 53′ |
| | 30 | 7743 | 7695 | 7646 | 7598 | 7550 | 7501 | 7453 | 7405 | 7356 | 30 | 24 | 26 | 27 | 29 | 30 | 32 | |
| | 40 | 7725 | 7676 | 7628 | 7579 | 7530 | 7481 | 7433 | 7384 | 7336 | 40 | 32 | 34 | 36 | 37 | 39 | 41 | |
| | 50 | 7707 | 7658 | 7609 | 7560 | 7511 | 7462 | 7413 | 7364 | 7315 | 50 | 41 | 42 | 44 | 46 | 47 | 48 | 1′ 2 |
| 22 | 0 | 7689 | 7639 | 7590 | 7540 | 7491 | 7442 | 7392 | 7343 | 7294 | 0 | 0 | 2 | 3 | 5 | 7 | 8 | 2 4 |
| | 10 | 7671 | 7621 | 7571 | 7521 | 7472 | 7422 | 7372 | 7323 | 7273 | 10 | 8 | 10 | 12 | 13 | 15 | 17 | 3 5 |
| | 20 | 7653 | 7602 | 7552 | 7502 | 7452 | 7402 | 7352 | 7302 | 7252 | 20 | 17 | 18 | 20 | 22 | 23 | 25 | 4 7 |
| | 30 | 7635 | 7584 | 7534 | 7483 | 7433 | 7383 | 7332 | 7282 | 7232 | 30 | 25 | 27 | 28 | 30 | 32 | 34 | 5 9 |
| | 40 | 7617 | 7566 | 7515 | 7464 | 7414 | 7363 | 7312 | 7261 | 7211 | 40 | 34 | 35 | 37 | 39 | 40 | 42 | 6 11 |
| | 50 | 7598 | 7547 | 7496 | 7445 | 7394 | 7343 | 7292 | 7241 | 7190 | 50 | 42 | 42 | 45 | 48 | 49 | 50 | 7 13 |
| 23 | 0 | 7581 | 7529 | 7478 | 7426 | 7375 | 7323 | 7272 | 7221 | 7169 | 0 | 0 | 2 | 3 | 5 | 7 | 9 | 8 14 |
| | 10 | 7563 | 7511 | 7459 | 7407 | 7356 | 7304 | 7252 | 7200 | 7149 | 10 | 9 | 10 | 12 | 14 | 15 | 17 | 9 16 |
| | 20 | 7545 | 7493 | 7441 | 7389 | 7336 | 7284 | 7232 | 7180 | 7128 | 20 | 17 | 19 | 21 | 23 | 24 | 26 | |
| | 30 | 7527 | 7474 | 7422 | 7370 | 7317 | 7265 | 7212 | 7160 | 7107 | 30 | 26 | 28 | 30 | 31 | 33 | 35 | |
| | 40 | 7509 | 7456 | 7403 | 7351 | 7298 | 7245 | 7192 | 7140 | 7087 | 40 | 35 | 37 | 39 | 40 | 42 | 44 | |
| | 50 | 7491 | 7438 | 7385 | 7332 | 7279 | 7226 | 7173 | 7119 | 7066 | 50 | 44 | 46 | 48 | 50 | 51 | 53 | |
| 24 | 0 | 7473 | 7420 | 7366 | 7313 | 7259 | 7206 | 7153 | 7099 | 7046 | 0 | 0 | 2 | 4 | 5 | 7 | 9 | |
| | 10 | 7455 | 7402 | 7348 | 7294 | 7240 | 7187 | 7133 | 7079 | 7025 | 10 | 9 | 11 | 13 | 14 | 16 | 18 | |
| | 20 | 7438 | 7384 | 7330 | 7275 | 7221 | 7167 | 7113 | 7059 | 7005 | 20 | 18 | 20 | 22 | 23 | 25 | 27 | |
| | 30 | 7420 | 7365 | 7311 | 7257 | 7202 | 7148 | 7093 | 7039 | 6984 | 30 | 27 | 29 | 31 | 33 | 34 | 36 | |
| | 40 | 7402 | 7347 | 7293 | 7238 | 7183 | 7128 | 7074 | 7019 | 6964 | 40 | 36 | 38 | 40 | 42 | 44 | 46 | |
| | 50 | 7384 | 7329 | 7274 | 7219 | 7164 | 7109 | 7054 | 6999 | 6944 | 50 | 46 | 48 | 49 | 51 | 53 | 55 | |
| 25 | 0 | 7367 | 7311 | 7256 | 7200 | 7145 | 7090 | 7034 | 6979 | 6923 | 0 | 0 | 2 | 4 | 5 | 7 | 9 | |
| | 10 | 7349 | 7293 | 7238 | 7182 | 7126 | 7070 | 7014 | 6959 | 6903 | 10 | 9 | 11 | 13 | 15 | 17 | 19 | |
| | 20 | 7331 | 7275 | 7219 | 7163 | 7107 | 7051 | 6995 | 6939 | 6883 | 20 | 19 | 20 | 22 | 24 | 26 | 28 | |
| | 30 | 7314 | 7258 | 7201 | 7145 | 7088 | 7032 | 6975 | 6919 | 6862 | 30 | 28 | 30 | 32 | 34 | 36 | 38 | |
| | 40 | 7296 | 7240 | 7183 | 7126 | 7069 | 7012 | 6956 | 6899 | 6842 | 40 | 38 | 40 | 42 | 44 | 45 | 48 | |
| | 50 | 7279 | 7222 | 7165 | 7107 | 7050 | 6993 | 6936 | 6879 | 6822 | 50 | 48 | 49 | 51 | 53 | 55 | 57 | |
| 26 | 0 | 7261 | 7204 | 7146 | 7089 | 7031 | 6974 | 6916 | 6859 | 6802 | 0 | 0 | 2 | 4 | 6 | 8 | 9 | |
| | 10 | 7244 | 7186 | 7128 | 7070 | 7013 | 6955 | 6897 | 6839 | 6781 | 10 | 9 | 12 | 14 | 15 | 17 | 19 | |
| | 20 | 7226 | 7168 | 7110 | 7052 | 6994 | 6936 | 6878 | 6820 | 6761 | 20 | 19 | 21 | 23 | 25 | 27 | 29 | |
| | 30 | 7209 | 7150 | 7092 | 7034 | 6975 | 6917 | 6858 | 6800 | 6741 | 30 | 29 | 31 | 33 | 35 | 37 | 39 | H.P. |
| | 40 | 7191 | 7133 | 7074 | 7015 | 6956 | 6898 | 6839 | 6780 | 6721 | 40 | 39 | 41 | 43 | 45 | 47 | 49 | 60′ |
| | 50 | 7174 | 7115 | 7056 | 6997 | 6938 | 6878 | 6819 | 6760 | 6701 | 50 | 49 | 51 | 53 | 55 | 57 | 59 | |
| 27 | 0 | 7156 | 7097 | 7038 | 6978 | 6919 | 6859 | 6800 | 6740 | 6681 | 0 | 0 | 2 | 4 | 6 | 8 | 10 | |
| | 10 | 7139 | 7079 | 7020 | 6960 | 6900 | 6840 | 6781 | 6721 | 6661 | 10 | 10 | 12 | 14 | 16 | 18 | 20 | 1′ 2 |
| | 20 | 7122 | 7062 | 7002 | 6942 | 6882 | 6822 | 6761 | 6701 | 6641 | 20 | 20 | 22 | 24 | 26 | 28 | 30 | 2 4 |
| | 30 | 7105 | 7044 | 6984 | 6923 | 6863 | 6803 | 6742 | 6682 | 6621 | 30 | 30 | 32 | 34 | 36 | 38 | 40 | 3 6 |
| | 40 | 7087 | 7027 | 6966 | 6905 | 6844 | 6784 | 6723 | 6662 | 6602 | 40 | 40 | 42 | 44 | 46 | 48 | 50 | 4 8 |
| | 50 | 7070 | 7009 | 6948 | 6887 | 6826 | 6765 | 6704 | 6643 | 6582 | 50 | 51 | 53 | 55 | 57 | 59 | 60 | 5 10 |
| 28 | 0 | 7053 | 6991 | 6930 | 6869 | 6807 | 6746 | 6684 | 6623 | 6562 | 0 | 0 | 2 | 4 | 6 | 8 | 10 | 6 13 |
| | 10 | 7036 | 6974 | 6912 | 6851 | 6789 | 6727 | 6665 | 6604 | 6542 | 10 | 10 | 12 | 14 | 16 | 18 | 21 | 7 15 |
| | 20 | 7018 | 6956 | 6894 | 6832 | 6770 | 6708 | 6646 | 6584 | 6522 | 20 | 21 | 23 | 25 | 27 | 29 | 31 | 8 17 |
| | 30 | 7001 | 6939 | 6877 | 6814 | 6752 | 6690 | 6627 | 6565 | 6503 | 30 | 31 | 33 | 35 | 37 | 39 | 42 | 9 19 |
| | 40 | 6984 | 6922 | 6859 | 6796 | 6734 | 6671 | 6608 | 6545 | 6483 | 40 | 42 | 44 | 46 | 48 | 50 | 52 | |
| | 50 | 6967 | 6904 | 6841 | 6778 | 6715 | 6651 | 6589 | 6526 | 6463 | 50 | 52 | 55 | 57 | 59 | 61 | 63 | |
| 29 | 0 | 6950 | 6887 | 6823 | 6760 | 6697 | 6633 | 6570 | 6507 | 6443 | 0 | 0 | 2 | 4 | 6 | 8 | 11 | |
| | 10 | 6933 | 6869 | 6806 | 6742 | 6678 | 6615 | 6551 | 6488 | 6424 | 10 | 11 | 13 | 15 | 17 | 19 | 21 | |
| | 20 | 6916 | 6852 | 6788 | 6724 | 6660 | 6596 | 6532 | 6469 | 6405 | 20 | 21 | 23 | 25 | 28 | 30 | 32 | |
| | 30 | 6899 | 6835 | 6771 | 6706 | 6642 | 6578 | 6514 | 6449 | 6385 | 30 | 32 | 34 | 36 | 39 | 41 | 43 | |
| | 40 | 6882 | 6818 | 6753 | 6688 | 6624 | 6559 | 6495 | 6430 | 6366 | 40 | 43 | 45 | 47 | 49 | 52 | 54 | |
| | 50 | 6865 | 6800 | 6735 | 6671 | 6506 | 6541 | 6476 | 6411 | 6346 | 50 | 54 | 56 | 58 | 60 | 63 | 65 | |

| Sun's Alt. | 5° | 6° | 7° | 8° | 14° | 25° | 34° | 42° | 51° | 61° | 90° |
|---|---|---|---|---|---|---|---|---|---|---|---|
| sub. | 17 | 13 | 11 | 9 | 7 | 9 | 11 | 13 | 15 | 17 | 18 |

| Star's Alt. | 5° | 6° | 7° | 8° | 9° | 11° | 12° | 14° | 18° | 30° |
|---|---|---|---|---|---|---|---|---|---|---|
| sub. | 15 | 11 | 9 | 7 | 5 | 4 | 3 | 2 | 1 | 0 |

## THE LOGARITHMIC DIFFERENCE

(Barometer, 30 inches. Fahrenheit's Thermometer, 50°.)

| ☽ App. Alt. | Horizontal Parallax. 53′ | 54′ | 55′ | 56′ | 57′ | 58′ | 59′ | 60′ | 61′ | ″ of Par. | Corr. for ″ of Par. sub. 0″ | 2″ | 4″ | 6″ | 8″ | 10″ | Cor. for of Alt. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° ′ | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | | | | | | | | |
| 30 0 | 6848 | 6783 | 6718 | 6653 | 6588 | 6522 | 6457 | 6392 | 6327 | 0 | 0 | 2 | 4 | 6 | 9 | 11 | |
| 10 | 6831 | 6766 | 6700 | 6635 | 6569 | 6504 | 6439 | 6373 | 6308 | 10 | 11 | 13 | 15 | 17 | 20 | 22 | sub. |
| 20 | 6815 | 6749 | 6683 | 6617 | 6551 | 6485 | 6420 | 6354 | 6288 | 20 | 22 | 24 | 26 | 29 | 31 | 33 | |
| 30 | 6798 | 6732 | 6665 | 6599 | 6533 | 6467 | 6401 | 6335 | 6269 | 30 | 33 | 35 | 37 | 40 | 42 | 44 | |
| 40 | 6781 | 6714 | 6648 | 6581 | 6515 | 6449 | 6382 | 6316 | 6249 | 40 | 44 | 46 | 49 | 51 | 53 | 56 | H.P. |
| 50 | 6764 | 6697 | 6630 | 6564 | 6497 | 6430 | 6363 | 6296 | 6230 | 50 | 56 | 58 | 60 | 62 | 64 | 66 | 53′ |
| 31 0 | 6747 | 6680 | 6613 | 6546 | 6479 | 6412 | 6344 | 6277 | 6210 | 0 | 0 | 2 | 4 | 7 | 9 | 11 | ′ |
| 10 | 6731 | 6663 | 6596 | 6528 | 6461 | 6393 | 6326 | 6258 | 6191 | 10 | 11 | 13 | 16 | 18 | 20 | 23 | |
| 20 | 6714 | 6646 | 6579 | 6511 | 6443 | 6375 | 6307 | 6240 | 6172 | 20 | 23 | 25 | 27 | 29 | 32 | 34 | 1 2 |
| 30 | 6697 | 6629 | 6561 | 6493 | 6425 | 6357 | 6289 | 6221 | 6153 | 30 | 34 | 36 | 38 | 41 | 43 | 46 | 2 3 |
| 40 | 6681 | 6612 | 6544 | 6476 | 6407 | 6339 | 6270 | 6202 | 6134 | 40 | 46 | 48 | 50 | 52 | 55 | 57 | 3 5 |
| 50 | 6664 | 6596 | 6527 | 6458 | 6389 | 6321 | 6252 | 6183 | 6115 | 50 | 57 | 59 | 62 | 64 | 66 | 68 | 4 6 |
| 32 0 | 6648 | 6579 | 6510 | 6441 | 6372 | 6303 | 6234 | 6165 | 6096 | 0 | 0 | 2 | 5 | 7 | 9 | 11 | 5 8 |
| 10 | 6631 | 6562 | 6493 | 6423 | 6354 | 6285 | 6215 | 6146 | 6077 | 10 | 11 | 14 | 16 | 18 | 21 | 23 | 6 10 |
| 20 | 6615 | 6545 | 6475 | 6406 | 6336 | 6267 | 6197 | 6127 | 6058 | 20 | 23 | 25 | 28 | 30 | 32 | 35 | 7 11 |
| 30 | 6598 | 6528 | 6458 | 6388 | 6318 | 6249 | 6179 | 6109 | 6039 | 30 | 35 | 37 | 40 | 42 | 44 | 47 | 8 13 |
| 40 | 6582 | 6512 | 6441 | 6371 | 6301 | 6231 | 6160 | 6090 | 6020 | 40 | 47 | 49 | 52 | 54 | 56 | 59 | 9 14 |
| 50 | 6565 | 6495 | 6424 | 6354 | 6283 | 6213 | 6142 | 6071 | 6001 | 50 | 59 | 61 | 63 | 66 | 68 | 71 | |
| 33 0 | 6549 | 6478 | 6407 | 6336 | 6265 | 6195 | 6124 | 6053 | 5982 | 0 | 0 | 2 | 5 | 7 | 9 | 12 | |
| 10 | 6533 | 6461 | 6390 | 6319 | 6248 | 6177 | 6106 | 6034 | 5963 | 10 | 12 | 14 | 17 | 19 | 21 | 24 | |
| 20 | 6516 | 6445 | 6373 | 6302 | 6230 | 6159 | 6087 | 6016 | 5944 | 20 | 24 | 26 | 29 | 31 | 33 | 36 | |
| 30 | 6500 | 6428 | 6356 | 6285 | 6213 | 6141 | 6069 | 5998 | 5926 | 30 | 36 | 38 | 41 | 43 | 45 | 48 | |
| 40 | 6484 | 6412 | 6340 | 6268 | 6195 | 6123 | 6051 | 5979 | 5907 | 40 | 48 | 50 | 53 | 55 | 58 | 60 | |
| 50 | 6468 | 6395 | 6323 | 6250 | 6178 | 6105 | 6033 | 5961 | 5888 | 50 | 60 | 63 | 65 | 68 | 70 | 72 | |
| 34 0 | 6451 | 6379 | 6306 | 6233 | 6160 | 6088 | 6015 | 5942 | 5869 | 0 | 0 | 2 | 5 | 7 | 10 | 12 | |
| 10 | 6435 | 6362 | 6289 | 6216 | 6143 | 6070 | 5997 | 5924 | 5851 | 10 | 12 | 15 | 17 | 19 | 22 | 24 | |
| 20 | 6419 | 6346 | 6273 | 6199 | 6126 | 6053 | 5979 | 5906 | 5833 | 20 | 24 | 27 | 29 | 32 | 34 | 37 | |
| 30 | 6403 | 6330 | 6256 | 6182 | 6109 | 6035 | 5961 | 5880 | 5814 | 30 | 37 | 39 | 42 | 44 | 47 | 49 | |
| 40 | 6387 | 6313 | 6239 | 6165 | 6091 | 6017 | 5943 | 5870 | 5796 | 40 | 49 | 52 | 54 | 57 | 59 | 62 | |
| 50 | 6371 | 6297 | 6223 | 6148 | 6074 | 6000 | 5926 | 5851 | 5777 | 50 | 62 | 64 | 67 | 69 | 72 | 74 | |
| 35 0 | 6355 | 6280 | 6206 | 6131 | 6057 | 5982 | 5908 | 5833 | 5759 | 0 | 0 | 2 | 5 | 7 | 10 | 12 | |
| 10 | 6339 | 6264 | 6189 | 6115 | 6040 | 5965 | 5890 | 5815 | 5740 | 10 | 12 | 15 | 17 | 20 | 22 | 25 | |
| 20 | 6323 | 6248 | 6173 | 6098 | 6023 | 5948 | 5872 | 5797 | 5722 | 20 | 25 | 27 | 30 | 32 | 35 | 38 | |
| 30 | 6307 | 6232 | 6156 | 6081 | 6006 | 5930 | 5855 | 5779 | 5704 | 30 | 38 | 40 | 43 | 45 | 48 | 50 | |
| 40 | 6292 | 6216 | 6140 | 6064 | 5989 | 5913 | 5837 | 5761 | 5686 | 40 | 50 | 53 | 55 | 58 | 61 | 63 | |
| 50 | 6276 | 6200 | 6124 | 6048 | 5971 | 5895 | 5819 | 5743 | 5667 | 50 | 63 | 66 | 68 | 71 | 74 | 76 | |
| 36 0 | 6260 | 6183 | 6107 | 6031 | 5954 | 5878 | 5802 | 5725 | 5649 | 0 | 0 | 2 | 5 | 8 | 10 | 13 | |
| 10 | 6244 | 6167 | 6091 | 6014 | 5938 | 5861 | 5784 | 5708 | 5631 | 10 | 13 | 15 | 18 | 20 | 23 | 26 | |
| 20 | 6228 | 6152 | 6075 | 5998 | 5921 | 5844 | 5767 | 5690 | 5613 | 20 | 26 | 28 | 31 | 33 | 36 | 39 | H.P. |
| 30 | 6213 | 6136 | 6058 | 5981 | 5904 | 5827 | 5749 | 5672 | 5596 | 30 | 39 | 41 | 44 | 46 | 49 | 52 | 61′ |
| 40 | 6197 | 6120 | 6042 | 5964 | 5887 | 5809 | 5732 | 5654 | 5577 | 40 | 52 | 54 | 57 | 59 | 62 | 65 | |
| 50 | 6181 | 6104 | 6026 | 5948 | 5870 | 5792 | 5714 | 5637 | 5559 | 50 | 65 | 67 | 70 | 73 | 75 | 78 | ′ |
| 37 0 | 6166 | 6088 | 6009 | 5931 | 5853 | 5775 | 5697 | 5619 | 5541 | 0 | 0 | 3 | 5 | 8 | 10 | 13 | 1 2 |
| 10 | 6150 | 6072 | 5993 | 5915 | 5837 | 5758 | 5680 | 5601 | 5523 | 10 | 13 | 16 | 18 | 21 | 23 | 26 | 2 4 |
| 20 | 6135 | 6056 | 5977 | 5899 | 5820 | 5741 | 5662 | 5584 | 5505 | 20 | 26 | 29 | 31 | 34 | 37 | 39 | 3 5 |
| 30 | 6119 | 6040 | 5961 | 5882 | 5803 | 5724 | 5645 | 5566 | 5487 | 30 | 39 | 42 | 45 | 47 | 50 | 53 | 4 7 |
| 40 | 6104 | 6024 | 5945 | 5866 | 5787 | 5707 | 5628 | 5549 | 5469 | 40 | 53 | 56 | 58 | 61 | 63 | 66 | 5 9 |
| 50 | 6088 | 6009 | 5929 | 5850 | 5770 | 5690 | 5611 | 5531 | 5452 | 50 | 66 | 69 | 72 | 74 | 77 | 79 | 6 11 |
| 38 0 | 6073 | 5993 | 5913 | 5833 | 5753 | 5673 | 5594 | 5514 | 5434 | 0 | 0 | 3 | 5 | 8 | 11 | 13 | 7 13 |
| 10 | 6058 | 5977 | 5897 | 5817 | 5737 | 5657 | 5577 | 5496 | 5416 | 10 | 13 | 16 | 19 | 21 | 24 | 27 | 8 14 |
| 20 | 6042 | 5962 | 5881 | 5801 | 5721 | 5640 | 5560 | 5479 | 5399 | 20 | 27 | 29 | 32 | 35 | 37 | 40 | 9 16 |
| 30 | 6027 | 5946 | 5866 | 5785 | 5704 | 5623 | 5543 | 5462 | 5381 | 30 | 40 | 43 | 46 | 48 | 51 | 54 | |
| 40 | 6012 | 5931 | 5850 | 5769 | 5688 | 5607 | 5526 | 5445 | 5364 | 40 | 54 | 57 | 59 | 62 | 65 | 68 | |
| 50 | 5997 | 5915 | 5834 | 5753 | 5671 | 5590 | 5509 | 5427 | 5346 | 50 | 68 | 70 | 73 | 76 | 79 | 81 | |
| 39 0 | 5981 | 5900 | 5818 | 5736 | 5655 | 5573 | 5492 | 5410 | 5328 | 0 | 0 | 3 | 5 | 8 | 11 | 14 | |
| 10 | 5966 | 5884 | 5802 | 5721 | 5639 | 5557 | 5475 | 5393 | 5311 | 10 | 14 | 16 | 19 | 22 | 25 | 27 | |
| 20 | 5951 | 5869 | 5787 | 5705 | 5622 | 5540 | 5458 | 5376 | 5294 | 20 | 27 | 30 | 33 | 36 | 38 | 41 | |
| 30 | 5936 | 5854 | 5771 | 5689 | 5606 | 5524 | 5441 | 5359 | 5277 | 30 | 41 | 44 | 47 | 49 | 52 | 55 | |
| 40 | 5921 | 5838 | 5756 | 5673 | 5590 | 5507 | 5425 | 5342 | 5259 | 40 | 55 | 58 | 61 | 63 | 66 | 69 | |
| 50 | 5906 | 5823 | 5740 | 5657 | 5574 | 5491 | 5408 | 5325 | 5242 | 50 | 69 | 72 | 75 | 77 | 80 | 82 | |

Sun's Alt. 5° 6° 7° 8° 14° 25° 34° 42° 51° 64° 90°
*sub.* 17 13 11 9 7 9 11 13 15 17 18

Star's Alt. 5° 6° 7° 8° 9° 11° 12° 14° 18° 30°
*sub.* 15 11 9 7 5 4 3 2 1 0

## THE LOGARITHMIC DIFFERENCE

(Barometer, 30 inches. Fahrenheit's Thermometer, 50°.)

| ☽ App. Alt. | Horizontal Parallax. 53′ | 54′ | 55′ | 56′ | 57′ | 58′ | 59′ | 60′ | 61′ | ″ of Par. | Corr. for ″ of Par. sub. 0″ | 2″ | 4″ | 6″ | 8″ | 10″ | Cor. for ′ of Alt. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° ′ | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | | | | | | | | |
| 40 0 | 5891 | 5808 | 5724 | 5641 | 5558 | 5474 | 5391 | 5308 | 5225 | 0 | 0 | 3 | 6 | 8 | 11 | 14 | sub. |
| 10 | 5876 | 5793 | 5709 | 5625 | 5542 | 5458 | 5375 | 5291 | 5207 | 10 | 14 | 17 | 19 | 22 | 25 | 28 | |
| 20 | 5861 | 5777 | 5694 | 5610 | 5526 | 5442 | 5358 | 5274 | 5190 | 20 | 28 | 31 | 34 | 36 | 39 | 42 | H.P. |
| 30 | 5847 | 5762 | 5678 | 5594 | 5510 | 5426 | 5342 | 5257 | 5173 | 30 | 42 | 45 | 48 | 50 | 53 | 56 | 53′ |
| 40 | 5832 | 5747 | 5663 | 5578 | 5494 | 5410 | 5325 | 5241 | 5156 | 40 | 56 | 59 | 62 | 65 | 68 | 71 | |
| 50 | 5817 | 5732 | 5647 | 5563 | 5478 | 5393 | 5309 | 5224 | 5139 | 50 | 71 | 73 | 76 | 79 | 82 | 84 | |
| 41 0 | 5802 | 5717 | 5632 | 5547 | 5462 | 5377 | 5292 | 5207 | 5122 | 0 | 0 | 3 | 6 | 8 | 11 | 14 | 1 1 |
| 10 | 5787 | 5702 | 5617 | 5532 | 5446 | 5361 | 5276 | 5191 | 5105 | 10 | 14 | 17 | 20 | 23 | 26 | 28 | 2 3 |
| 20 | 5773 | 5687 | 5602 | 5516 | 5431 | 5345 | 5260 | 5174 | 5089 | 20 | 28 | 31 | 34 | 37 | 40 | 43 | 3 4 |
| 30 | 5758 | 5672 | 5587 | 5501 | 5415 | 5329 | 5243 | 5158 | 5072 | 30 | 43 | 46 | 49 | 51 | 54 | 57 | 4 6 |
| 40 | 5744 | 5658 | 5571 | 5485 | 5399 | 5313 | 5227 | 5141 | 5055 | 40 | 57 | 60 | 63 | 66 | 69 | 72 | 5 7 |
| 50 | 5729 | 5643 | 5556 | 5470 | 5384 | 5297 | 5211 | 5124 | 5038 | 50 | 72 | 75 | 78 | 81 | 83 | 86 | 6 8 |
| 42 0 | 5714 | 5628 | 5541 | 5455 | 5368 | 5281 | 5195 | 5108 | 5021 | 0 | 0 | 3 | 6 | 9 | 11 | 14 | 7 10 |
| 10 | 5700 | 5613 | 5526 | 5439 | 5352 | 5266 | 5179 | 5092 | 5005 | 10 | 14 | 17 | 20 | 23 | 26 | 29 | 8 11 |
| 20 | 5686 | 5599 | 5511 | 5424 | 5337 | 5250 | 5163 | 5075 | 4988 | 20 | 29 | 32 | 35 | 38 | 41 | 44 | 9 13 |
| 30 | 5671 | 5584 | 5496 | 5409 | 5322 | 5234 | 5147 | 5059 | 4972 | 30 | 44 | 47 | 49 | 52 | 55 | 58 | |
| 40 | 5657 | 5569 | 5482 | 5394 | 5306 | 5218 | 5131 | 5043 | 4955 | 40 | 58 | 61 | 64 | 67 | 70 | 73 | |
| 50 | 5643 | 5555 | 5467 | 5379 | 5291 | 5203 | 5115 | 5027 | 4939 | 50 | 73 | 76 | 79 | 82 | 85 | 87 | |
| 43 0 | 5628 | 5540 | 5452 | 5363 | 5275 | 5187 | 5099 | 5010 | 4922 | 0 | 0 | 3 | 6 | 9 | 12 | 15 | |
| 10 | 5614 | 5526 | 5437 | 5349 | 5260 | 5171 | 5083 | 4994 | 4906 | 10 | 15 | 18 | 21 | 24 | 26 | 30 | |
| 20 | 5600 | 5511 | 5422 | 5334 | 5245 | 5156 | 5067 | 4978 | 4890 | 20 | 30 | 32 | 35 | 38 | 41 | 45 | |
| 30 | 5586 | 5497 | 5408 | 5319 | 5230 | 5141 | 5051 | 4962 | 4873 | 30 | 45 | 47 | 50 | 53 | 56 | 60 | |
| 40 | 5572 | 5482 | 5393 | 5304 | 5214 | 5125 | 5036 | 4946 | 4857 | 40 | 60 | 63 | 65 | 68 | 71 | 75 | |
| 50 | 5558 | 5468 | 5378 | 5289 | 5199 | 5110 | 5020 | 4930 | 4841 | 50 | 75 | 78 | 81 | 84 | 87 | 89 | |
| 44 0 | 5544 | 5454 | 5364 | 5274 | 5184 | 5094 | 5004 | 4914 | 4825 | 0 | 0 | 3 | 6 | 9 | 12 | 15 | |
| 10 | 5530 | 5439 | 5349 | 5259 | 5169 | 5079 | 4989 | 4899 | 4809 | 10 | 15 | 18 | 21 | 24 | 27 | 30 | |
| 20 | 5516 | 5425 | 5335 | 5245 | 5154 | 5064 | 4973 | 4883 | 4793 | 20 | 30 | 33 | 36 | 39 | 42 | 45 | |
| 30 | 5502 | 5411 | 5320 | 5230 | 5139 | 5048 | 4958 | 4867 | 4777 | 30 | 45 | 48 | 51 | 54 | 57 | 61 | |
| 40 | 5488 | 5397 | 5306 | 5215 | 5124 | 5033 | 4942 | 4851 | 4760 | 40 | 61 | 64 | 67 | 70 | 73 | 76 | |
| 50 | 5474 | 5383 | 5292 | 5200 | 5109 | 5018 | 4927 | 4836 | 4744 | 50 | 76 | 79 | 82 | 85 | 88 | 90 | |
| 45 0 | 5460 | 5369 | 5277 | 5186 | 5094 | 5003 | 4911 | 4820 | 4728 | 0 | 0 | 3 | 6 | 9 | 12 | 15 | |
| 10 | 5446 | 5355 | 5263 | 5171 | 5080 | 4988 | 4896 | 4804 | 4713 | 10 | 15 | 18 | 21 | 24 | 27 | 31 | |
| 20 | 5433 | 5341 | 5249 | 5157 | 5065 | 4973 | 4881 | 4789 | 4697 | 20 | 31 | 34 | 37 | 40 | 43 | 46 | |
| 30 | 5419 | 5327 | 5235 | 5142 | 5050 | 4958 | 4866 | 4774 | 4681 | 30 | 46 | 49 | 52 | 55 | 58 | 62 | |
| 40 | 5405 | 5313 | 5220 | 5128 | 5035 | 4943 | 4851 | 4758 | 4666 | 40 | 62 | 65 | 68 | 71 | 74 | 77 | |
| 50 | 5392 | 5299 | 5206 | 5113 | 5021 | 4928 | 4835 | 4743 | 4650 | 50 | 77 | 80 | 83 | 87 | 90 | 92 | |
| 46 0 | 5378 | 5285 | 5192 | 5099 | 5006 | 4913 | 4820 | 4727 | 4634 | 0 | 0 | 3 | 6 | 9 | 12 | 15 | |
| 10 | 5365 | 5271 | 5178 | 5085 | 4992 | 4898 | 4805 | 4712 | 4619 | 10 | 15 | 19 | 22 | 25 | 28 | 31 | |
| 20 | 5351 | 5258 | 5164 | 5071 | 4977 | 4884 | 4790 | 4697 | 4603 | 20 | 31 | 34 | 37 | 40 | 44 | 47 | H.P. |
| 30 | 5338 | 5244 | 5150 | 5057 | 4963 | 4869 | 4775 | 4682 | 4588 | 30 | 47 | 50 | 53 | 56 | 59 | 63 | 61 |
| 40 | 5324 | 5230 | 5136 | 5042 | 4948 | 4854 | 4760 | 4666 | 4572 | 40 | 63 | 66 | 69 | 72 | 75 | 78 | |
| 50 | 5311 | 5217 | 5123 | 5028 | 4934 | 4840 | 4745 | 4651 | 4557 | 50 | 78 | 82 | 85 | 88 | 91 | 94 | |
| 47 0 | 5298 | 5203 | 5109 | 5014 | 4920 | 4825 | 4731 | 4636 | 4542 | 0 | 0 | 3 | 6 | 9 | 13 | 16 | 1 2 |
| 10 | 5284 | 5190 | 5095 | 5000 | 4906 | 4811 | 4716 | 4621 | 4527 | 10 | 16 | 19 | 22 | 25 | 28 | 32 | 2 3 |
| 20 | 5271 | 5176 | 5081 | 4986 | 4891 | 4796 | 4701 | 4606 | 4511 | 20 | 32 | 35 | 38 | 41 | 44 | 48 | 3 5 |
| 30 | 5258 | 5163 | 5068 | 4972 | 4877 | 4782 | 4687 | 4592 | 4496 | 30 | 48 | 51 | 54 | 56 | 60 | 64 | 4 6 |
| 40 | 5245 | 5149 | 5054 | 4959 | 4863 | 4768 | 4672 | 4577 | 4481 | 40 | 64 | 66 | 70 | 73 | 76 | 80 | 5 8 |
| 50 | 5232 | 5136 | 5040 | 4945 | 4849 | 4753 | 4658 | 4562 | 4466 | 50 | 80 | 83 | 86 | 89 | 93 | 96 | 6 10 |
| 48 0 | 5218 | 5123 | 5027 | 4931 | 4835 | 4739 | 4643 | 4547 | 4451 | 0 | 0 | 3 | 6 | 10 | 13 | 16 | 7 11 |
| 10 | 5206 | 5109 | 5013 | 4917 | 4821 | 4725 | 4629 | 4533 | 4436 | 10 | 16 | 19 | 22 | 26 | 29 | 32 | 8 13 |
| 20 | 5193 | 5096 | 5000 | 4903 | 4807 | 4711 | 4614 | 4518 | 4421 | 20 | 32 | 35 | 39 | 42 | 45 | 48 | 9 14 |
| 30 | 5180 | 5083 | 4986 | 4890 | 4793 | 4696 | 4600 | 4503 | 4406 | 30 | 48 | 52 | 55 | 58 | 61 | 65 | |
| 40 | 5167 | 5070 | 4973 | 4876 | 4779 | 4682 | 4585 | 4488 | 4391 | 40 | 65 | 67 | 71 | 74 | 78 | 81 | |
| 50 | 5154 | 5057 | 4960 | 4862 | 4765 | 4668 | 4571 | 4474 | 4376 | 50 | 81 | 84 | 87 | 90 | 94 | 97 | |
| 49 0 | 5141 | 5044 | 4946 | 4849 | 4751 | 4654 | 4556 | 4459 | 4361 | 0 | 0 | 3 | 6 | 10 | 13 | 16 | |
| 10 | 5128 | 5031 | 4933 | 4835 | 4738 | 4640 | 4542 | 4444 | 4347 | 10 | 16 | 19 | 23 | 26 | 29 | 33 | |
| 20 | 5116 | 5018 | 4920 | 4822 | 4724 | 4626 | 4528 | 4430 | 4332 | 20 | 33 | 36 | 39 | 42 | 46 | 49 | |
| 30 | 5103 | 5005 | 4907 | 4809 | 4710 | 4612 | 4514 | 4416 | 4318 | 30 | 49 | 52 | 56 | 59 | 62 | 66 | |
| 40 | 5091 | 4992 | 4894 | 4795 | 4697 | 4598 | 4500 | 4402 | 4303 | 40 | 66 | 69 | 72 | 75 | 79 | 82 | |
| 50 | 5078 | 4979 | 4881 | 4782 | 4683 | 4585 | 4486 | 4387 | 4289 | 50 | 82 | 85 | 89 | 92 | 95 | 98 | |

| Sun's Alt. | 5° | 6° | 7° | 8° | 14° | 25° | 34° | 42° | 51° | 64° | 90° |
|---|---|---|---|---|---|---|---|---|---|---|---|
| sub. | 17 | 13 | 11 | 9 | 7 | 9 | 11 | 13 | 15 | 17 | 18 |

| Star's Alt. | 5° | 6° | 7° | 8° | 9° | 11° | 12° | 14° | 18° | 30° |
|---|---|---|---|---|---|---|---|---|---|---|
| sub. | 15 | 11 | 9 | 7 | 5 | 4 | 3 | 2 | 1 | 0 |

## THE LOGARITHMIC DIFFERENCE

(Barometer, 30 inches. Fahrenheit's Thermometer, 50°.)

| ☽ App. Alt. | | Horizontal Parallax. 53′ | 54′ | 55′ | 56′ | 57′ | 58′ | 59′ | 60′ | 61′ | ″ of Par. | Corr. for ″ of Par. sub. 0″ | 2″ | 4″ | 6″ | 8″ | 10″ | Cor. for ′ of Alt. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 50° | ′ | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | | | | | | | | | |
| | 0 | 5065 | 4966 | 4867 | 4769 | 4670 | 4571 | 4472 | 4373 | 4274 | 0 | 0 | 3 | 7 | 10 | 13 | 16 | | |
| | 10 | 5053 | 4954 | 4855 | 4755 | 4656 | 4557 | 4458 | 4359 | 4260 | 10 | 16 | 20 | 23 | 26 | 30 | 33 | sub. | |
| | 20 | 5040 | 4941 | 4842 | 4742 | 4643 | 4544 | 4444 | 4345 | 4246 | 20 | 33 | 36 | 40 | 43 | 46 | 50 | | |
| | 30 | 5028 | 4928 | 4829 | 4729 | 4630 | 4530 | 4430 | 4331 | 4231 | 30 | 50 | 53 | 56 | 60 | 63 | 67 | H.P. | |
| | 40 | 5016 | 4916 | 4816 | 4716 | 4616 | 4516 | 4417 | 4317 | 4217 | 40 | 67 | 70 | 73 | 77 | 80 | 83 | 53′ | |
| | 50 | 5003 | 4903 | 4803 | 4703 | 4603 | 4503 | 4403 | 4303 | 4203 | 50 | 83 | 87 | 90 | 93 | 97 | 100 | | |
| 51 | 0 | 4991 | 4891 | 4790 | 4690 | 4590 | 4489 | 4389 | 4289 | 4188 | 0 | 0 | 3 | 7 | 10 | 13 | 17 | 1′ | 1 |
| | 10 | 4979 | 4878 | 4778 | 4677 | 4577 | 4476 | 4376 | 4275 | 4174 | 10 | 17 | 20 | 23 | 26 | 30 | 34 | 2 | 2 |
| | 20 | 4967 | 4866 | 4765 | 4664 | 4564 | 4463 | 4362 | 4261 | 4160 | 20 | 34 | 37 | 40 | 43 | 47 | 50 | 3 | 4 |
| | 30 | 4954 | 4853 | 4752 | 4651 | 4550 | 4449 | 4348 | 4247 | 4146 | 30 | 50 | 54 | 57 | 60 | 64 | 67 | 4 | 5 |
| | 40 | 4942 | 4841 | 4740 | 4639 | 4537 | 4436 | 4335 | 4234 | 4133 | 40 | 67 | 71 | 74 | 78 | 81 | 84 | 5 | 6 |
| | 50 | 4930 | 4829 | 4727 | 4626 | 4524 | 4423 | 4321 | 4220 | 4119 | 50 | 84 | 88 | 91 | 95 | 98 | 101 | 6 | 7 |
| 52 | 0 | 4918 | 4816 | 4715 | 4613 | 4511 | 4410 | 4308 | 4206 | 4105 | 0 | 0 | 3 | 7 | 10 | 14 | 17 | 7 | 8 |
| | 10 | 4906 | 4804 | 4702 | 4600 | 4499 | 4397 | 4295 | 4193 | 4091 | 10 | 17 | 20 | 24 | 27 | 31 | 34 | 8 | 10 |
| | 20 | 4894 | 4792 | 4690 | 4588 | 4486 | 4384 | 4281 | 4179 | 4077 | 20 | 34 | 37 | 41 | 44 | 48 | 51 | 9 | 11 |
| | 30 | 4882 | 4780 | 4678 | 4575 | 4473 | 4371 | 4268 | 4166 | 4064 | 30 | 51 | 54 | 58 | 61 | 65 | 68 | | |
| | 40 | 4871 | 4768 | 4665 | 4563 | 4460 | 4358 | 4255 | 4153 | 4050 | 40 | 68 | 72 | 75 | 79 | 82 | 86 | | |
| | 50 | 4859 | 4756 | 4653 | 4550 | 4448 | 4345 | 4242 | 4139 | 4036 | 50 | 86 | 89 | 93 | 96 | 99 | 102 | H.P. | |
| 53 | 0 | 4847 | 4744 | 4641 | 4538 | 4435 | 4332 | 4229 | 4126 | 4023 | 0 | 0 | 3 | 7 | 10 | 14 | 17 | 61′ | |
| | 10 | 4835 | 4732 | 4629 | 4526 | 4422 | 4319 | 4216 | 4113 | 4009 | 10 | 17 | 21 | 24 | 27 | 31 | 34 | 1′ | 1 |
| | 20 | 4824 | 4720 | 4617 | 4513 | 4410 | 4306 | 4203 | 4099 | 3996 | 20 | 34 | 39 | 41 | 45 | 48 | 52 | 2 | 3 |
| | 30 | 4812 | 4708 | 4605 | 4501 | 4397 | 4294 | 4190 | 4086 | 3983 | 30 | 52 | 55 | 59 | 62 | 66 | 69 | 3 | 4 |
| | 40 | 4800 | 4697 | 4593 | 4489 | 4385 | 4281 | 4177 | 4073 | 3969 | 40 | 69 | 73 | 76 | 80 | 83 | 87 | 4 | 6 |
| | 50 | 4789 | 4685 | 4581 | 4476 | 4372 | 4268 | 4164 | 4060 | 3956 | 50 | 87 | 90 | 94 | 97 | 101 | 104 | 5 | 7 |
| 54 | 0 | 4777 | 4673 | 4568 | 4464 | 4360 | 4255 | 4151 | 4047 | 3942 | 0 | 0 | 3 | 7 | 10 | 14 | 17 | 6 | 8 |
| | 10 | 4766 | 4661 | 4557 | 4452 | 4348 | 4243 | 4139 | 4034 | 3930 | 10 | 17 | 21 | 24 | 28 | 31 | 35 | 7 | 10 |
| | 20 | 4755 | 4650 | 4545 | 4440 | 4336 | 4231 | 4126 | 4021 | 3917 | 20 | 35 | 39 | 42 | 45 | 49 | 52 | 8 | 11 |
| | 30 | 4743 | 4638 | 4533 | 4428 | 4324 | 4219 | 4114 | 4009 | 3904 | 30 | 52 | 56 | 59 | 63 | 66 | 70 | 9 | 13 |
| | 40 | 4732 | 4627 | 4522 | 4417 | 4311 | 4206 | 4101 | 3996 | 3891 | 40 | 70 | 74 | 77 | 81 | 84 | 88 | | |
| | 50 | 4721 | 4615 | 4510 | 4405 | 4299 | 4194 | 4089 | 3983 | 3878 | 50 | 88 | 91 | 95 | 98 | 102 | 105 | | |
| 55 | 0 | 4709 | 4604 | 4498 | 4393 | 4287 | 4182 | 4076 | 3971 | 3865 | 0 | 0 | 3 | 7 | 11 | 14 | 18 | | |
| | 10 | 4698 | 4593 | 4487 | 4381 | 4275 | 4170 | 4064 | 3958 | 3852 | 10 | 18 | 21 | 25 | 28 | 32 | 35 | | |
| | 20 | 4687 | 4581 | 4475 | 4369 | 4263 | 4157 | 4051 | 3946 | 3840 | 20 | 35 | 39 | 42 | 46 | 49 | 53 | | |
| | 30 | 4676 | 4570 | 4464 | 4358 | 4251 | 4145 | 4039 | 3933 | 3827 | 30 | 53 | 57 | 61 | 64 | 67 | 71 | H.P | |
| | 40 | 4665 | 4559 | 4452 | 4346 | 4240 | 4133 | 4027 | 3920 | 3814 | 40 | 71 | 74 | 78 | 82 | 85 | 89 | 53′ | |
| | 50 | 4654 | 4548 | 4441 | 4334 | 4228 | 4121 | 4014 | 3908 | 3801 | 50 | 89 | 92 | 96 | 99 | 103 | 106 | | |
| 56 | 0 | 4643 | 4536 | 4429 | 4323 | 4216 | 4109 | 4002 | 3895 | 3788 | 0 | 0 | 4 | 7 | 11 | 14 | 18 | 1′ | 1 |
| | 10 | 4632 | 4525 | 4418 | 4311 | 4204 | 4097 | 3990 | 3883 | 3776 | 10 | 18 | 21 | 25 | 28 | 32 | 36 | 2 | 2 |
| | 20 | 4622 | 4514 | 4407 | 4300 | 4192 | 4085 | 3978 | 3871 | 3763 | 20 | 36 | 39 | 43 | 46 | 50 | 54 | 3 | 3 |
| | 30 | 4611 | 4503 | 4396 | 4288 | 4181 | 4073 | 3966 | 3858 | 3751 | 30 | 54 | 57 | 61 | 64 | 68 | 72 | 4 | 4 |
| | 40 | 4600 | 4492 | 4385 | 4277 | 4169 | 4062 | 3954 | 3846 | 3739 | 40 | 72 | 75 | 79 | 82 | 86 | 90 | 5 | 5 |
| | 50 | 4589 | 4481 | 4373 | 4266 | 4158 | 4050 | 3942 | 3834 | 3726 | 50 | 90 | 93 | 97 | 101 | 104 | 108 | 6 | 6 |
| 57 | 0 | 4578 | 4470 | 4362 | 4254 | 4146 | 4038 | 3930 | 3822 | 3714 | 0 | 0 | 4 | 7 | 11 | 14 | 18 | 7 | 7 |
| | 10 | 4568 | 4460 | 4351 | 4243 | 4135 | 4027 | 3918 | 3810 | 3702 | 10 | 18 | 22 | 25 | 29 | 32 | 36 | 8 | 8 |
| | 20 | 4558 | 4449 | 4341 | 4232 | 4124 | 4015 | 3907 | 3798 | 3690 | 20 | 36 | 40 | 43 | 47 | 51 | 54 | 9 | 9 |
| | 30 | 4547 | 4439 | 4330 | 4221 | 4112 | 4004 | 3895 | 3786 | 3678 | 30 | 54 | 58 | 61 | 65 | 69 | 73 | | |
| | 40 | 4537 | 4428 | 4319 | 4210 | 4101 | 3992 | 3883 | 3774 | 3666 | 40 | 73 | 76 | 80 | 83 | 87 | 91 | H.P. | |
| | 50 | 4526 | 4417 | 4308 | 4199 | 4090 | 3981 | 3872 | 3763 | 3654 | 50 | 91 | 94 | 98 | 102 | 105 | 109 | 61′ | |
| 58 | 0 | 4516 | 4407 | 4297 | 4188 | 4079 | 3969 | 3860 | 3751 | 3642 | 0 | 0 | 4 | 7 | 11 | 15 | 18 | | |
| | 10 | 4506 | 4396 | 4287 | 4177 | 4068 | 3958 | 3849 | 3739 | 3630 | 10 | 18 | 22 | 25 | 29 | 33 | 37 | 1′ | 1 |
| | 20 | 4496 | 4386 | 4276 | 4166 | 4057 | 3947 | 3837 | 3728 | 3618 | 20 | 37 | 40 | 44 | 48 | 51 | 55 | 2 | 2 |
| | 30 | 4485 | 4375 | 4266 | 4156 | 4046 | 3936 | 3826 | 3716 | 3606 | 30 | 55 | 59 | 62 | 66 | 70 | 73 | 3 | 4 |
| | 40 | 4475 | 4365 | 4255 | 4145 | 4035 | 3925 | 3815 | 3705 | 3595 | 40 | 73 | 77 | 81 | 84 | 88 | 92 | 4 | 6 |
| | 50 | 4465 | 4355 | 4244 | 4134 | 4024 | 3914 | 3803 | 3693 | 3583 | 50 | 92 | 95 | 99 | 103 | 107 | 110 | 5 | 6 |
| 59 | 0 | 4455 | 4344 | 4234 | 4123 | 4013 | 3903 | 3792 | 3682 | 3571 | 0 | 0 | 4 | 7 | 11 | 15 | 18 | 6 | 7 |
| | 10 | 4445 | 4334 | 4224 | 4113 | 4002 | 3892 | 3781 | 3670 | 3560 | 10 | 18 | 22 | 26 | 29 | 33 | 37 | 7 | 8 |
| | 20 | 4435 | 4324 | 4213 | 4102 | 3992 | 3881 | 3770 | 3659 | 3548 | 20 | 37 | 41 | 44 | 48 | 52 | 55 | 8 | 10 |
| | 30 | 4425 | 4314 | 4203 | 4092 | 3981 | 3870 | 3759 | 3648 | 3537 | 30 | 55 | 59 | 63 | 67 | 70 | 74 | 9 | 11 |
| | 40 | 4415 | 4304 | 4193 | 4082 | 3970 | 3859 | 3748 | 3637 | 3526 | 40 | 74 | 78 | 81 | 85 | 89 | 93 | | |
| | 50 | 4405 | 4294 | 4182 | 4071 | 3960 | 3848 | 3738 | 3626 | 3514 | 50 | 93 | 96 | 100 | 104 | 108 | 111 | | |

| Sun's Alt. | 5° | 6° | 7° | 8° | 14° | 25° | 34° | 42° | 51° | 64° | 90° |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *sub.* | 17 | 13 | 11 | 9 | 7 | 9 | 11 | 13 | 15 | 17 | 18 |

| Star's Alt. | 5° | 6° | 7° | 8° | 9° | 11° | 12° | 14° | 18° | 30° |
|---|---|---|---|---|---|---|---|---|---|---|
| *sub.* | 15 | 11 | 9 | 7 | 5 | 4 | 3 | 2 | 1 | 0 |

## THE LOGARITHMIC DIFFERENCE

(Barometer, 30 inches. Fahrenheit's Thermometer, 50°.)

| ☽ App. Alt. | Horizontal Parallax. 53′ | 54′ | 55′ | 56′ | 57′ | 58′ | 59′ | 60′ | 61′ | ″ of Par. | Corr. for ″ of Par. sub. 0″ | 2″ | 4″ | 6″ | 8″ | 10″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° ′ | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | | | | | | | |
| 60 0 | 4395 | 4284 | 4172 | 4061 | 3949 | 3838 | 3726 | 3615 | 3503 | 0 | 0 | 4 | 7 | 11 | 15 | 19 |
| 10 | 4386 | 4274 | 4162 | 4051 | 3939 | 3827 | 3715 | 3604 | 3492 | 10 | 19 | 22 | 26 | 30 | 33 | 37 |
| 20 | 4376 | 4264 | 4152 | 4040 | 3928 | 3817 | 3705 | 3593 | 3481 | 20 | 37 | 41 | 45 | 48 | 52 | 56 |
| 30 | 4366 | 4254 | 4142 | 4030 | 3918 | 3806 | 3694 | 3582 | 3470 | 30 | 56 | 60 | 63 | 67 | 71 | 75 |
| 40 | 4357 | 4245 | 4132 | 4020 | 3908 | 3796 | 3683 | 3571 | 3459 | 40 | 75 | 79 | 82 | 86 | 90 | 94 |
| 50 | 4347 | 4235 | 4122 | 4010 | 3898 | 3785 | 3673 | 3560 | 3448 | 50 | 94 | 97 | 101 | 105 | 109 | 112 |
| 61 0 | 4338 | 4225 | 4113 | 4000 | 3887 | 3775 | 3662 | 3549 | 3437 | 0 | 0 | 4 | 7 | 11 | 15 | 19 |
| 10 | 4328 | 4216 | 4103 | 3990 | 3877 | 3764 | 3652 | 3539 | 3426 | 10 | 19 | 23 | 26 | 30 | 34 | 38 |
| 20 | 4319 | 4206 | 4093 | 3980 | 3867 | 3754 | 3641 | 3528 | 3415 | 20 | 38 | 41 | 45 | 49 | 53 | 57 |
| 30 | 4310 | 4197 | 4084 | 3970 | 3857 | 3744 | 3631 | 3518 | 3405 | 30 | 57 | 60 | 64 | 68 | 72 | 76 |
| 40 | 4301 | 4187 | 4074 | 3961 | 3847 | 3734 | 3621 | 3507 | 3394 | 40 | 76 | 79 | 83 | 87 | 91 | 95 |
| 50 | 4291 | 4178 | 4064 | 3951 | 3837 | 3724 | 3610 | 3497 | 3383 | 50 | 95 | 98 | 102 | 106 | 110 | 113 |
| 62 0 | 4282 | 4168 | 4055 | 3941 | 3827 | 3714 | 3600 | 3486 | 3373 | 0 | 0 | 4 | 8 | 11 | 15 | 19 |
| 10 | 4273 | 4159 | 4045 | 3931 | 3818 | 3704 | 3590 | 3476 | 3362 | 10 | 19 | 23 | 27 | 30 | 34 | 38 |
| 20 | 4264 | 4150 | 4036 | 3922 | 3808 | 3694 | 3580 | 3466 | 3352 | 20 | 38 | 42 | 46 | 49 | 53 | 57 |
| 30 | 4255 | 4141 | 4027 | 3912 | 3798 | 3684 | 3570 | 3456 | 3342 | 30 | 57 | 61 | 65 | 68 | 72 | 76 |
| 40 | 4246 | 4132 | 4017 | 3903 | 3789 | 3674 | 3560 | 3446 | 3331 | 40 | 76 | 80 | 84 | 88 | 91 | 95 |
| 50 | 4237 | 4122 | 4008 | 3893 | 3779 | 3664 | 3550 | 3435 | 3321 | 50 | 95 | 99 | 103 | 107 | 111 | 114 |
| 63 0 | 4228 | 4113 | 3999 | 3884 | 3769 | 3655 | 3540 | 3425 | 3310 | 0 | 0 | 4 | 8 | 11 | 15 | 19 |
| 10 | 4219 | 4104 | 3989 | 3875 | 3760 | 3645 | 3530 | 3415 | 3300 | 10 | 19 | 23 | 27 | 31 | 34 | 38 |
| 20 | 4210 | 4095 | 3980 | 3865 | 3750 | 3635 | 3520 | 3405 | 3290 | 20 | 38 | 42 | 46 | 50 | 54 | 58 |
| 30 | 4202 | 4087 | 3971 | 3856 | 3741 | 3626 | 3511 | 3395 | 3280 | 30 | 58 | 61 | 65 | 69 | 73 | 77 |
| 40 | 4193 | 4078 | 3962 | 3847 | 3732 | 3616 | 3501 | 3386 | 3270 | 40 | 77 | 81 | 85 | 88 | 92 | 96 |
| 50 | 4184 | 4069 | 3953 | 3838 | 3722 | 3607 | 3491 | 3376 | 3260 | 50 | 96 | 100 | 104 | 108 | 112 | 115 |
| 64 0 | 4175 | 4060 | 3944 | 3828 | 3713 | 3597 | 3481 | 3366 | 3250 | 0 | 0 | 4 | 8 | 12 | 15 | 19 |
| 10 | 4167 | 4051 | 3935 | 3820 | 3704 | 3588 | 3472 | 3356 | 3241 | 10 | 19 | 23 | 27 | 31 | 35 | 39 |
| 20 | 4159 | 4043 | 3927 | 3811 | 3695 | 3579 | 3463 | 3347 | 3231 | 20 | 39 | 42 | 46 | 50 | 54 | 58 |
| 30 | 4150 | 4034 | 3918 | 3802 | 3686 | 3570 | 3454 | 3337 | 3221 | 30 | 58 | 62 | 66 | 70 | 73 | 77 |
| 40 | 4142 | 4026 | 3909 | 3793 | 3677 | 3561 | 3444 | 3328 | 3212 | 40 | 77 | 81 | 85 | 89 | 93 | 97 |
| 50 | 4134 | 4017 | 3901 | 3784 | 3668 | 3551 | 3435 | 3318 | 3202 | 50 | 97 | 101 | 105 | 109 | 113 | 116 |
| 65 0 | 4125 | 4009 | 3892 | 3776 | 3659 | 3542 | 3426 | 3309 | 3192 | 0 | 0 | 4 | 8 | 12 | 15 | 19 |
| 10 | 4117 | 4001 | 3884 | 3767 | 3650 | 3533 | 3417 | 3300 | 3183 | 10 | 19 | 23 | 27 | 31 | 35 | 39 |
| 20 | 4109 | 3992 | 3875 | 3758 | 3641 | 3524 | 3407 | 3291 | 3174 | 20 | 39 | 43 | 47 | 51 | 54 | 59 |
| 30 | 4101 | 3984 | 3867 | 3750 | 3633 | 3516 | 3398 | 3281 | 3164 | 30 | 59 | 62 | 66 | 70 | 74 | 78 |
| 40 | 4093 | 3976 | 3858 | 3741 | 3624 | 3507 | 3389 | 3272 | 3155 | 40 | 78 | 82 | 86 | 90 | 94 | 98 |
| 50 | 4085 | 3967 | 3850 | 3733 | 3615 | 3498 | 3380 | 3263 | 3146 | 50 | 98 | 102 | 106 | 109 | 113 | 117 |
| 66 0 | 4077 | 3959 | 3841 | 3724 | 3606 | 3489 | 3371 | 3254 | 3136 | 0 | 0 | 4 | 8 | 12 | 16 | 20 |
| 10 | 4069 | 3951 | 3833 | 3716 | 3598 | 3480 | 3363 | 3245 | 3127 | 10 | 20 | 24 | 27 | 31 | 35 | 40 |
| 20 | 4061 | 3943 | 3825 | 3708 | 3590 | 3472 | 3354 | 3236 | 3118 | 20 | 40 | 43 | 47 | 51 | 55 | 59 |
| 30 | 4053 | 3935 | 3817 | 3699 | 3581 | 3463 | 3345 | 3227 | 3110 | 30 | 59 | 63 | 67 | 71 | 75 | 79 |
| 40 | 4045 | 3927 | 3809 | 3691 | 3573 | 3455 | 3337 | 3219 | 3101 | 40 | 79 | 83 | 86 | 90 | 94 | 98 |
| 50 | 4038 | 3919 | 3801 | 3683 | 3565 | 3446 | 3328 | 3210 | 3092 | 50 | 98 | 102 | 106 | 110 | 114 | 118 |
| 67 0 | 4030 | 3912 | 3793 | 3675 | 3556 | 3438 | 3320 | 3201 | 3083 | 0 | 0 | 4 | 8 | 12 | 16 | 20 |
| 10 | 4023 | 3904 | 3785 | 3667 | 3548 | 3430 | 3311 | 3193 | 3074 | 10 | 20 | 24 | 28 | 32 | 36 | 40 |
| 20 | 4015 | 3896 | 3778 | 3659 | 3540 | 3422 | 3303 | 3184 | 3066 | 20 | 40 | 43 | 47 | 51 | 55 | 59 |
| 30 | 4008 | 3889 | 3770 | 3651 | 3532 | 3414 | 3295 | 3176 | 3057 | 30 | 59 | 63 | 67 | 71 | 75 | 79 |
| 40 | 4000 | 3881 | 3762 | 3643 | 3524 | 3405 | 3286 | 3167 | 3048 | 40 | 79 | 83 | 87 | 91 | 95 | 99 |
| 50 | 3993 | 3874 | 3755 | 3635 | 3516 | 3397 | 3278 | 3159 | 3040 | 50 | 99 | 103 | 107 | 111 | 115 | 119 |
| 68 0 | 3985 | 3866 | 3747 | 3628 | 3508 | 3389 | 3270 | 3150 | 3031 | 0 | 0 | 4 | 8 | 12 | 16 | 20 |
| 10 | 3978 | 3859 | 3739 | 3620 | 3501 | 3381 | 3262 | 3142 | 3023 | 10 | 20 | 24 | 28 | 32 | 36 | 40 |
| 20 | 3971 | 3852 | 3732 | 3613 | 3493 | 3373 | 3254 | 3134 | 3015 | 20 | 40 | 44 | 48 | 52 | 56 | 60 |
| 30 | 3964 | 3844 | 3725 | 3605 | 3485 | 3366 | 3246 | 3126 | 3007 | 30 | 60 | 64 | 68 | 72 | 76 | 80 |
| 40 | 3957 | 3837 | 3717 | 3598 | 3478 | 3358 | 3238 | 3118 | 2998 | 40 | 80 | 84 | 88 | 92 | 96 | 100 |
| 50 | 3950 | 3830 | 3710 | 3590 | 3470 | 3350 | 3230 | 3110 | 2990 | 50 | 100 | 104 | 108 | 112 | 116 | 120 |
| 69 0 | 3943 | 3823 | 3703 | 3583 | 3462 | 3342 | 3222 | 3102 | 2982 | 0 | 0 | 4 | 8 | 12 | 16 | 20 |
| 10 | 3936 | 3816 | 3695 | 3575 | 3455 | 3335 | 3215 | 3095 | 2974 | 10 | 20 | 24 | 28 | 32 | 36 | 40 |
| 20 | 3929 | 3809 | 3688 | 3568 | 3448 | 3327 | 3207 | 3087 | 2966 | 20 | 40 | 44 | 48 | 52 | 56 | 60 |
| 30 | 3922 | 3802 | 3681 | 3561 | 3440 | 3320 | 3199 | 3079 | 2959 | 30 | 60 | 64 | 68 | 72 | 76 | 80 |
| 40 | 3915 | 3795 | 3674 | 3554 | 3433 | 3312 | 3192 | 3071 | 2951 | 40 | 80 | 84 | 88 | 92 | 96 | 101 |
| 50 | 3909 | 3788 | 3667 | 3546 | 3426 | 3305 | 3184 | 3064 | 2943 | 50 | 101 | 105 | 109 | 113 | 117 | 120 |

Cor. for ′ of Alt. sub.

| H.P. 53′ | | H.P. 61′ | | H.P. 53′ | | H.P. 61′ | |
|---|---|---|---|---|---|---|---|
| 1′ | 1 | 1′ | 1 | 1′ | 1 | 1′ | 1 |
| 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| 4 | 4 | 4 | 4 | 4 | 3 | 4 | 3 |
| 5 | 4 | 5 | 5 | 5 | 4 | 5 | 4 |
| 6 | 5 | 6 | 7 | 6 | 5 | 6 | 5 |
| 7 | 6 | 7 | 8 | 7 | 6 | 7 | 5 |
| 8 | 7 | 8 | 9 | 8 | 6 | 8 | 6 |
| 9 | 8 | 9 | 10 | 9 | 7 | 9 | 7 |

| Sun's Alt. | 5° | 6° | 7° | 8° | 14° | 25° | 31° | 42 | 51° | 64° | 90° |
|---|---|---|---|---|---|---|---|---|---|---|---|
| sub. | 17 | 13 | 11 | 9 | 7 | 9 | 11 | 13 | 15 | 17 | 18 |

| Star's Alt. | 5° | 6° | 7° | 8° | 9° | 11° | 12° | 14° | 18° | 30° |
|---|---|---|---|---|---|---|---|---|---|---|
| sub. | 15 | 11 | 9 | 7 | 5 | 4 | 3 | 2 | 1 | 0 |

## THE LOGARITHMIC DIFFERENCE

(Barometer, 30 inches. Fahrenheit's Thermometer, 50°.)

| ☽ App. Alt. | | Horizontal Parallax. 53′ | 54′ | 55′ | 56′ | 57′ | 58′ | 59′ | 60′ | 61′ | ″ of Par. | Corr. for ″ of Par. sub. 0′ | 2′ | 4′ | 6′ | 8′ | 10′ | Cor. for ′ of Alt. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | | | | | | | | | |
| 70 | 0 | 3902 | 3781 | 3660 | 3539 | 3418 | 3298 | 3177 | 3056 | 2935 | 0 | 0 | 4 | 8 | 12 | 16 | 20 | | |
| | 10 | 3895 | 3774 | 3653 | 3532 | 3411 | 3290 | 3169 | 3049 | 2928 | 10 | 20 | 24 | 28 | 32 | 36 | 40 | sub | |
| | 20 | 3889 | 3768 | 3647 | 3526 | 3404 | 3283 | 3162 | 3041 | 2920 | 20 | 40 | 44 | 48 | 52 | 56 | 61 | | |
| | 30 | 3882 | 3701 | 3640 | 3519 | 3398 | 3276 | 3155 | 3034 | 2913 | 30 | 61 | 65 | 69 | 73 | 77 | 81 | | |
| | 40 | 3876 | 3755 | 3633 | 3512 | 3391 | 3269 | 3148 | 3027 | 2905 | 40 | 81 | 85 | 89 | 93 | 97 | 101 | | |
| | 50 | 3869 | 3748 | 3626 | 3505 | 3384 | 3262 | 3141 | 3019 | 2898 | 50 | 101 | 105 | 109 | 113 | 117 | 121 | | |
| 71 | 0 | 3863 | 3741 | 3620 | 3498 | 3377 | 3255 | 3133 | 3012 | 2890 | 0 | 0 | 4 | 8 | 12 | 16 | 20 | ′ | |
| | 10 | 3857 | 3735 | 3613 | 3492 | 3370 | 3248 | 3127 | 3005 | 2883 | 10 | 20 | 24 | 28 | 32 | 37 | 41 | 1 | 1 |
| | 20 | 3851 | 3729 | 3607 | 3485 | 3363 | 3242 | 3120 | 2998 | 2876 | 20 | 41 | 45 | 49 | 53 | 57 | 61 | 2 | 1 |
| | 30 | 3844 | 3722 | 3601 | 3479 | 3357 | 3235 | 3113 | 2991 | 2869 | 30 | 61 | 65 | 69 | 73 | 77 | 81 | 3 | 2 |
| | 40 | 3838 | 3716 | 3594 | 3472 | 3350 | 3228 | 3106 | 2984 | 2862 | 40 | 81 | 85 | 89 | 93 | 98 | 102 | 4 | 2 |
| | 50 | 3832 | 3710 | 3588 | 3466 | 3343 | 3221 | 3099 | 2977 | 2855 | 50 | 102 | 106 | 110 | 114 | 118 | 122 | 5 | 3 |
| 72 | 0 | 3826 | 3704 | 3581 | 3459 | 3337 | 3214 | 3092 | 2970 | 2848 | 0 | 0 | 4 | 8 | 12 | 16 | 20 | 6 | 4 |
| | 10 | 3820 | 3698 | 3575 | 3453 | 3330 | 3208 | 3085 | 2963 | 2841 | 10 | 20 | 24 | 29 | 33 | 37 | 41 | 7 | 4 |
| | 20 | 3814 | 3692 | 3569 | 3447 | 3324 | 3202 | 3079 | 2957 | 2834 | 20 | 41 | 45 | 49 | 53 | 57 | 61 | 8 | 5 |
| | 30 | 3808 | 3686 | 3563 | 3440 | 3318 | 3195 | 3073 | 2950 | 2827 | 30 | 61 | 65 | 69 | 74 | 78 | 82 | 9 | 5 |
| | 40 | 3803 | 3680 | 3557 | 3434 | 3312 | 3189 | 3066 | 2943 | 2821 | 40 | 82 | 86 | 90 | 94 | 98 | 102 | | |
| | 50 | 3797 | 3674 | 3551 | 3428 | 3305 | 3182 | 3060 | 2937 | 2814 | 50 | 102 | 106 | 111 | 115 | 119 | 123 | | |
| 73 | 0 | 3791 | 3668 | 3545 | 3422 | 3299 | 3176 | 3053 | 2930 | 2807 | 0 | 0 | 4 | 8 | 12 | 16 | 20 | | |
| | 10 | 3785 | 3662 | 3539 | 3416 | 3293 | 3170 | 3047 | 2924 | 2801 | 10 | 20 | 25 | 29 | 33 | 37 | 41 | | |
| | 20 | 3780 | 3657 | 3533 | 3410 | 3287 | 3164 | 3041 | 2918 | 2794 | 20 | 41 | 45 | 49 | 53 | 57 | 62 | | |
| | 30 | 3774 | 3651 | 3528 | 3404 | 3281 | 3158 | 3035 | 2911 | 2788 | 30 | 62 | 66 | 70 | 74 | 78 | 82 | | |
| | 40 | 3769 | 3645 | 3522 | 3398 | 3275 | 3152 | 3028 | 2905 | 2782 | 40 | 82 | 86 | 90 | 95 | 98 | 103 | | |
| | 50 | 3763 | 3640 | 3516 | 3393 | 3269 | 3146 | 3022 | 2899 | 2775 | 50 | 103 | 107 | 111 | 115 | 119 | 123 | | |
| 74 | 0 | 3757 | 3634 | 3510 | 3387 | 3263 | 3140 | 3016 | 2892 | 2769 | 0 | 0 | 4 | 8 | 12 | 16 | 21 | | |
| | 10 | 3752 | 3629 | 3505 | 3381 | 3258 | 3134 | 3010 | 2887 | 2763 | 10 | 21 | 25 | 29 | 33 | 37 | 41 | | |
| | 20 | 3747 | 3623 | 3500 | 3376 | 3252 | 3128 | 3004 | 2881 | 2757 | 20 | 41 | 45 | 49 | 54 | 58 | 62 | | |
| | 30 | 3742 | 3618 | 3494 | 3370 | 3246 | 3123 | 2999 | 2875 | 2751 | 30 | 62 | 66 | 70 | 74 | 78 | 83 | | |
| | 40 | 3737 | 3613 | 3489 | 3365 | 3241 | 3117 | 2993 | 2869 | 2745 | 40 | 83 | 87 | 91 | 95 | 99 | 103 | | |
| | 50 | 3731 | 3607 | 3483 | 3359 | 3235 | 3111 | 2987 | 2863 | 2739 | 50 | 103 | 107 | 112 | 116 | 120 | 124 | | |
| 75 | 0 | 3726 | 3602 | 3478 | 3354 | 3230 | 3105 | 2981 | 2857 | 2733 | 0 | 0 | 4 | 8 | 12 | 17 | 21 | | |
| | 10 | 3721 | 3597 | 3473 | 3349 | 3224 | 3100 | 2976 | 2852 | 2727 | 10 | 21 | 25 | 29 | 33 | 37 | 41 | | |
| | 20 | 3716 | 3592 | 3468 | 3343 | 3219 | 3095 | 2970 | 2846 | 2722 | 20 | 41 | 46 | 50 | 54 | 58 | 62 | | |
| | 30 | 3712 | 3587 | 3463 | 3338 | 3214 | 3089 | 2965 | 2841 | 2716 | 30 | 62 | 66 | 70 | 75 | 79 | 83 | | |
| | 40 | 3707 | 3582 | 3458 | 3333 | 3209 | 3084 | 2960 | 2835 | 2710 | 40 | 83 | 87 | 91 | 95 | 100 | 104 | | |
| | 50 | 3702 | 3577 | 3453 | 3328 | 3203 | 3079 | 2954 | 2829 | 2705 | 50 | 104 | 108 | 112 | 116 | 120 | 124 | | |
| 76 | 0 | 3697 | 3572 | 3448 | 3323 | 3198 | 3073 | 2949 | 2824 | 2699 | 0 | 0 | 4 | 8 | 12 | 17 | 21 | | |
| | 10 | 3692 | 3568 | 3443 | 3318 | 3193 | 3068 | 2944 | 2819 | 2694 | 10 | 21 | 25 | 29 | 33 | 37 | 42 | | |
| | 20 | 3688 | 3563 | 3438 | 3313 | 3188 | 3063 | 2939 | 2814 | 2689 | 20 | 42 | 46 | 50 | 54 | 58 | 62 | | |
| | 30 | 3683 | 3558 | 3433 | 3308 | 3183 | 3058 | 2933 | 2808 | 2684 | 30 | 62 | 67 | 71 | 75 | 79 | 83 | | |
| | 40 | 3679 | 3554 | 3429 | 3304 | 3178 | 3053 | 2928 | 2803 | 2678 | 40 | 83 | 88 | 92 | 96 | 100 | 104 | | |
| | 50 | 3674 | 3549 | 3424 | 3299 | 3174 | 3048 | 2923 | 2798 | 2673 | 50 | 104 | 108 | 113 | 117 | 121 | 125 | | |
| 77 | 0 | 3670 | 3544 | 3419 | 3294 | 3169 | 3043 | 2918 | 2793 | 2668 | 0 | 0 | 4 | 8 | 12 | 17 | 21 | ′ | |
| | 10 | 3665 | 3540 | 3415 | 3289 | 3164 | 3039 | 2914 | 2788 | 2663 | 10 | 21 | 25 | 29 | 33 | 38 | 42 | 1 | 0 |
| | 20 | 3661 | 3536 | 3410 | 3285 | 3160 | 3034 | 2909 | 2783 | 2658 | 20 | 42 | 46 | 50 | 54 | 58 | 63 | 2 | 1 |
| | 30 | 3657 | 3531 | 3406 | 3281 | 3155 | 3030 | 2904 | 2779 | 2653 | 30 | 63 | 67 | 71 | 75 | 79 | 84 | 3 | 1 |
| | 40 | 3653 | 3527 | 3402 | 3276 | 3151 | 3025 | 2899 | 2774 | 2648 | 40 | 84 | 88 | 92 | 96 | 100 | 105 | 4 | 2 |
| | 50 | 3648 | 3523 | 3397 | 3272 | 3146 | 3020 | 2895 | 2769 | 2644 | 50 | 105 | 109 | 113 | 117 | 121 | 126 | 5 | 2 |
| 78 | 0 | 3644 | 3519 | 3393 | 3267 | 3141 | 3016 | 2890 | 2764 | 2639 | 0 | 0 | 4 | 8 | 13 | 17 | 21 | 6 | 3 |
| | 10 | 3640 | 3515 | 3389 | 3263 | 3137 | 3012 | 2886 | 2760 | 2634 | 10 | 21 | 25 | 29 | 33 | 38 | 42 | 7 | 3 |
| | 20 | 3636 | 3511 | 3385 | 3259 | 3133 | 3007 | 2881 | 2756 | 2630 | 20 | 42 | 46 | 50 | 54 | 59 | 63 | 8 | 4 |
| | 30 | 3633 | 3507 | 3381 | 3255 | 3129 | 3003 | 2877 | 2751 | 2625 | 30 | 63 | 67 | 71 | 76 | 80 | 84 | 9 | 4 |
| | 40 | 3629 | 3403 | 3377 | 3251 | 3125 | 2999 | 2873 | 2747 | 2621 | 40 | 84 | 88 | 92 | 97 | 101 | 105 | | |
| | 50 | 3625 | 3499 | 3373 | 3247 | 3121 | 2995 | 2868 | 2742 | 2616 | 50 | 105 | 109 | 113 | 118 | 122 | 126 | | |
| 79 | 0 | 3621 | 3495 | 3369 | 3243 | 3116 | 2990 | 2864 | 2738 | 2612 | 0 | 0 | 4 | 8 | 13 | 17 | 21 | | |
| | 10 | 3617 | 3491 | 3365 | 3239 | 3113 | 2986 | 2860 | 2734 | 2608 | 10 | 21 | 25 | 29 | 34 | 38 | 42 | | |
| | 20 | 3614 | 3488 | 3361 | 3235 | 3109 | 2982 | 2856 | 2730 | 2604 | 20 | 42 | 46 | 50 | 55 | 59 | 63 | | |
| | 30 | 3610 | 3484 | 3358 | 3231 | 3105 | 2979 | 2852 | 2726 | 2600 | 30 | 63 | 67 | 71 | 76 | 80 | 84 | | |
| | 40 | 3607 | 3480 | 3354 | 3228 | 3101 | 2975 | 2848 | 2722 | 2596 | 40 | 84 | 87 | 93 | 97 | 101 | 105 | | |
| | 50 | 3603 | 3477 | 3350 | 3224 | 3097 | 2971 | 2844 | 2718 | 2591 | 50 | 105 | 110 | 114 | 118 | 122 | 126 | | |

| Sun's Alt. | 5° | 6° | 7° | 8° | 14° | 25° | 34° | 42° | 51° | 64° | 90° |
|---|---|---|---|---|---|---|---|---|---|---|---|
| sub. | 17 | 13 | 11 | 9 | 7 | 9 | 11 | 13 | 15 | 17 | 18 |

| Star's Alt. | 5° | 6° | 7° | 8° | 9° | 11° | 12° | 14° | 18° | 30° |
|---|---|---|---|---|---|---|---|---|---|---|
| sub. | 15 | 11 | 9 | 7 | 5 | 4 | 3 | 2 | 1 | 0 |

## THE LOGARITHMIC DIFFERENCE

(Barometer, 30 inches. Fahrenheit's Thermometer, 50°.)

| ☽ App. Alt. | Horizontal Parallax. 53′ | 54′ | 55′ | 56′ | 57′ | 58′ | 59′ | 60′ | 61′ | ″ of Par. | Corr. for ″ of Par. *sub.* 0′ | 2′ | 4′ | 6′ | 8′ | 10′ | Cor. for ′ of Alt. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° ′ | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | 9·99 | | | | | | | | |
| 80 0 | 3600 | 3473 | 3347 | 3220 | 3094 | 2967 | 2840 | 2714 | 2587 | 0 | | | | | | | |
| 10 | 3596 | 3470 | 3343 | 3217 | 3090 | 2963 | 2837 | 2710 | 2584 | 10 | | | | | | | |
| 20 | 3593 | 3467 | 3340 | 3213 | 3087 | 2960 | 2833 | 2707 | 2580 | 20 | | | | | | | *sub.* |
| 30 | 3590 | 3463 | 3337 | 3210 | 3083 | 2956 | 2830 | 2703 | 2576 | 30 | | | | | | | |
| 40 | 3587 | 3460 | 3333 | 3206 | 3080 | 2953 | 2826 | 2699 | 2573 | 40 | | | | | | | |
| 50 | 3584 | 3457 | 3330 | 3203 | 3076 | 2949 | 2823 | 2696 | 2569 | 50 | | | | | | | |
| 81 0 | 3580 | 3453 | 3327 | 3200 | 3073 | 2946 | 2819 | 2692 | 2565 | 0 | | | | | | | |
| 10 | 3577 | 3451 | 3324 | 3197 | 3070 | 2943 | 2816 | 2689 | 2562 | 10 | | | | | | | H.P. |
| 20 | 3575 | 3448 | 3321 | 3194 | 3067 | 2940 | 2813 | 2686 | 2559 | 20 | | | | | | | 53 |
| 30 | 3572 | 3445 | 3318 | 3191 | 3063 | 2936 | 2809 | 2682 | 2555 | 30 | | | | | | | |
| 40 | 3569 | 3442 | 3315 | 3188 | 3060 | 2933 | 2806 | 2679 | 2552 | 40 | | | | | | | |
| 50 | 3566 | 3439 | 3312 | 3184 | 3057 | 2930 | 2803 | 2676 | 2549 | 50 | | | | | | | 1′ 0 |
| 82 0 | 3563 | 3436 | 3309 | 3181 | 3054 | 2927 | 2800 | 2673 | 2545 | 0 | 0 | 4 | 8 | 13 | 17 | 21 | 2 0 |
| 10 | 3561 | 3433 | 3306 | 3179 | 3052 | 2924 | 2797 | 2670 | 2542 | 10 | 21 | 25 | 29 | 34 | 38 | 42 | 3 1 |
| 20 | 3558 | 3431 | 3303 | 3176 | 3049 | 2921 | 2794 | 2667 | 2539 | 20 | 42 | 46 | 51 | 55 | 59 | 63 | 4 1 |
| 30 | 3555 | 3428 | 3301 | 3173 | 3046 | 2919 | 2791 | 2664 | 2537 | 30 | 63 | 68 | 72 | 76 | 80 | 84 | 5 1 |
| 40 | 3553 | 3425 | 3298 | 3171 | 3043 | 2916 | 2788 | 2661 | 2534 | 40 | 84 | 89 | 93 | 97 | 101 | 106 | 6 2 |
| 50 | 3550 | 3423 | 3295 | 3168 | 3041 | 2913 | 2786 | 2658 | 2531 | 50 | 106 | 110 | 114 | 118 | 123 | 127 | 7 2 |
| 83 0 | 3548 | 3420 | 3293 | 3166 | 3038 | 2911 | 2783 | 2656 | 2528 | 0 | | | | | | | 8 3 |
| 10 | 3546 | 3418 | 3291 | 3164 | 3036 | 2909 | 2781 | 2654 | 2526 | 10 | | | | | | | 9 3 |
| 20 | 3543 | 3416 | 3289 | 3162 | 3034 | 2907 | 2779 | 2652 | 2524 | 20 | | | | | | | |
| 30 | 3541 | 3414 | 3286 | 3159 | 3031 | 2904 | 2776 | 2649 | 2521 | 30 | | | | | | | |
| 40 | 3539 | 3411 | 3284 | 3156 | 3029 | 2901 | 2773 | 2646 | 2518 | 40 | | | | | | | |
| 50 | 3537 | 3409 | 3282 | 3154 | 3027 | 2899 | 2771 | 2643 | 2516 | 50 | | | | | | | |
| 84 0 | 3535 | 3407 | 3279 | 3151 | 3024 | 2896 | 2768 | 2640 | 2513 | 0 | | | | | | | |
| 10 | 3533 | 3405 | 3277 | 3149 | 3022 | 2894 | 2766 | 2638 | 2511 | 10 | | | | | | | |
| 20 | 3531 | 3403 | 3275 | 3147 | 3020 | 2892 | 2764 | 2636 | 2508 | 20 | | | | | | | |
| 30 | 3529 | 3401 | 3273 | 3145 | 3018 | 2890 | 2762 | 2634 | 2506 | 30 | | | | | | | |
| 40 | 3527 | 3399 | 3271 | 3143 | 3016 | 2888 | 2760 | 2632 | 2504 | 40 | | | | | | | |
| 50 | 3525 | 3397 | 3269 | 3141 | 3014 | 2886 | 2758 | 2630 | 2502 | 50 | | | | | | | |
| 85 0 | 3523 | 3396 | 3268 | 3140 | 3013 | 2884 | 2756 | 2628 | 2500 | 0 | | | | | | | |
| 10 | 3522 | 3394 | 3266 | 3138 | 3010 | 2882 | 2754 | 2626 | 2498 | 10 | | | | | | | |
| 20 | 3520 | 3392 | 3264 | 3136 | 3007 | 2880 | 2752 | 2624 | 2496 | 20 | | | | | | | |
| 30 | 3518 | 3391 | 3263 | 3134 | 3006 | 2878 | 2750 | 2621 | 2494 | 30 | | | | | | | |
| 40 | 3517 | 3389 | 3261 | 3133 | 3005 | 2877 | 2749 | 2620 | 2493 | 40 | | | | | | | |
| 50 | 3516 | 3388 | 3259 | 3131 | 3003 | 2875 | 2747 | 2619 | 2491 | 50 | | | | | | | |
| 86 0 | 3514 | 3386 | 3258 | 3130 | 3002 | 2874 | 2746 | 2617 | 2489 | 0 | | | | | | | |
| 10 | 3513 | 3385 | 3257 | 3128 | 3000 | 2872 | 2744 | 2616 | 2487 | 10 | | | | | | | |
| 20 | 3511 | 3383 | 3255 | 3127 | 2999 | 2871 | 2743 | 2614 | 2486 | 20 | | | | | | | |
| 30 | 3510 | 3382 | 3253 | 3126 | 2998 | 2869 | 2741 | 2613 | 2485 | 30 | | | | | | | H.P. |
| 40 | 3509 | 3381 | 3252 | 3124 | 2996 | 2868 | 2740 | 2612 | 2483 | 40 | | | | | | | 60′ |
| 50 | 3508 | 3380 | 3251 | 3123 | 2995 | 2867 | 2739 | 2610 | 2482 | 50 | | | | | | | |
| 87 0 | 3507 | 3379 | 3250 | 3122 | 2994 | 2866 | 2738 | 2609 | 2481 | 0 | 0 | 4 | 9 | 13 | 17 | 21 | |
| 10 | 3506 | 3378 | 3250 | 3121 | 2993 | 2865 | 2736 | 2608 | 2480 | 10 | 21 | 25 | 30 | 34 | 38 | 43 | 1′ 0 |
| 20 | 3505 | 3377 | 3249 | 3120 | 2992 | 2864 | 2735 | 2607 | 2479 | 20 | 43 | 47 | 52 | 56 | 60 | 64 | 2 0 |
| 30 | 3504 | 3376 | 3248 | 3119 | 2991 | 2863 | 2734 | 2606 | 2478 | 30 | 64 | 68 | 73 | 77 | 81 | 85 | 3 0 |
| 40 | 3503 | 3375 | 3247 | 3119 | 2990 | 2862 | 2734 | 2605 | 2477 | 40 | 85 | 90 | 94 | 98 | 102 | 107 | 4 0 |
| 50 | 3502 | 3374 | 3246 | 3118 | 2989 | 2861 | 2733 | 2604 | 2476 | 50 | 107 | 111 | 115 | 119 | 124 | 128 | 5 1 |
| 88 0 | 3501 | 3374 | 3245 | 3117 | 2989 | 2860 | 2732 | 2603 | 2475 | 0 | | | | | | | 6 1 |
| 10 | 3501 | 3373 | 3244 | 3116 | 2988 | 2860 | 2731 | 2602 | 2474 | 10 | | | | | | | 7 1 |
| 20 | 3500 | 3373 | 3244 | 3116 | 2987 | 2859 | 2731 | 2602 | 2474 | 20 | | | | | | | 8 1 |
| 30 | 3500 | 3372 | 3244 | 3115 | 2987 | 2858 | 2730 | 2601 | 2473 | 30 | | | | | | | 9 1 |
| 40 | 3499 | 3371 | 3243 | 3115 | 2986 | 2858 | 2729 | 2601 | 2473 | 40 | | | | | | | |
| 50 | 3499 | 3371 | 3243 | 3114 | 2986 | 2858 | 2729 | 2600 | 2472 | 50 | | | | | | | |
| 89 0 | 3499 | 3371 | 3242 | 3114 | 2985 | 2857 | 2729 | 2600 | 2472 | 0 | | | | | | | |
| 10 | 3499 | 3370 | 3242 | 3113 | 2985 | 2857 | 2728 | 2600 | 2471 | 10 | | | | | | | |
| 20 | 3498 | 3370 | 3242 | 3113 | 2985 | 2856 | 2728 | 2599 | 2471 | 20 | | | | | | | |
| 30 | 3498 | 3370 | 3241 | 3113 | 2985 | 2856 | 2728 | 2599 | 2471 | 30 | | | | | | | |
| 40 | 3498 | 3370 | 3241 | 3113 | 2984 | 2856 | 2727 | 2599 | 2471 | 40 | | | | | | | |
| 50 | 3498 | 3370 | 3241 | 3113 | 2984 | 2856 | 2727 | 2599 | 2470 | 50 | | | | | | | |

| Sun's Alt. | 5° | 6° | 7° | 8° | 14° | 25° | 34° | 42° | 51° | 64° | 90° |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *sub.* | 17 | 13 | 11 | 9 | 7 | 9 | 11 | 13 | 15 | 17 | 18 |

| Star's Alt. | 5° | 6° | 7° | 8° | 9° | 11° | 12° | 14° | 18° | 30° |
|---|---|---|---|---|---|---|---|---|---|---|
| *sub.* | 15 | 11 | 9 | 7 | 5 | 4 | 3 | 2 | 1 | 0 |

## PROPORTIONAL LOGARITHMS

| sec. ″ | h m 0° 0′ | h m 0° 1′ | h m 0° 2′ | h m 0° 3′ | h m 0° 4′ | h m 0° 5′ | h m 0° 6′ | h m 0° 7′ | h m 0° 8′ | h m 0° 9′ | sec ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | 2·2553 | 1·9542 | 1·7782 | 1·6532 | 1·5563 | 1·4771 | 1·4102 | 1·3522 | 1·3010 | 0 |
| 1 | 4·0334 | 2·2481 | 1·9506 | 1·7757 | 1·6514 | 1·5549 | 1·4759 | 1·4091 | 1·3513 | 1·3002 | 1 |
| 2 | 3·7324 | 2·2410 | 1·9471 | 1·7734 | 1·6496 | 1·5534 | 1·4747 | 1·4081 | 1·3504 | 1·2994 | 2 |
| 3 | 3·5563 | 2·2341 | 1·9435 | 1·7710 | 1·6478 | 1·5520 | 1·4735 | 1·4071 | 1·3495 | 1·2986 | 3 |
| 4 | 3·4314 | 2·2272 | 1·9400 | 1·7686 | 1·6460 | 1·5505 | 1·4723 | 1·4061 | 1·3486 | 1·2978 | 4 |
| 5 | 3·3345 | 2·2205 | 1·9365 | 1·7663 | 1·6443 | 1·5491 | 1·4711 | 1·4050 | 1·3477 | 1·2970 | 5 |
| 6 | 3·2553 | 2·2139 | 1·9331 | 1·7639 | 1·6425 | 1·5477 | 1·4699 | 1·4040 | 1·3468 | 1·2962 | 6 |
| 7 | 3·1883 | 2·2073 | 1·9296 | 1·7616 | 1·6407 | 1·5463 | 1·4688 | 1·4030 | 1·3459 | 1·2954 | 7 |
| 8 | 3·1303 | 2·2009 | 1·9262 | 1·7593 | 1·6390 | 1·5449 | 1·4676 | 1·4020 | 1·3450 | 1·2946 | 8 |
| 9 | 3·0792 | 2·1946 | 1·9228 | 1·7570 | 1·6372 | 1·5435 | 1·4664 | 1·4010 | 1·3441 | 1·2939 | 9 |
| 10 | 3·0334 | 2·1883 | 1·9195 | 1·7547 | 1·6355 | 1·5421 | 1·4652 | 1·4000 | 1·3432 | 1·2931 | 10 |
| 11 | 2·9920 | 2·1822 | 1·9162 | 1·7524 | 1·6337 | 1·5407 | 1·4640 | 1·3989 | 1·3423 | 1·2923 | 11 |
| 12 | 2·9542 | 2·1761 | 1·9128 | 1·7501 | 1·6320 | 1·5393 | 1·4629 | 1·3979 | 1·3415 | 1·2915 | 12 |
| 13 | 2·9195 | 2·1701 | 1·9096 | 1·7479 | 1·6303 | 1·5379 | 1·4617 | 1·3969 | 1·3406 | 1·2907 | 13 |
| 14 | 2·8873 | 2·1642 | 1·9063 | 1·7456 | 1·6286 | 1·5365 | 1·4605 | 1·3959 | 1·3397 | 1·2899 | 14 |
| 15 | 2·8573 | 2·1584 | 1·9031 | 1·7434 | 1·6269 | 1·5351 | 1·4594 | 1·3949 | 1·3388 | 1·2891 | 15 |
| 16 | 2·8293 | 2·1526 | 1·8999 | 1·7412 | 1·6252 | 1·5337 | 1·4582 | 1·3939 | 1·3379 | 1·2883 | 16 |
| 17 | 2·8030 | 2·1469 | 1·8967 | 1·7390 | 1·6235 | 1·5324 | 1·4571 | 1·3929 | 1·3371 | 1·2876 | 17 |
| 18 | 2·7782 | 2·1413 | 1·8935 | 1·7368 | 1·6218 | 1·5310 | 1·4559 | 1·3919 | 1·3362 | 1·2868 | 18 |
| 19 | 2·7547 | 2·1358 | 1·8904 | 1·7346 | 1·6201 | 1·5296 | 1·4548 | 1·3910 | 1·3353 | 1·2860 | 19 |
| 20 | 2·7324 | 2·1303 | 1·8873 | 1·7324 | 1·6184 | 1·5283 | 1·4536 | 1·3900 | 1·3344 | 1·2852 | 20 |
| 21 | 2·7112 | 2·1249 | 1·8842 | 1·7302 | 1·6168 | 1·5269 | 1·4525 | 1·3890 | 1·3336 | 1·2845 | 21 |
| 22 | 2·6910 | 2·1196 | 1·8811 | 1·7281 | 1·6151 | 1·5256 | 1·4514 | 1·3880 | 1·3327 | 1·2837 | 22 |
| 23 | 2·6717 | 2·1143 | 1·8781 | 1·7259 | 1·6135 | 1·5242 | 1·4502 | 1·3870 | 1·3319 | 1·2829 | 23 |
| 24 | 2·6532 | 2·1091 | 1·8751 | 1·7238 | 1·6118 | 1·5229 | 1·4491 | 1·3860 | 1·3310 | 1·2821 | 24 |
| 25 | 2·6355 | 2·1040 | 1·8721 | 1·7217 | 1·6102 | 1·5215 | 1·4480 | 1·3851 | 1·3301 | 1·2814 | 25 |
| 26 | 2·6184 | 2·0989 | 1·8691 | 1·7196 | 1·6085 | 1·5202 | 1·4468 | 1·3841 | 1·3293 | 1·2806 | 26 |
| 27 | 2·6021 | 2·0939 | 1·8661 | 1·7175 | 1·6069 | 1·5189 | 1·4457 | 1·3831 | 1·3284 | 1·2798 | 27 |
| 28 | 2·5863 | 2·0889 | 1·8632 | 1·7154 | 1·6053 | 1·5175 | 1·4446 | 1·3821 | 1·3276 | 1·2791 | 28 |
| 29 | 2·5710 | 2·0840 | 1·8602 | 1·7133 | 1·6037 | 1·5162 | 1·4435 | 1·3812 | 1·3267 | 1·2783 | 29 |
| 30 | 2·5563 | 2·0792 | 1·8573 | 1·7112 | 1·6021 | 1·5149 | 1·4424 | 1·3802 | 1·3259 | 1·2775 | 30 |
| 31 | 2·5421 | 2·0744 | 1·8544 | 1·7091 | 1·6004 | 1·5136 | 1·4412 | 1·3792 | 1·3250 | 1·2768 | 31 |
| 32 | 2·5283 | 2·0696 | 1·8516 | 1·7071 | 1·5988 | 1·5123 | 1·4401 | 1·3783 | 1·3241 | 1·2760 | 32 |
| 33 | 2·5149 | 2·0649 | 1·8487 | 1·7050 | 1·5973 | 1·5110 | 1·4390 | 1·3773 | 1·3233 | 1·2753 | 33 |
| 34 | 2·5019 | 2·0603 | 1·8459 | 1·7030 | 1·5957 | 1·5097 | 1·4379 | 1·3764 | 1·3225 | 1·2745 | 34 |
| 35 | 2·4894 | 2·0557 | 1·8431 | 1·7010 | 1·5941 | 1·5084 | 1·4368 | 1·3754 | 1·3216 | 1·2738 | 35 |
| 36 | 2·4771 | 2·0512 | 1·8403 | 1·6990 | 1·5925 | 1·5071 | 1·4357 | 1·3745 | 1·3208 | 1·2730 | 36 |
| 37 | 2·4652 | 2·0467 | 1·8375 | 1·6970 | 1·5909 | 1·5058 | 1·4346 | 1·3735 | 1·3199 | 1·2722 | 37 |
| 38 | 2·4536 | 2·0422 | 1·8348 | 1·6950 | 1·5894 | 1·5045 | 1·4335 | 1·3726 | 1·3191 | 1·2715 | 38 |
| 39 | 2·4424 | 2·0378 | 1·8320 | 1·6930 | 1·5878 | 1·5032 | 1·4325 | 1·3716 | 1·3183 | 1·2707 | 39 |
| 40 | 2·4314 | 2·0334 | 1·8293 | 1·6910 | 1·5863 | 1·5019 | 1·4314 | 1·3707 | 1·3174 | 1·2700 | 40 |
| 41 | 2·4206 | 2·0291 | 1·8266 | 1·6890 | 1·5847 | 1·5007 | 1·4303 | 1·3697 | 1·3166 | 1·2692 | 41 |
| 42 | 2·4102 | 2·0248 | 1·8239 | 1·6871 | 1·5832 | 1·4994 | 1·4292 | 1·3688 | 1·3158 | 1·2685 | 42 |
| 43 | 2·4000 | 2·0206 | 1·8212 | 1·6851 | 1·5816 | 1·4981 | 1·4281 | 1·3678 | 1·3149 | 1·2678 | 43 |
| 44 | 2·3900 | 2·0164 | 1·8186 | 1·6832 | 1·5801 | 1·4969 | 1·4270 | 1·3669 | 1·3141 | 1·2670 | 44 |
| 45 | 2·3802 | 2·0122 | 1·8159 | 1·6812 | 1·5786 | 1·4956 | 1·4260 | 1·3660 | 1·3133 | 1·2663 | 45 |
| 46 | 2·3707 | 2·0081 | 1·8133 | 1·6793 | 1·5771 | 1·4943 | 1·4249 | 1·3650 | 1·3124 | 1·2655 | 46 |
| 47 | 2·3613 | 2·0040 | 1·8107 | 1·6774 | 1·5755 | 1·4931 | 1·4238 | 1·3641 | 1·3116 | 1·2648 | 47 |
| 48 | 2·3522 | 2·0000 | 1·8081 | 1·6755 | 1·5740 | 1·4918 | 1·4228 | 1·3632 | 1·3108 | 1·2640 | 48 |
| 49 | 2·3432 | 1·9960 | 1·8055 | 1·6736 | 1·5725 | 1·4906 | 1·4217 | 1·3622 | 1·3100 | 1·2633 | 49 |
| 50 | 2·3345 | 1·9920 | 1·8030 | 1·6717 | 1·5710 | 1·4894 | 1·4206 | 1·3613 | 1·3091 | 1·2626 | 50 |
| 51 | 2·3259 | 1·9881 | 1·8004 | 1·6698 | 1·5695 | 1·4881 | 1·4196 | 1·3604 | 1·3083 | 1·2618 | 51 |
| 52 | 2·3174 | 1·9842 | 1·7979 | 1·6679 | 1·5680 | 1·4869 | 1·4185 | 1·3595 | 1·3075 | 1·2611 | 52 |
| 53 | 2·3091 | 1·9803 | 1·7954 | 1·6661 | 1·5666 | 1·4856 | 1·4175 | 1·3586 | 1·3067 | 1·2604 | 53 |
| 54 | 2·3010 | 1·9765 | 1·7929 | 1·6642 | 1·5651 | 1·4844 | 1·4164 | 1·3576 | 1·3059 | 1·2596 | 54 |
| 55 | 2·2931 | 1·9727 | 1·7904 | 1·6624 | 1·5636 | 1·4832 | 1·4154 | 1·3567 | 1·3051 | 1·2589 | 55 |
| 56 | 2·2852 | 1·9690 | 1·7879 | 1·6605 | 1·5621 | 1·4820 | 1·4143 | 1·3558 | 1·3043 | 1·2582 | 56 |
| 57 | 2·2775 | 1·9652 | 1·7855 | 1·6587 | 1·5607 | 1·4808 | 1·4133 | 1·3549 | 1·3034 | 1·2574 | 57 |
| 58 | 2·2700 | 1·9615 | 1·7830 | 1·6568 | 1·5592 | 1·4795 | 1·4122 | 1·3540 | 1·3026 | 1·2567 | 58 |
| 59 | 2·2626 | 1·9579 | 1·7806 | 1·6550 | 1·5577 | 1·4783 | 1·4112 | 1·3531 | 1·3018 | 1·2560 | 59 |
| 60 | 2·2553 | 1·9542 | 1·7782 | 1·6532 | 1·5563 | 1·4771 | 1·4102 | 1·3522 | 1·3010 | 1·2553 | 60 |

## PROPORTIONAL LOGARITHMS

| sec. ″ | 0h 10m | 0h 11m | 0h 12m | 0h 13m | 0h 14m | 0h 15m | 0h 16m | 0h 17m | 0h 18m | 0h 19m | 0h 20m | sec. ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1·2553 | 1·2139 | 1·1761 | 1·1413 | 1·1091 | 1·0792 | 1·0512 | 1·0248 | 1·0000 | 9765 | 9542 | 0 |
| 1 | 1·2545 | 1·2132 | 1·1755 | 1·1408 | 1·1086 | 1·0787 | 1·0507 | 1·0244 | 0·9996 | 9761 | 9539 | 1 |
| 2 | 1·2538 | 1·2126 | 1·1749 | 1·1402 | 1·1081 | 1·0782 | 1·0502 | 1·0240 | 0·9992 | 9758 | 9535 | 2 |
| 3 | 1·2531 | 1·2119 | 1·1743 | 1·1397 | 1·1076 | 1·0777 | 1·0498 | 1·0235 | 0·9988 | 9754 | 9532 | 3 |
| 4 | 1·2524 | 1·2113 | 1·1737 | 1·1391 | 1·1071 | 1·0773 | 1·0493 | 1·0231 | 0·9984 | 9750 | 9528 | 4 |
| 5 | 1·2517 | 1·2106 | 1·1731 | 1·1385 | 1·1066 | 1·0768 | 1·0489 | 1·0227 | 0·9980 | 9746 | 9524 | 5 |
| 6 | 1·2510 | 1·2099 | 1·1725 | 1·1380 | 1·1061 | 1·0763 | 1·0484 | 1·0223 | 0·9976 | 9742 | 9521 | 6 |
| 7 | 1·2502 | 1·2093 | 1·1719 | 1·1374 | 1·1055 | 1·0758 | 1·0480 | 1·0218 | 0·9972 | 9739 | 9517 | 7 |
| 8 | 1·2495 | 1·2086 | 1·1713 | 1·1369 | 1·1050 | 1·0753 | 1·0475 | 1·0214 | 0·9968 | 9735 | 9514 | 8 |
| 9 | 1·2488 | 1·2080 | 1·1707 | 1·1363 | 1·1045 | 1·0749 | 1·0471 | 1·0210 | 0·9964 | 9731 | 9510 | 9 |
| 10 | 1·2481 | 1·2073 | 1·1701 | 1·1358 | 1·1040 | 1·0744 | 1·0467 | 1·0206 | 0·9960 | 9727 | 9506 | 10 |
| 11 | 1·2474 | 1·2067 | 1·1695 | 1·1352 | 1·1035 | 1·0739 | 1·0462 | 1·0202 | 0·9956 | 9723 | 9503 | 11 |
| 12 | 1·2467 | 1·2061 | 1·1689 | 1·1347 | 1·1030 | 1·0734 | 1·0458 | 1·0197 | 0·9952 | 9720 | 9499 | 12 |
| 13 | 1·2460 | 1·2054 | 1·1683 | 1·1341 | 1·1025 | 1·0729 | 1·0453 | 1·0193 | 0·9948 | 9716 | 9496 | 13 |
| 14 | 1·2453 | 1·2048 | 1·1677 | 1·1336 | 1·1020 | 1·0725 | 1·0449 | 1·0189 | 0·9944 | 9712 | 9492 | 14 |
| 15 | 1·2445 | 1·2041 | 1·1671 | 1·1331 | 1·1015 | 1·0720 | 1·0444 | 1·0185 | 0·9940 | 9708 | 9488 | 15 |
| 16 | 1·2438 | 1·2035 | 1·1665 | 1·1325 | 1·1009 | 1·0715 | 1·0440 | 1·0181 | 0·9936 | 9705 | 9485 | 16 |
| 17 | 1·2431 | 1·2028 | 1·1660 | 1·1320 | 1·1004 | 1·0710 | 1·0435 | 1·0176 | 0·9932 | 9701 | 9481 | 17 |
| 18 | 1·2424 | 1·2022 | 1·1654 | 1·1314 | 1·0999 | 1·0706 | 1·0431 | 1·0172 | 0·9928 | 9697 | 9478 | 18 |
| 19 | 1·2417 | 1·2015 | 1·1648 | 1·1309 | 1·0994 | 1·0701 | 1·0426 | 1·0168 | 0·9924 | 9693 | 9474 | 19 |
| 20 | 1·2410 | 1·2009 | 1·1642 | 1·1303 | 1·0989 | 1·0696 | 1·0422 | 1·0164 | 0·9920 | 9690 | 9471 | 20 |
| 21 | 1·2403 | 1·2003 | 1·1636 | 1·1298 | 1·0984 | 1·0692 | 1·0418 | 1·0160 | 0·9916 | 9686 | 9467 | 21 |
| 22 | 1·2396 | 1·1996 | 1·1630 | 1·1292 | 1·0979 | 1·0687 | 1·0413 | 1·0156 | 0·9912 | 9682 | 9464 | 22 |
| 23 | 1·2389 | 1·1990 | 1·1624 | 1·1287 | 1·0974 | 1·0682 | 1·0409 | 1·0151 | 0·9908 | 9678 | 9460 | 23 |
| 24 | 1·2382 | 1·1984 | 1·1619 | 1·1282 | 1·0969 | 1·0678 | 1·0404 | 1·0147 | 0·9905 | 9675 | 9456 | 24 |
| 25 | 1·2375 | 1·1977 | 1·1613 | 1·1276 | 1·0964 | 1·0673 | 1·0400 | 1·0143 | 0·9901 | 9671 | 9453 | 25 |
| 26 | 1·2368 | 1·1971 | 1·1607 | 1·1271 | 1·0959 | 1·0668 | 1·0395 | 1·0139 | 0·9897 | 9667 | 9449 | 26 |
| 27 | 1·2362 | 1·1965 | 1·1601 | 1·1266 | 1·0954 | 1·0663 | 1·0391 | 1·0135 | 0·9893 | 9664 | 9446 | 27 |
| 28 | 1·2355 | 1·1958 | 1·1595 | 1·1260 | 1·0949 | 1·0659 | 1·0387 | 1·0131 | 0·9889 | 9660 | 9442 | 28 |
| 29 | 1·2348 | 1·1952 | 1·1589 | 1·1255 | 1·0944 | 1·0654 | 1·0382 | 1·0126 | 0·9885 | 9656 | 9439 | 29 |
| 30 | 1·2341 | 1·1946 | 1·1584 | 1·1249 | 1·0939 | 1·0649 | 1·0378 | 1·0122 | 0·9881 | 9652 | 9435 | 30 |
| 31 | 1·2334 | 1·1939 | 1·1578 | 1·1244 | 1·0934 | 1·0645 | 1·0373 | 1·0118 | 0·9877 | 9649 | 9432 | 31 |
| 32 | 1·2327 | 1·1933 | 1·1572 | 1·1239 | 1·0929 | 1·0640 | 1·0369 | 1·0114 | 0·9873 | 9645 | 9428 | 32 |
| 33 | 1·2320 | 1·1927 | 1·1566 | 1·1233 | 1·0924 | 1·0635 | 1·0365 | 1·0110 | 0·9869 | 9641 | 9425 | 33 |
| 34 | 1·2313 | 1·1921 | 1·1560 | 1·1228 | 1·0919 | 1·0631 | 1·0360 | 1·0106 | 0·9865 | 9638 | 9421 | 34 |
| 35 | 1·2306 | 1·1914 | 1·1555 | 1·1223 | 1·0914 | 1·0626 | 1·0356 | 1·0102 | 0·9861 | 9634 | 9418 | 35 |
| 36 | 1·2300 | 1·1908 | 1·1549 | 1·1217 | 1·0909 | 1·0621 | 1·0352 | 1·0098 | 0·9858 | 9630 | 9414 | 36 |
| 37 | 1·2293 | 1·1902 | 1·1543 | 1·1212 | 1·0904 | 1·0617 | 1·0347 | 1·0093 | 0·9854 | 9626 | 9410 | 37 |
| 38 | 1·2286 | 1·1896 | 1·1537 | 1·1207 | 1·0899 | 1·0612 | 1·0343 | 1·0089 | 0·9850 | 9623 | 9407 | 38 |
| 39 | 1·2279 | 1·1889 | 1·1532 | 1·1201 | 1·0894 | 1·0608 | 1·0339 | 1·0085 | 0·9846 | 9619 | 9404 | 39 |
| 40 | 1·2272 | 1·1883 | 1·1526 | 1·1196 | 1·0889 | 1·0603 | 1·0334 | 1·0081 | 0·9842 | 9615 | 9400 | 40 |
| 41 | 1·2266 | 1·1877 | 1·1520 | 1·1191 | 1·0884 | 1·0598 | 1·0330 | 1·0077 | 0·9838 | 9612 | 9396 | 41 |
| 42 | 1·2259 | 1·1871 | 1·1515 | 1·1186 | 1·0880 | 1·0594 | 1·0326 | 1·0073 | 0·9834 | 9608 | 9393 | 42 |
| 43 | 1·2252 | 1·1865 | 1·1509 | 1·1180 | 1·0875 | 1·0589 | 1·0321 | 1·0069 | 0·9830 | 9604 | 9389 | 43 |
| 44 | 1·2245 | 1·1858 | 1·1503 | 1·1175 | 1·0870 | 1·0584 | 1·0317 | 1·0065 | 0·9827 | 9601 | 9386 | 44 |
| 45 | 1·2239 | 1·1852 | 1·1498 | 1·1170 | 1·0865 | 1·0580 | 1·0313 | 1·0061 | 0·9823 | 9597 | 9383 | 45 |
| 46 | 1·2232 | 1·1846 | 1·1492 | 1·1164 | 1·0860 | 1·0575 | 1·0308 | 1·0057 | 0·9819 | 9593 | 9379 | 46 |
| 47 | 1·2225 | 1·1840 | 1·1486 | 1·1159 | 1·0855 | 1·0571 | 1·0304 | 1·0053 | 0·9815 | 9590 | 9376 | 47 |
| 48 | 1·2218 | 1·1834 | 1·1481 | 1·1154 | 1·0850 | 1·0566 | 1·0300 | 1·0049 | 0·9811 | 9586 | 9372 | 48 |
| 49 | 1·2212 | 1·1828 | 1·1475 | 1·1149 | 1·0845 | 1·0562 | 1·0295 | 1·0044 | 0·9807 | 9582 | 9369 | 49 |
| 50 | 1·2205 | 1·1822 | 1·1469 | 1·1143 | 1·0840 | 1·0557 | 1·0291 | 1·0040 | 0·9803 | 9579 | 9365 | 50 |
| 51 | 1·2198 | 1·1816 | 1·1464 | 1·1138 | 1·0835 | 1·0552 | 1·0287 | 1·0036 | 0·9800 | 9575 | 9362 | 51 |
| 52 | 1·2192 | 1·1809 | 1·1458 | 1·1133 | 1·0831 | 1·0548 | 1·0282 | 1·0032 | 0·9796 | 9571 | 9358 | 52 |
| 53 | 1·2185 | 1·1803 | 1·1452 | 1·1128 | 1·0826 | 1·0543 | 1·0278 | 1·0028 | 0·9792 | 9568 | 9355 | 53 |
| 54 | 1·2178 | 1·1797 | 1·1447 | 1·1123 | 1·0821 | 1·0539 | 1·0274 | 1·0024 | 0·9788 | 9564 | 9351 | 54 |
| 55 | 1·2172 | 1·1791 | 1·1441 | 1·1117 | 1·0816 | 1·0534 | 1·0270 | 1·0020 | 0·9784 | 9561 | 9348 | 55 |
| 56 | 1·2165 | 1·1785 | 1·1436 | 1·1112 | 1·0811 | 1·0530 | 1·0265 | 1·0016 | 0·9780 | 9557 | 9344 | 56 |
| 57 | 1·2159 | 1·1779 | 1·1430 | 1·1107 | 1·0806 | 1·0525 | 1·0261 | 1·0012 | 0·9777 | 9553 | 9341 | 57 |
| 58 | 1·2152 | 1·1773 | 1·1424 | 1·1102 | 1·0801 | 1·0521 | 1·0257 | 1·0008 | 0·9773 | 9550 | 9337 | 58 |
| 59 | 1·2145 | 1·1767 | 1·1419 | 1·1097 | 1·0797 | 1·0516 | 1·0252 | 1·0004 | 0·9769 | 9546 | 9334 | 59 |
| 60 | 1·2139 | 1·1761 | 1·1413 | 1·1091 | 1·0792 | 1·0512 | 1·0248 | 1·0000 | 0·9765 | 9542 | 9331 | 60 |

## PROPORTIONAL LOGARITHMS

| sec. ″ | h m 0° 21′ | h m 0° 22′ | h m 0° 23′ | h m 0° 24′ | h m 0° 25′ | h m 0° 26′ | h m 0° 27′ | h m 0° 28′ | h m 0° 29′ | h m 0° 30′ | h m 0° 31′ | h m 0° 32′ | sec. ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 9331 | 9128 | 8935 | 8751 | 8573 | 8403 | 8239 | 8081 | 7929 | 7782 | 7639 | 7501 | 0 |
| 1 | 9327 | 9125 | 8932 | 8748 | 8570 | 8400 | 8236 | 8079 | 7926 | 7779 | 7637 | 7499 | 1 |
| 2 | 9324 | 9122 | 8929 | 8745 | 8567 | 8397 | 8234 | 8076 | 7924 | 7777 | 7634 | 7497 | 2 |
| 3 | 9320 | 9119 | 8926 | 8742 | 8565 | 8395 | 8231 | 8073 | 7921 | 7774 | 7632 | 7494 | 3 |
| 4 | 9317 | 9115 | 8923 | 8739 | 8562 | 8392 | 8228 | 8071 | 7919 | 7772 | 7630 | 7492 | 4 |
| 5 | 9313 | 9112 | 8920 | 8736 | 8559 | 8389 | 8226 | 8068 | 7916 | 7769 | 7627 | 7490 | 5 |
| 6 | 9310 | 9109 | 8917 | 8733 | 8556 | 8386 | 8223 | 8066 | 7914 | 7767 | 7625 | 7488 | 6 |
| 7 | 9306 | 9105 | 8913 | 8730 | 8553 | 8383 | 8220 | 8063 | 7911 | 7765 | 7623 | 7485 | 7 |
| 8 | 9303 | 9102 | 8910 | 8727 | 8550 | 8381 | 8218 | 8060 | 7909 | 7762 | 7620 | 7483 | 8 |
| 9 | 9300 | 9099 | 8907 | 8724 | 8547 | 8378 | 8215 | 8058 | 7906 | 7760 | 7618 | 7481 | 9 |
| 10 | 9296 | 9096 | 8904 | 8721 | 8544 | 8375 | 8212 | 8055 | 7904 | 7757 | 7616 | 7479 | 10 |
| 11 | 9293 | 9092 | 8901 | 8718 | 8542 | 8372 | 8210 | 8053 | 7901 | 7755 | 7613 | 7476 | 1 |
| 12 | 9289 | 9089 | 8898 | 8715 | 8539 | 8370 | 8207 | 8050 | 7899 | 7753 | 7611 | 7474 | 2 |
| 13 | 9286 | 9086 | 8895 | 8712 | 8536 | 8367 | 8204 | 8048 | 7896 | 7750 | 7609 | 7472 | 13 |
| 14 | 9283 | 9083 | 8892 | 8709 | 8533 | 8364 | 8202 | 8045 | 7894 | 7748 | 7606 | 7470 | 14 |
| 15 | 9279 | 9079 | 8888 | 8706 | 8530 | 8361 | 8199 | 8043 | 7891 | 7745 | 7604 | 7467 | 15 |
| 16 | 9276 | 9076 | 8885 | 8703 | 8527 | 8359 | 8196 | 8040 | 7889 | 7743 | 7602 | 7465 | 16 |
| 17 | 9272 | 9073 | 8882 | 8700 | 8524 | 8356 | 8194 | 8037 | 7886 | 7741 | 7600 | 7463 | 17 |
| 18 | 9269 | 9070 | 8879 | 8697 | 8522 | 8353 | 8191 | 8035 | 7884 | 7738 | 7597 | 7461 | 18 |
| 19 | 9265 | 9066 | 8876 | 8694 | 8519 | 8350 | 8188 | 8032 | 7882 | 7736 | 7595 | 7458 | 19 |
| 20 | 9262 | 9063 | 8873 | 8691 | 8516 | 8348 | 8186 | 8030 | 7879 | 7734 | 7593 | 7456 | 20 |
| 21 | 9259 | 9060 | 8870 | 8688 | 8513 | 8345 | 8183 | 8027 | 7877 | 7731 | 7590 | 7454 | 21 |
| 22 | 9255 | 9057 | 8867 | 8685 | 8510 | 8342 | 8180 | 8025 | 7874 | 7729 | 7588 | 7452 | 22 |
| 23 | 9252 | 9053 | 8864 | 8682 | 8507 | 8339 | 8178 | 8022 | 7872 | 7726 | 7586 | 7449 | 23 |
| 24 | 9249 | 9050 | 8861 | 8679 | 8504 | 8337 | 8175 | 8020 | 7869 | 7724 | 7583 | 7447 | 24 |
| 25 | 9245 | 9047 | 8857 | 8676 | 8501 | 8334 | 8173 | 8017 | 7867 | 7722 | 7581 | 7445 | 25 |
| 26 | 9242 | 9044 | 8854 | 8673 | 8499 | 8331 | 8170 | 8014 | 7864 | 7719 | 7579 | 7443 | 26 |
| 27 | 9238 | 9041 | 8851 | 8670 | 8496 | 8328 | 8167 | 8012 | 7862 | 7717 | 7577 | 7441 | 27 |
| 28 | 9235 | 9037 | 8848 | 8667 | 8493 | 8326 | 8165 | 8009 | 7859 | 7714 | 7574 | 7438 | 28 |
| 29 | 9232 | 9034 | 8845 | 8664 | 8490 | 8323 | 8162 | 8007 | 7857 | 7712 | 7572 | 7436 | 29 |
| 30 | 9228 | 9031 | 8842 | 8661 | 8487 | 8320 | 8159 | 8004 | 7855 | 7710 | 7570 | 7434 | 30 |
| 31 | 9225 | 9028 | 8839 | 8658 | 8484 | 8317 | 8157 | 8002 | 7852 | 7707 | 7567 | 7432 | 31 |
| 32 | 9222 | 9024 | 8836 | 8655 | 8482 | 8315 | 8154 | 7999 | 7850 | 7705 | 7565 | 7429 | 32 |
| 33 | 9218 | 9021 | 8833 | 8652 | 8479 | 8312 | 8152 | 7997 | 7847 | 7703 | 7563 | 7427 | 33 |
| 34 | 9215 | 9018 | 8830 | 8649 | 8476 | 8309 | 8149 | 7994 | 7845 | 7700 | 7560 | 7425 | 34 |
| 35 | 9211 | 9015 | 8827 | 8646 | 8473 | 8307 | 8146 | 7992 | 7842 | 7698 | 7558 | 7423 | 35 |
| 36 | 9208 | 9012 | 8824 | 8643 | 8470 | 8304 | 8144 | 7989 | 7840 | 7696 | 7556 | 7421 | 36 |
| 37 | 9205 | 9008 | 8820 | 8640 | 8467 | 8301 | 8141 | 7986 | 7837 | 7693 | 7554 | 7418 | 37 |
| 38 | 9201 | 9005 | 8817 | 8637 | 8465 | 8298 | 8138 | 7984 | 7835 | 7691 | 7551 | 7416 | 38 |
| 39 | 9198 | 9002 | 8814 | 8635 | 8462 | 8296 | 8136 | 7981 | 7832 | 7688 | 7549 | 7414 | 39 |
| 40 | 9195 | 8999 | 8811 | 8632 | 8459 | 8293 | 8133 | 7979 | 7830 | 7686 | 7547 | 7412 | 40 |
| 41 | 9191 | 8996 | 8808 | 8629 | 8456 | 8290 | 8130 | 7976 | 7828 | 7684 | 7544 | 7409 | 41 |
| 42 | 9188 | 8992 | 8805 | 8626 | 8453 | 8288 | 8128 | 7974 | 7825 | 7681 | 7542 | 7407 | 42 |
| 43 | 9185 | 8989 | 8802 | 8623 | 8451 | 8285 | 8125 | 7971 | 7823 | 7679 | 7540 | 7405 | 43 |
| 44 | 9181 | 8986 | 8799 | 8620 | 8448 | 8282 | 8123 | 7969 | 7820 | 7677 | 7538 | 7403 | 44 |
| 45 | 9178 | 8983 | 8796 | 8617 | 8445 | 8279 | 8120 | 7966 | 7818 | 7674 | 7535 | 7401 | 45 |
| 46 | 9175 | 8980 | 8793 | 8614 | 8442 | 8277 | 8117 | 7964 | 7815 | 7672 | 7533 | 7398 | 46 |
| 47 | 9171 | 8977 | 8790 | 8611 | 8439 | 8274 | 8115 | 7961 | 7813 | 7670 | 7531 | 7396 | 47 |
| 48 | 9168 | 8973 | 8787 | 8608 | 8437 | 8271 | 8112 | 7959 | 7811 | 7667 | 7528 | 7394 | 48 |
| 49 | 9165 | 8970 | 8784 | 8605 | 8434 | 8269 | 8110 | 7956 | 7808 | 7665 | 7526 | 7392 | 49 |
| 50 | 9161 | 8967 | 8781 | 8602 | 8431 | 8266 | 8107 | 7954 | 7806 | 7662 | 7524 | 7390 | 50 |
| 51 | 9158 | 8964 | 8778 | 8599 | 8428 | 8263 | 8104 | 7951 | 7803 | 7660 | 7522 | 7387 | 51 |
| 52 | 9155 | 8961 | 8775 | 8596 | 8425 | 8261 | 8102 | 7949 | 7801 | 7658 | 7519 | 7385 | 52 |
| 53 | 9152 | 8957 | 8772 | 8594 | 8422 | 8258 | 8099 | 7946 | 7798 | 7655 | 7517 | 7383 | 53 |
| 54 | 9148 | 8954 | 8769 | 8591 | 8420 | 8255 | 8097 | 7944 | 7796 | 7653 | 7515 | 7381 | 54 |
| 55 | 9145 | 8951 | 8766 | 8588 | 8417 | 8252 | 8094 | 7941 | 7794 | 7651 | 7513 | 7379 | 55 |
| 56 | 9142 | 8948 | 8763 | 8585 | 8414 | 8250 | 8091 | 7939 | 7791 | 7648 | 7510 | 7376 | 56 |
| 57 | 9138 | 8945 | 8760 | 8582 | 8411 | 8247 | 8089 | 7936 | 7789 | 7646 | 7508 | 7374 | 57 |
| 58 | 9135 | 8942 | 8757 | 8579 | 8409 | 8244 | 8086 | 7934 | 7786 | 7644 | 7506 | 7372 | 58 |
| 59 | 9132 | 8939 | 8754 | 8576 | 8406 | 8242 | 8084 | 7931 | 7784 | 7641 | 7503 | 7370 | 59 |
| 60 | 9128 | 8935 | 8751 | 8573 | 8403 | 8239 | 8081 | 7929 | 7782 | 7639 | 7501 | 7368 | 60 |

## PROPORTIONAL LOGARITHMS

| sec. ″ | h m 0° 33′ | h m 0° 34′ | h m 0° 35′ | h m 0° 36′ | h m 0° 37′ | h m 0° 38′ | h m 0° 39′ | h m 0° 40′ | h m 0° 41′ | h m 0° 42′ | h m 0° 43′ | h m 0° 44′ | sec ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 7368 | 7238 | 7112 | 6990 | 6871 | 6755 | 6642 | 6532 | 6425 | 6320 | 6218 | 6118 | 0 |
| 1 | 7365 | 7236 | 7110 | 6988 | 6869 | 6753 | 6640 | 6530 | 6423 | 6318 | 6216 | 6117 | 1 |
| 2 | 7363 | 7234 | 7108 | 6986 | 6867 | 6751 | 6638 | 6528 | 6421 | 6317 | 6215 | 6115 | 2 |
| 3 | 7361 | 7232 | 7106 | 6984 | 6865 | 6749 | 6637 | 6527 | 6420 | 6315 | 6213 | 6113 | 3 |
| 4 | 7359 | 7229 | 7104 | 6982 | 6863 | 6747 | 6635 | 6525 | 6418 | 6313 | 6211 | 6112 | 4 |
| 5 | 7357 | 7227 | 7102 | 6980 | 6861 | 6745 | 6633 | 6523 | 6416 | 6312 | 6210 | 6110 | 5 |
| 6 | 7354 | 7225 | 7100 | 6978 | 6859 | 6743 | 6631 | 6521 | 6414 | 6310 | 6208 | 6108 | 6 |
| 7 | 7352 | 7223 | 7098 | 6976 | 6857 | 6742 | 6629 | 6519 | 6412 | 6308 | 6206 | 6107 | 7 |
| 8 | 7350 | 7221 | 7095 | 6974 | 6855 | 6740 | 6627 | 6518 | 6411 | 6306 | 6205 | 6105 | 8 |
| 9 | 7348 | 7219 | 7093 | 6972 | 6853 | 6738 | 6625 | 6516 | 6409 | 6305 | 6203 | 6103 | 9 |
| 10 | 7346 | 7217 | 7091 | 6970 | 6851 | 6736 | 6624 | 6514 | 6407 | 6303 | 6201 | 6102 | 10 |
| 11 | 7343 | 7215 | 7089 | 6968 | 6849 | 6734 | 6622 | 6512 | 6405 | 6301 | 6200 | 6100 | 11 |
| 12 | 7341 | 7212 | 7087 | 6966 | 6847 | 6732 | 6620 | 6510 | 6404 | 6300 | 6198 | 6099 | 12 |
| 13 | 7339 | 7210 | 7085 | 6964 | 6845 | 6730 | 6618 | 6509 | 6402 | 6298 | 6196 | 6097 | 13 |
| 14 | 7337 | 7208 | 7083 | 6962 | 6843 | 6728 | 6616 | 6507 | 6400 | 6296 | 6194 | 6095 | 14 |
| 15 | 7335 | 7206 | 7081 | 6960 | 6841 | 6726 | 6614 | 6505 | 6398 | 6294 | 6193 | 6094 | 15 |
| 16 | 7333 | 7204 | 7079 | 6958 | 6839 | 6724 | 6612 | 6503 | 6397 | 6293 | 6191 | 6092 | 16 |
| 17 | 7330 | 7202 | 7077 | 6956 | 6838 | 6723 | 6611 | 6501 | 6395 | 6291 | 6189 | 6090 | 17 |
| 18 | 7328 | 7200 | 7075 | 6954 | 6836 | 6721 | 6609 | 6500 | 6393 | 6289 | 6188 | 6089 | 18 |
| 19 | 7326 | 7198 | 7073 | 6952 | 6834 | 6719 | 6607 | 6498 | 6391 | 6288 | 6186 | 6087 | 19 |
| 20 | 7324 | 7196 | 7071 | 6950 | 6832 | 6717 | 6605 | 6496 | 6390 | 6286 | 6184 | 6085 | 20 |
| 21 | 7322 | 7193 | 7069 | 6948 | 6830 | 6715 | 6603 | 6494 | 6388 | 6284 | 6183 | 6084 | 21 |
| 22 | 7320 | 7191 | 7067 | 6946 | 6828 | 6713 | 6601 | 6492 | 6386 | 6282 | 6181 | 6082 | 22 |
| 23 | 7317 | 7189 | 7065 | 6944 | 6826 | 6711 | 6600 | 6491 | 6384 | 6281 | 6179 | 6080 | 23 |
| 24 | 7315 | 7187 | 7063 | 6942 | 6824 | 6709 | 6598 | 6489 | 6383 | 6279 | 6178 | 6079 | 24 |
| 25 | 7313 | 7185 | 7061 | 6940 | 6822 | 6707 | 6596 | 6487 | 6381 | 6277 | 6176 | 6077 | 25 |
| 26 | 7311 | 7183 | 7059 | 6938 | 6820 | 6706 | 6594 | 6485 | 6379 | 6276 | 6174 | 6076 | 26 |
| 27 | 7309 | 7181 | 7057 | 6936 | 6818 | 6704 | 6592 | 6484 | 6377 | 6274 | 6173 | 6074 | 27 |
| 28 | 7307 | 7179 | 7054 | 6934 | 6816 | 6702 | 6590 | 6482 | 6376 | 6272 | 6171 | 6072 | 28 |
| 29 | 7304 | 7177 | 7052 | 6932 | 6814 | 6700 | 6589 | 6480 | 6374 | 6270 | 6169 | 6071 | 29 |
| 30 | 7302 | 7175 | 7050 | 6930 | 6812 | 6698 | 6587 | 6478 | 6372 | 6269 | 6168 | 6069 | 30 |
| 31 | 7300 | 7172 | 7048 | 6928 | 6810 | 6696 | 6585 | 6476 | 6370 | 6267 | 6166 | 6067 | 31 |
| 32 | 7298 | 7170 | 7046 | 6926 | 6809 | 6694 | 6583 | 6475 | 6369 | 6265 | 6164 | 6066 | 32 |
| 33 | 7296 | 7168 | 7044 | 6924 | 6807 | 6692 | 6581 | 6473 | 6367 | 6264 | 6163 | 6064 | 33 |
| 34 | 7294 | 7166 | 7042 | 6922 | 6805 | 6691 | 6579 | 6471 | 6365 | 6262 | 6161 | 6063 | 34 |
| 35 | 7291 | 7164 | 7040 | 6920 | 6803 | 6689 | 6578 | 6469 | 6363 | 6260 | 6159 | 6061 | 35 |
| 36 | 7289 | 7162 | 7038 | 6918 | 6801 | 6687 | 6576 | 6467 | 6362 | 6259 | 6158 | 6059 | 36 |
| 37 | 7287 | 7160 | 7036 | 6916 | 6799 | 6685 | 6574 | 6466 | 6360 | 6257 | 6156 | 6058 | 37 |
| 38 | 7285 | 7158 | 7034 | 6914 | 6797 | 6683 | 6572 | 6464 | 6358 | 6255 | 6154 | 6056 | 38 |
| 39 | 7283 | 7156 | 7032 | 6912 | 6795 | 6681 | 6570 | 6462 | 6357 | 6254 | 6153 | 6055 | 39 |
| 40 | 7281 | 7154 | 7030 | 6910 | 6793 | 6679 | 6568 | 6460 | 6355 | 6252 | 6151 | 6053 | 40 |
| 41 | 7279 | 7152 | 7028 | 6908 | 6791 | 6677 | 6567 | 6459 | 6353 | 6250 | 6150 | 6051 | 41 |
| 42 | 7276 | 7149 | 7026 | 6906 | 6789 | 6676 | 6565 | 6457 | 6351 | 6248 | 6148 | 6050 | 42 |
| 43 | 7274 | 7147 | 7024 | 6904 | 6787 | 6674 | 6563 | 6455 | 6350 | 6247 | 6146 | 6048 | 43 |
| 44 | 7272 | 7145 | 7022 | 6902 | 6785 | 6672 | 6561 | 6453 | 6348 | 6245 | 6145 | 6046 | 44 |
| 45 | 7270 | 7143 | 7020 | 6900 | 6784 | 6670 | 6559 | 6451 | 6346 | 6243 | 6143 | 6045 | 45 |
| 46 | 7268 | 7141 | 7018 | 6898 | 6782 | 6668 | 6557 | 6450 | 6344 | 6242 | 6141 | 6043 | 46 |
| 47 | 7266 | 7139 | 7016 | 6896 | 6780 | 6666 | 6556 | 6448 | 6343 | 6240 | 6140 | 6042 | 47 |
| 48 | 7264 | 7137 | 7014 | 6894 | 6778 | 6664 | 6554 | 6446 | 6341 | 6238 | 6138 | 6040 | 48 |
| 49 | 7261 | 7135 | 7012 | 6892 | 6776 | 6662 | 6552 | 6444 | 6339 | 6237 | 6136 | 6038 | 49 |
| 50 | 7259 | 7133 | 7010 | 6890 | 6774 | 6661 | 6550 | 6443 | 6338 | 6235 | 6135 | 6037 | 50 |
| 51 | 7257 | 7131 | 7008 | 6888 | 6772 | 6659 | 6548 | 6441 | 6336 | 6233 | 6133 | 6035 | 51 |
| 52 | 7255 | 7129 | 7006 | 6886 | 6770 | 6657 | 6547 | 6439 | 6334 | 6231 | 6131 | 6033 | 52 |
| 53 | 7253 | 7126 | 7004 | 6884 | 6768 | 6655 | 6545 | 6437 | 6332 | 6230 | 6130 | 6032 | 53 |
| 54 | 7251 | 7124 | 7002 | 6882 | 6766 | 6653 | 6543 | 6435 | 6331 | 6228 | 6128 | 6030 | 54 |
| 55 | 7249 | 7122 | 7000 | 6880 | 6764 | 6651 | 6541 | 6434 | 6329 | 6226 | 6126 | 6029 | 55 |
| 56 | 7246 | 7120 | 6998 | 6878 | 6762 | 6649 | 6539 | 6432 | 6327 | 6225 | 6125 | 6027 | 56 |
| 57 | 7244 | 7118 | 6996 | 6877 | 6761 | 6648 | 6538 | 6430 | 6325 | 6223 | 6123 | 6025 | 57 |
| 58 | 7242 | 7116 | 6994 | 6875 | 6759 | 6646 | 6536 | 6428 | 6324 | 6221 | 6121 | 6024 | 58 |
| 59 | 7240 | 7114 | 6992 | 6873 | 6757 | 6644 | 6534 | 6427 | 6322 | 6220 | 6120 | 6022 | 59 |
| 60 | 7238 | 7112 | 6990 | 6871 | 6755 | 6642 | 6532 | 6425 | 6320 | 6218 | 6118 | 6021 | 60 |

## PROPORTIONAL LOGARITHMS

| sec. ″ | 0h 45m | 0h 46m | 0h 47m | 0h 48m | 0h 49m | 0h 50m | 0h 51m | 0h 52m | 0h 53m | 0h 54m | 0h 55m | 0h 56m | sec. ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 6021 | 5925 | 5832 | 5740 | 5651 | 5563 | 5477 | 5393 | 5310 | 5229 | 5149 | 5071 | 0 |
| 1 | 6019 | 5924 | 5830 | 5739 | 5649 | 5562 | 5476 | 5391 | 5309 | 5227 | 5148 | 5070 | 1 |
| 2 | 6017 | 5922 | 5829 | 5737 | 5648 | 5560 | 5474 | 5390 | 5307 | 5226 | 5146 | 5068 | 2 |
| 3 | 6016 | 5920 | 5827 | 5736 | 5646 | 5559 | 5473 | 5389 | 5306 | 5225 | 5145 | 5067 | 3 |
| 4 | 6014 | 5919 | 5826 | 5734 | 5645 | 5557 | 5471 | 5387 | 5304 | 5223 | 5144 | 5066 | 4 |
| 5 | 6013 | 5917 | 5824 | 5733 | 5643 | 5556 | 5470 | 5386 | 5303 | 5222 | 5142 | 5064 | 5 |
| 6 | 6011 | 5916 | 5823 | 5731 | 5642 | 5554 | 5469 | 5384 | 5302 | 5221 | 5141 | 5063 | 6 |
| 7 | 6009 | 5914 | 5821 | 5730 | 5640 | 5553 | 5467 | 5383 | 5300 | 5219 | 5140 | 5062 | 7 |
| 8 | 6008 | 5913 | 5819 | 5728 | 5639 | 5551 | 5466 | 5382 | 5299 | 5218 | 5139 | 5060 | 8 |
| 9 | 6006 | 5911 | 5818 | 5727 | 5637 | 5550 | 5464 | 5380 | 5298 | 5217 | 5137 | 5059 | 9 |
| 10 | 6004 | 5909 | 5816 | 5725 | 5636 | 5549 | 5463 | 5379 | 5296 | 5215 | 5136 | 5058 | 10 |
| 11 | 6003 | 5908 | 5815 | 5724 | 5634 | 5547 | 5461 | 5377 | 5295 | 5214 | 5135 | 5057 | 11 |
| 12 | 6001 | 5906 | 5813 | 5722 | 5633 | 5546 | 5460 | 5376 | 5294 | 5213 | 5133 | 5055 | 12 |
| 13 | 6000 | 5905 | 5812 | 5721 | 5632 | 5544 | 5459 | 5375 | 5292 | 5211 | 5132 | 5054 | 13 |
| 14 | 5998 | 5903 | 5810 | 5719 | 5630 | 5543 | 5457 | 5373 | 5291 | 5210 | 5131 | 5053 | 14 |
| 15 | 5997 | 5902 | 5809 | 5718 | 5629 | 5541 | 5456 | 5372 | 5290 | 5209 | 5129 | 5051 | 15 |
| 16 | 5995 | 5900 | 5807 | 5716 | 5627 | 5540 | 5454 | 5370 | 5288 | 5207 | 5128 | 5050 | 16 |
| 17 | 5993 | 5898 | 5806 | 5715 | 5626 | 5538 | 5453 | 5369 | 5287 | 5206 | 5127 | 5049 | 17 |
| 18 | 5992 | 5897 | 5804 | 5713 | 5624 | 5537 | 5452 | 5368 | 5285 | 5205 | 5125 | 5048 | 18 |
| 19 | 5990 | 5895 | 5803 | 5712 | 5623 | 5536 | 5450 | 5366 | 5284 | 5203 | 5124 | 5046 | 19 |
| 20 | 5988 | 5894 | 5801 | 5710 | 5621 | 5534 | 5449 | 5365 | 5283 | 5202 | 5123 | 5045 | 20 |
| 21 | 5987 | 5892 | 5800 | 5709 | 5620 | 5533 | 5447 | 5364 | 5281 | 5201 | 5122 | 5044 | 21 |
| 22 | 5985 | 5891 | 5798 | 5707 | 5618 | 5531 | 5446 | 5362 | 5280 | 5199 | 5120 | 5042 | 22 |
| 23 | 5984 | 5889 | 5796 | 5706 | 5617 | 5530 | 5444 | 5361 | 5279 | 5198 | 5119 | 5041 | 23 |
| 24 | 5982 | 5888 | 5795 | 5704 | 5615 | 5528 | 5443 | 5359 | 5277 | 5197 | 5118 | 5040 | 24 |
| 25 | 5981 | 5886 | 5793 | 5703 | 5614 | 5527 | 5442 | 5358 | 5276 | 5195 | 5116 | 5039 | 25 |
| 26 | 5979 | 5884 | 5792 | 5701 | 5612 | 5525 | 5440 | 5357 | 5275 | 5194 | 5115 | 5037 | 26 |
| 27 | 5977 | 5883 | 5790 | 5700 | 5611 | 5524 | 5439 | 5355 | 5273 | 5193 | 5114 | 5036 | 27 |
| 28 | 5976 | 5881 | 5789 | 5698 | 5610 | 5523 | 5437 | 5354 | 5272 | 5191 | 5112 | 5035 | 28 |
| 29 | 5974 | 5880 | 5787 | 5697 | 5608 | 5521 | 5436 | 5352 | 5270 | 5190 | 5111 | 5033 | 29 |
| 30 | 5973 | 5878 | 5786 | 5695 | 5607 | 5520 | 5435 | 5351 | 5269 | 5189 | 5110 | 5032 | 30 |
| 31 | 5971 | 5877 | 5784 | 5694 | 5605 | 5518 | 5433 | 5350 | 5268 | 5187 | 5108 | 5031 | 31 |
| 32 | 5969 | 5875 | 5783 | 5692 | 5604 | 5517 | 5432 | 5348 | 5266 | 5186 | 5107 | 5030 | 32 |
| 33 | 5968 | 5874 | 5781 | 5691 | 5602 | 5516 | 5430 | 5347 | 5265 | 5185 | 5106 | 5028 | 33 |
| 34 | 5966 | 5872 | 5780 | 5689 | 5601 | 5514 | 5429 | 5346 | 5264 | 5183 | 5105 | 5027 | 34 |
| 35 | 5965 | 5870 | 5778 | 5688 | 5599 | 5513 | 5428 | 5344 | 5262 | 5182 | 5103 | 5026 | 35 |
| 36 | 5963 | 5869 | 5777 | 5686 | 5598 | 5511 | 5426 | 5343 | 5261 | 5181 | 5102 | 5025 | 36 |
| 37 | 5961 | 5867 | 5775 | 5685 | 5596 | 5510 | 5425 | 5341 | 5260 | 5179 | 5101 | 5023 | 37 |
| 38 | 5960 | 5866 | 5774 | 5683 | 5595 | 5508 | 5423 | 5340 | 5258 | 5178 | 5099 | 5022 | 38 |
| 39 | 5958 | 5864 | 5772 | 5682 | 5594 | 5507 | 5422 | 5339 | 5257 | 5177 | 5098 | 5021 | 39 |
| 40 | 5957 | 5863 | 5771 | 5680 | 5592 | 5505 | 5421 | 5337 | 5256 | 5175 | 5097 | 5019 | 40 |
| 41 | 5955 | 5861 | 5769 | 5679 | 5591 | 5504 | 5419 | 5336 | 5254 | 5174 | 5095 | 5018 | 41 |
| 42 | 5954 | 5860 | 5768 | 5677 | 5589 | 5503 | 5418 | 5335 | 5253 | 5173 | 5094 | 5017 | 42 |
| 43 | 5952 | 5858 | 5766 | 5676 | 5588 | 5501 | 5416 | 5333 | 5252 | 5171 | 5093 | 5016 | 43 |
| 44 | 5950 | 5856 | 5764 | 5674 | 5586 | 5500 | 5415 | 5332 | 5250 | 5170 | 5092 | 5014 | 44 |
| 45 | 5949 | 5855 | 5763 | 5673 | 5585 | 5498 | 5414 | 5331 | 5249 | 5169 | 5090 | 5013 | 45 |
| 46 | 5947 | 5853 | 5761 | 5671 | 5583 | 5497 | 5412 | 5329 | 5248 | 5168 | 5089 | 5012 | 46 |
| 47 | 5946 | 5852 | 5760 | 5670 | 5582 | 5495 | 5411 | 5328 | 5246 | 5166 | 5088 | 5010 | 47 |
| 48 | 5944 | 5850 | 5758 | 5669 | 5580 | 5494 | 5409 | 5326 | 5245 | 5165 | 5086 | 5009 | 48 |
| 49 | 5942 | 5849 | 5757 | 5667 | 5579 | 5493 | 5408 | 5325 | 5244 | 5164 | 5085 | 5008 | 49 |
| 50 | 5941 | 5847 | 5755 | 5666 | 5577 | 5491 | 5407 | 5324 | 5242 | 5162 | 5084 | 5007 | 50 |
| 51 | 5939 | 5846 | 5754 | 5664 | 5576 | 5490 | 5405 | 5322 | 5241 | 5161 | 5082 | 5005 | 51 |
| 52 | 5938 | 5844 | 5752 | 5663 | 5575 | 5488 | 5404 | 5321 | 5239 | 5160 | 5081 | 5004 | 52 |
| 53 | 5936 | 5842 | 5751 | 5661 | 5573 | 5487 | 5402 | 5319 | 5238 | 5158 | 5080 | 5003 | 53 |
| 54 | 5935 | 5841 | 5749 | 5660 | 5572 | 5486 | 5401 | 5318 | 5237 | 5157 | 5079 | 5002 | 54 |
| 55 | 5933 | 5839 | 5748 | 5658 | 5570 | 5484 | 5400 | 5317 | 5235 | 5156 | 5077 | 5000 | 55 |
| 56 | 5931 | 5838 | 5746 | 5657 | 5569 | 5483 | 5398 | 5315 | 5234 | 5154 | 5076 | 4999 | 56 |
| 57 | 5930 | 5836 | 5745 | 5655 | 5567 | 5481 | 5397 | 5314 | 5233 | 5153 | 5075 | 4998 | 57 |
| 58 | 5928 | 5835 | 5743 | 5654 | 5566 | 5480 | 5395 | 5313 | 5231 | 5152 | 5073 | 4996 | 58 |
| 59 | 5927 | 5833 | 5742 | 5652 | 5564 | 5478 | 5394 | 5311 | 5230 | 5150 | 5072 | 4995 | 59 |
| 60 | 5925 | 5832 | 5740 | 5651 | 5563 | 5477 | 5393 | 5310 | 5229 | 5149 | 5071 | 4994 | 60 |

## PROPORTIONAL LOGARITHMS

| sec. ″ | h m 0° 57′ | h m 0° 58′ | h m 0° 59′ | h m 1° 0′ | h m 1° 1′ | h m 1° 2′ | h m 1° 3′ | h m 1° 4′ | h m 1° 5′ | h m 1° 6′ | h m 1° 7′ | h m 1° 8′ | h m 1° 9′ | sec. ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 4994 | 4918 | 4844 | 4771 | 4699 | 4629 | 4559 | 4491 | 4424 | 4357 | 4292 | 4228 | 4164 | 0 |
| 1 | 4993 | 4917 | 4843 | 4770 | 4698 | 4628 | 4558 | 4490 | 4422 | 4356 | 4291 | 4227 | 4163 | 1 |
| 2 | 4991 | 4916 | 4842 | 4769 | 4697 | 4626 | 4557 | 4489 | 4421 | 4355 | 4290 | 4225 | 4162 | 2 |
| 3 | 4990 | 4915 | 4841 | 4768 | 4696 | 4625 | 4556 | 4488 | 4420 | 4354 | 4289 | 4224 | 4161 | 3 |
| 4 | 4989 | 4913 | 4839 | 4766 | 4694 | 4624 | 4555 | 4486 | 4419 | 4353 | 4288 | 4223 | 4160 | 4 |
| 5 | 4988 | 4912 | 4838 | 4765 | 4693 | 4623 | 4554 | 4485 | 4418 | 4352 | 4287 | 4222 | 4159 | 5 |
| 6 | 4986 | 4911 | 4837 | 4764 | 4692 | 4622 | 4552 | 4484 | 4417 | 4351 | 4285 | 4221 | 4158 | 6 |
| 7 | 4985 | 4910 | 4836 | 4763 | 4691 | 4621 | 4551 | 4483 | 4416 | 4350 | 4284 | 4220 | 4157 | 7 |
| 8 | 4984 | 4908 | 4834 | 4762 | 4690 | 4619 | 4550 | 4482 | 4415 | 4348 | 4283 | 4219 | 4156 | 8 |
| 9 | 4983 | 4907 | 4833 | 4760 | 4689 | 4618 | 4549 | 4481 | 4414 | 4347 | 4282 | 4218 | 4155 | 9 |
| 10 | 4981 | 4906 | 4832 | 4759 | 4688 | 4617 | 4548 | 4480 | 4412 | 4346 | 4281 | 4217 | 4154 | 10 |
| 11 | 4980 | 4905 | 4831 | 4758 | 4686 | 4616 | 4547 | 4478 | 4411 | 4345 | 4280 | 4216 | 4153 | 11 |
| 12 | 4979 | 4903 | 4830 | 4757 | 4685 | 4615 | 4546 | 4477 | 4410 | 4344 | 4279 | 4215 | 4152 | 12 |
| 13 | 4977 | 4902 | 4828 | 4756 | 4684 | 4614 | 4544 | 4476 | 4409 | 4343 | 4278 | 4214 | 4151 | 13 |
| 14 | 4976 | 4901 | 4827 | 4754 | 4683 | 4612 | 4543 | 4475 | 4408 | 4342 | 4277 | 4213 | 4150 | 14 |
| 15 | 4975 | 4900 | 4826 | 4753 | 4682 | 4611 | 4542 | 4474 | 4407 | 4341 | 4276 | 4212 | 4149 | 15 |
| 16 | 4974 | 4898 | 4825 | 4752 | 4680 | 4610 | 4541 | 4473 | 4406 | 4340 | 4275 | 4211 | 4147 | 16 |
| 17 | 4972 | 4897 | 4823 | 4751 | 4679 | 4609 | 4540 | 4472 | 4405 | 4339 | 4274 | 4210 | 4146 | 17 |
| 18 | 4971 | 4896 | 4822 | 4750 | 4678 | 4608 | 4539 | 4471 | 4404 | 4338 | 4273 | 4209 | 4145 | 18 |
| 19 | 4970 | 4895 | 4821 | 4748 | 4677 | 4607 | 4537 | 4469 | 4402 | 4336 | 4271 | 4207 | 4144 | 19 |
| 20 | 4969 | 4894 | 4820 | 4747 | 4676 | 4605 | 4536 | 4468 | 4401 | 4335 | 4270 | 4206 | 4143 | 20 |
| 21 | 4967 | 4892 | 4819 | 4746 | 4675 | 4604 | 4535 | 4467 | 4400 | 4334 | 4269 | 4205 | 4142 | 21 |
| 22 | 4966 | 4891 | 4817 | 4745 | 4673 | 4603 | 4534 | 4466 | 4399 | 4333 | 4268 | 4204 | 4141 | 22 |
| 23 | 4965 | 4890 | 4816 | 4744 | 4672 | 4602 | 4533 | 4465 | 4398 | 4332 | 4267 | 4203 | 4140 | 23 |
| 24 | 4964 | 4889 | 4815 | 4742 | 4671 | 4601 | 4532 | 4464 | 4397 | 4331 | 4266 | 4202 | 4139 | 24 |
| 25 | 4962 | 4887 | 4814 | 4741 | 4670 | 4600 | 4531 | 4463 | 4396 | 4330 | 4265 | 4201 | 4138 | 25 |
| 26 | 4961 | 4886 | 4812 | 4740 | 4669 | 4599 | 4529 | 4462 | 4395 | 4329 | 4264 | 4200 | 4137 | 26 |
| 27 | 4960 | 4885 | 4811 | 4739 | 4668 | 4597 | 4528 | 4460 | 4394 | 4328 | 4263 | 4199 | 4136 | 27 |
| 28 | 4959 | 4884 | 4810 | 4738 | 4666 | 4596 | 4527 | 4459 | 4392 | 4327 | 4262 | 4198 | 4135 | 28 |
| 29 | 4957 | 4882 | 4809 | 4736 | 4665 | 4595 | 4526 | 4458 | 4391 | 4326 | 4261 | 4197 | 4134 | 29 |
| 30 | 4956 | 4881 | 4808 | 4735 | 4664 | 4594 | 4525 | 4457 | 4390 | 4325 | 4260 | 4196 | 4133 | 30 |
| 31 | 4955 | 4880 | 4806 | 4734 | 4663 | 4593 | 4524 | 4456 | 4389 | 4323 | 4259 | 4195 | 4132 | 31 |
| 32 | 4953 | 4879 | 4805 | 4733 | 4662 | 4592 | 4523 | 4455 | 4388 | 4322 | 4257 | 4194 | 4131 | 32 |
| 33 | 4952 | 4877 | 4804 | 4732 | 4660 | 4590 | 4522 | 4454 | 4387 | 4321 | 4256 | 4193 | 4130 | 33 |
| 34 | 4951 | 4876 | 4803 | 4730 | 4659 | 4589 | 4520 | 4453 | 4386 | 4320 | 4255 | 4192 | 4129 | 34 |
| 35 | 4950 | 4875 | 4801 | 4729 | 4658 | 4588 | 4519 | 4451 | 4385 | 4319 | 4254 | 4190 | 4128 | 35 |
| 36 | 4949 | 4874 | 4800 | 4728 | 4657 | 4587 | 4518 | 4450 | 4384 | 4318 | 4253 | 4189 | 4127 | 36 |
| 37 | 4947 | 4872 | 4799 | 4727 | 4656 | 4586 | 4517 | 4449 | 4383 | 4317 | 4252 | 4188 | 4126 | 37 |
| 38 | 4946 | 4871 | 4798 | 4726 | 4655 | 4585 | 4516 | 4448 | 4381 | 4316 | 4251 | 4187 | 4125 | 38 |
| 39 | 4945 | 4870 | 4797 | 4724 | 4653 | 4584 | 4515 | 4447 | 4380 | 4315 | 4250 | 4186 | 4124 | 39 |
| 40 | 4943 | 4869 | 4795 | 4723 | 4652 | 4582 | 4514 | 4446 | 4379 | 4314 | 4249 | 4185 | 4122 | 40 |
| 41 | 4942 | 4868 | 4794 | 4722 | 4651 | 4581 | 4512 | 4445 | 4378 | 4313 | 4248 | 4184 | 4121 | 41 |
| 42 | 4941 | 4866 | 4793 | 4721 | 4650 | 4580 | 4511 | 4444 | 4377 | 4311 | 4247 | 4183 | 4120 | 42 |
| 43 | 4940 | 4865 | 4792 | 4720 | 4649 | 4579 | 4510 | 4443 | 4376 | 4310 | 4246 | 4182 | 4119 | 43 |
| 44 | 4938 | 4864 | 4791 | 4718 | 4647 | 4578 | 4509 | 4441 | 4375 | 4309 | 4245 | 4181 | 4118 | 44 |
| 45 | 4937 | 4863 | 4789 | 4717 | 4646 | 4577 | 4508 | 4440 | 4374 | 4308 | 4244 | 4180 | 4117 | 45 |
| 46 | 4936 | 4861 | 4788 | 4716 | 4645 | 4575 | 4507 | 4439 | 4373 | 4307 | 4243 | 4179 | 4116 | 46 |
| 47 | 4935 | 4860 | 4787 | 4715 | 4644 | 4574 | 4506 | 4438 | 4372 | 4306 | 4241 | 4178 | 4115 | 47 |
| 48 | 4933 | 4859 | 4786 | 4714 | 4643 | 4573 | 4505 | 4437 | 4370 | 4305 | 4240 | 4177 | 4114 | 48 |
| 49 | 4932 | 4858 | 4784 | 4712 | 4642 | 4572 | 4503 | 4436 | 4369 | 4304 | 4239 | 4176 | 4113 | 49 |
| 50 | 4931 | 4856 | 4783 | 4711 | 4640 | 4571 | 4502 | 4435 | 4368 | 4303 | 4238 | 4175 | 4112 | 50 |
| 51 | 4930 | 4855 | 4782 | 4710 | 4639 | 4570 | 4501 | 4434 | 4367 | 4302 | 4237 | 4174 | 4111 | 51 |
| 52 | 4928 | 4854 | 4781 | 4709 | 4638 | 4568 | 4500 | 4432 | 4366 | 4301 | 4236 | 4173 | 4110 | 52 |
| 53 | 4927 | 4853 | 4780 | 4708 | 4637 | 4567 | 4499 | 4431 | 4365 | 4299 | 4235 | 4172 | 4109 | 53 |
| 54 | 4926 | 4852 | 4778 | 4707 | 4636 | 4566 | 4498 | 4430 | 4364 | 4298 | 4234 | 4171 | 4108 | 54 |
| 55 | 4925 | 4850 | 4777 | 4705 | 4635 | 4565 | 4497 | 4429 | 4363 | 4297 | 4233 | 4169 | 4107 | 55 |
| 56 | 4923 | 4849 | 4776 | 4704 | 4633 | 4564 | 4495 | 4428 | 4362 | 4296 | 4232 | 4168 | 4106 | 56 |
| 57 | 4922 | 4848 | 4775 | 4703 | 4632 | 4563 | 4494 | 4427 | 4361 | 4295 | 4231 | 4167 | 4105 | 57 |
| 58 | 4921 | 4846 | 4774 | 4702 | 4631 | 4562 | 4493 | 4426 | 4359 | 4294 | 4230 | 4166 | 4104 | 58 |
| 59 | 4920 | 4845 | 4772 | 4701 | 4630 | 4560 | 4492 | 4425 | 4358 | 4293 | 4229 | 4165 | 4103 | 59 |
| 60 | 4918 | 4844 | 4771 | 4699 | 4629 | 4559 | 4491 | 4424 | 4357 | 4292 | 4228 | 4164 | 4102 | 60 |

## PROPORTIONAL LOGARITHMS

| sec. ″ | h m 1° 10′ | h m 1° 11′ | h m 1° 12′ | h m 1° 13′ | h m 1° 14′ | h m 1° 15′ | h m 1° 16′ | h m 1° 17′ | h m 1° 18′ | h m 1° 19′ | h m 1° 20′ | h m 1° 21′ | sec. ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 4102 | 4040 | 3979 | 3919 | 3860 | 3802 | 3745 | 3688 | 3632 | 3576 | 3522 | 3468 | 0 |
| 1 | 4101 | 4039 | 3978 | 3918 | 3859 | 3801 | 3744 | 3687 | 3631 | 3575 | 3521 | 3467 | 1 |
| 2 | 4100 | 4038 | 3977 | 3917 | 3858 | 3800 | 3743 | 3686 | 3630 | 3575 | 3520 | 3466 | 2 |
| 3 | 4099 | 4037 | 3976 | 3917 | 3857 | 3799 | 3742 | 3685 | 3629 | 3574 | 3519 | 3465 | 3 |
| 4 | 4098 | 4036 | 3975 | 3916 | 3856 | 3798 | 3741 | 3684 | 3628 | 3573 | 3518 | 3464 | 4 |
| 5 | 4097 | 4035 | 3974 | 3915 | 3855 | 3797 | 3740 | 3683 | 3627 | 3572 | 3517 | 3463 | 5 |
| 6 | 4096 | 4034 | 3973 | 3914 | 3855 | 3796 | 3739 | 3682 | 3626 | 3571 | 3516 | 3463 | 6 |
| 7 | 4094 | 4033 | 3972 | 3913 | 3854 | 3795 | 3738 | 3681 | 3625 | 3570 | 3515 | 3462 | 7 |
| 8 | 4093 | 4032 | 3971 | 3912 | 3853 | 3794 | 3737 | 3680 | 3624 | 3569 | 3515 | 3461 | 8 |
| 9 | 4092 | 4031 | 3970 | 3911 | 3852 | 3793 | 3736 | 3679 | 3623 | 3568 | 3514 | 3460 | 9 |
| 10 | 4091 | 4030 | 3969 | 3910 | 3851 | 3792 | 3735 | 3678 | 3622 | 3567 | 3513 | 3459 | 10 |
| 11 | 4090 | 4029 | 3968 | 3909 | 3850 | 3791 | 3734 | 3677 | 3622 | 3566 | 3512 | 3458 | 11 |
| 12 | 4089 | 4028 | 3967 | 3908 | 3849 | 3791 | 3733 | 3677 | 3621 | 3565 | 3511 | 3457 | 12 |
| 13 | 4088 | 4027 | 3966 | 3907 | 3848 | 3790 | 3732 | 3676 | 3620 | 3565 | 3510 | 3456 | 13 |
| 14 | 4087 | 4026 | 3965 | 3906 | 3847 | 3789 | 3731 | 3675 | 3619 | 3564 | 3509 | 3455 | 14 |
| 15 | 4086 | 4025 | 3964 | 3905 | 3846 | 3788 | 3730 | 3674 | 3618 | 3563 | 3508 | 3454 | 15 |
| 16 | 4085 | 4024 | 3963 | 3904 | 3845 | 3787 | 3729 | 3673 | 3617 | 3562 | 3507 | 3454 | 16 |
| 17 | 4084 | 4023 | 3962 | 3903 | 3844 | 3786 | 3728 | 3672 | 3616 | 3561 | 3506 | 3453 | 17 |
| 18 | 4083 | 4022 | 3961 | 3902 | 3843 | 3785 | 3727 | 3671 | 3615 | 3560 | 3506 | 3452 | 18 |
| 19 | 4082 | 4021 | 3960 | 3901 | 3842 | 3784 | 3726 | 3670 | 3614 | 3559 | 3505 | 3451 | 19 |
| 20 | 4081 | 4020 | 3959 | 3900 | 3841 | 3783 | 3726 | 3669 | 3613 | 3558 | 3504 | 3450 | 20 |
| 21 | 4080 | 4019 | 3958 | 3899 | 3840 | 3782 | 3725 | 3668 | 3612 | 3557 | 3503 | 3449 | 21 |
| 22 | 4079 | 4018 | 3957 | 3898 | 3839 | 3781 | 3724 | 3667 | 3611 | 3556 | 3502 | 3448 | 22 |
| 23 | 4078 | 4017 | 3956 | 3897 | 3838 | 3780 | 3723 | 3666 | 3610 | 3555 | 3501 | 3447 | 23 |
| 24 | 4077 | 4016 | 3955 | 3896 | 3837 | 3779 | 3722 | 3665 | 3610 | 3555 | 3500 | 3446 | 24 |
| 25 | 4076 | 4015 | 3954 | 3895 | 3836 | 3778 | 3721 | 3664 | 3609 | 3554 | 3499 | 3446 | 25 |
| 26 | 4075 | 4014 | 3953 | 3894 | 3835 | 3777 | 3720 | 3663 | 3608 | 3553 | 3498 | 3445 | 26 |
| 27 | 4074 | 4013 | 3952 | 3893 | 3834 | 3776 | 3719 | 3663 | 3607 | 3552 | 3497 | 3444 | 27 |
| 28 | 4073 | 4012 | 3951 | 3892 | 3833 | 3775 | 3718 | 3662 | 3606 | 3551 | 3496 | 3443 | 28 |
| 29 | 4072 | 4011 | 3950 | 3891 | 3832 | 3774 | 3717 | 3661 | 3605 | 3550 | 3496 | 3442 | 29 |
| 30 | 4071 | 4010 | 3949 | 3890 | 3831 | 3773 | 3716 | 3660 | 3604 | 3549 | 3495 | 3441 | 30 |
| 31 | 4070 | 4009 | 3948 | 3889 | 3830 | 3772 | 3715 | 3659 | 3603 | 3548 | 3494 | 3440 | 31 |
| 32 | 4069 | 4008 | 3947 | 3888 | 3829 | 3771 | 3714 | 3658 | 3602 | 3547 | 3493 | 3439 | 32 |
| 33 | 4068 | 4007 | 3946 | 3887 | 3828 | 3770 | 3713 | 3657 | 3601 | 3546 | 3492 | 3438 | 33 |
| 34 | 4067 | 4006 | 3945 | 3886 | 3827 | 3769 | 3712 | 3656 | 3600 | 3545 | 3491 | 3438 | 34 |
| 35 | 4066 | 4005 | 3944 | 3885 | 3826 | 3768 | 3711 | 3655 | 3599 | 3544 | 3490 | 3437 | 35 |
| 36 | 4065 | 4004 | 3943 | 3884 | 3825 | 3768 | 3710 | 3654 | 3598 | 3544 | 3489 | 3436 | 36 |
| 37 | 4064 | 4003 | 3942 | 3883 | 3824 | 3767 | 3709 | 3653 | 3598 | 3543 | 3488 | 3435 | 37 |
| 38 | 4063 | 4002 | 3941 | 3882 | 3823 | 3766 | 3708 | 3652 | 3597 | 3542 | 3488 | 3434 | 38 |
| 39 | 4062 | 4001 | 3940 | 3881 | 3822 | 3765 | 3708 | 3651 | 3596 | 3541 | 3487 | 3433 | 39 |
| 40 | 4061 | 4000 | 3939 | 3880 | 3821 | 3764 | 3707 | 3650 | 3595 | 3540 | 3486 | 3432 | 40 |
| 41 | 4060 | 3999 | 3938 | 3879 | 3820 | 3763 | 3706 | 3649 | 3594 | 3539 | 3485 | 3431 | 41 |
| 42 | 4059 | 3998 | 3937 | 3878 | 3820 | 3762 | 3705 | 3649 | 3593 | 3538 | 3484 | 3431 | 42 |
| 43 | 4057 | 3997 | 3936 | 3877 | 3819 | 3761 | 3704 | 3648 | 3592 | 3537 | 3483 | 3430 | 43 |
| 44 | 4056 | 3996 | 3935 | 3876 | 3818 | 3760 | 3703 | 3647 | 3591 | 3536 | 3482 | 3429 | 44 |
| 45 | 4055 | 3995 | 3934 | 3875 | 3817 | 3759 | 3702 | 3646 | 3590 | 3535 | 3481 | 3428 | 45 |
| 46 | 4054 | 3993 | 3933 | 3874 | 3816 | 3758 | 3701 | 3645 | 3589 | 3534 | 3480 | 3427 | 46 |
| 47 | 4053 | 3992 | 3932 | 3873 | 3815 | 3757 | 3700 | 3644 | 3588 | 3533 | 3479 | 3426 | 47 |
| 48 | 4052 | 3991 | 3931 | 3872 | 3814 | 3756 | 3699 | 3643 | 3587 | 3533 | 3479 | 3425 | 48 |
| 49 | 4051 | 3990 | 3930 | 3871 | 3813 | 3755 | 3698 | 3642 | 3586 | 3532 | 3478 | 3424 | 49 |
| 50 | 4050 | 3989 | 3929 | 3870 | 3812 | 3754 | 3697 | 3641 | 3586 | 3531 | 3477 | 3423 | 50 |
| 51 | 4049 | 3988 | 3928 | 3869 | 3811 | 3753 | 3696 | 3640 | 3585 | 3530 | 3476 | 3423 | 51 |
| 52 | 4048 | 3987 | 3927 | 3868 | 3810 | 3752 | 3695 | 3639 | 3584 | 3529 | 3475 | 3422 | 52 |
| 53 | 4047 | 3986 | 3926 | 3867 | 3809 | 3751 | 3694 | 3638 | 3583 | 3528 | 3474 | 3421 | 53 |
| 54 | 4046 | 3985 | 3925 | 3866 | 3808 | 3750 | 3693 | 3637 | 3582 | 3527 | 3473 | 3420 | 54 |
| 55 | 4045 | 3984 | 3924 | 3865 | 3807 | 3749 | 3692 | 3636 | 3581 | 3526 | 3472 | 3419 | 55 |
| 56 | 4044 | 3983 | 3923 | 3864 | 3806 | 3748 | 3692 | 3635 | 3580 | 3525 | 3471 | 3418 | 56 |
| 57 | 4043 | 3982 | 3922 | 3863 | 3805 | 3747 | 3691 | 3635 | 3579 | 3525 | 3471 | 3417 | 57 |
| 58 | 4042 | 3981 | 3921 | 3862 | 3804 | 3746 | 3690 | 3634 | 3578 | 3524 | 3470 | 3416 | 58 |
| 59 | 4041 | 3980 | 3920 | 3861 | 3803 | 3745 | 3689 | 3633 | 3577 | 3523 | 3469 | 3415 | 59 |
| 60 | 4040 | 3979 | 3919 | 3860 | 3802 | 3745 | 3688 | 3632 | 3576 | 3522 | 3468 | 3415 | 60 |

## PROPORTIONAL LOGARITHMS

| sec. ″ | h m 1° 22′ | h m 1° 23′ | h m 1° 24′ | h m 1° 25′ | h m 1° 26′ | h m 1° 27′ | h m 1° 28′ | h m 1° 29′ | h m 1° 30′ | h m 1° 31′ | h m 1° 32′ | h m 1° 33′ | sec. ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 3415 | 3362 | 3310 | 3259 | 3208 | 3158 | 3108 | 3059 | 3010 | 2962 | 2915 | 2868 | 0 |
| 1 | 3414 | 3361 | 3309 | 3258 | 3207 | 3157 | 3107 | 3058 | 3009 | 2961 | 2914 | 2867 | 1 |
| 2 | 3413 | 3360 | 3308 | 3257 | 3206 | 3156 | 3106 | 3057 | 3009 | 2961 | 2913 | 2866 | 2 |
| 3 | 3412 | 3359 | 3307 | 3256 | 3205 | 3155 | 3105 | 3056 | 3008 | 2960 | 2912 | 2866 | 3 |
| 4 | 3411 | 3358 | 3306 | 3255 | 3204 | 3154 | 3105 | 3056 | 3007 | 2959 | 2912 | 2865 | 4 |
| 5 | 3410 | 3358 | 3306 | 3254 | 3203 | 3153 | 3104 | 3055 | 3006 | 2958 | 2911 | 2864 | 5 |
| 6 | 3409 | 3357 | 3305 | 3253 | 3203 | 3153 | 3103 | 3054 | 3005 | 2958 | 2910 | 2863 | 6 |
| 7 | 3408 | 3356 | 3304 | 3253 | 3202 | 3152 | 3102 | 3053 | 3005 | 2957 | 2909 | 2862 | 7 |
| 8 | 3407 | 3355 | 3303 | 3252 | 3201 | 3151 | 3101 | 3052 | 3004 | 2956 | 2909 | 2862 | 8 |
| 9 | 3407 | 3354 | 3302 | 3251 | 3200 | 3150 | 3101 | 3052 | 3003 | 2955 | 2908 | 2861 | 9 |
| 10 | 3406 | 3353 | 3301 | 3250 | 3199 | 3149 | 3100 | 3051 | 3002 | 2954 | 2907 | 2860 | 10 |
| 11 | 3405 | 3352 | 3300 | 3249 | 3198 | 3148 | 3099 | 3050 | 3001 | 2954 | 2906 | 2859 | 11 |
| 12 | 3404 | 3351 | 3300 | 3248 | 3198 | 3148 | 3098 | 3049 | 3001 | 2953 | 2905 | 2859 | 12 |
| 13 | 3403 | 3351 | 3299 | 3247 | 3197 | 3147 | 3097 | 3048 | 3000 | 2952 | 2905 | 2858 | 13 |
| 14 | 3402 | 3350 | 3298 | 3247 | 3196 | 3146 | 3097 | 3047 | 2999 | 2951 | 2904 | 2857 | 14 |
| 15 | 3401 | 3349 | 3297 | 3246 | 3195 | 3145 | 3096 | 3047 | 2998 | 2950 | 2903 | 2856 | 15 |
| 16 | 3400 | 3348 | 3296 | 3245 | 3194 | 3144 | 3095 | 3046 | 2997 | 2950 | 2902 | 2855 | 16 |
| 17 | 3400 | 3347 | 3295 | 3244 | 3193 | 3143 | 3094 | 3045 | 2997 | 2949 | 2901 | 2855 | 17 |
| 18 | 3399 | 3346 | 3294 | 3243 | 3193 | 3143 | 3093 | 3044 | 2996 | 2948 | 2901 | 2854 | 18 |
| 19 | 3398 | 3345 | 3294 | 3242 | 3192 | 3142 | 3092 | 3043 | 2995 | 2947 | 2900 | 2853 | 19 |
| 20 | 3397 | 3344 | 3293 | 3241 | 3191 | 3141 | 3091 | 3043 | 2994 | 2946 | 2899 | 2852 | 20 |
| 21 | 3396 | 3344 | 3292 | 3241 | 3190 | 3140 | 3091 | 3042 | 2993 | 2946 | 2898 | 2852 | 21 |
| 22 | 3395 | 3343 | 3291 | 3240 | 3189 | 3139 | 3090 | 3041 | 2993 | 2945 | 2898 | 2851 | 22 |
| 23 | 3394 | 3342 | 3290 | 3239 | 3188 | 3138 | 3089 | 3040 | 2992 | 2944 | 2897 | 2850 | 23 |
| 24 | 3393 | 3341 | 3289 | 3238 | 3188 | 3138 | 3088 | 3039 | 2991 | 2943 | 2896 | 2849 | 24 |
| 25 | 3393 | 3340 | 3288 | 3237 | 3187 | 3137 | 3087 | 3038 | 2990 | 2942 | 2895 | 2848 | 25 |
| 26 | 3392 | 3339 | 3288 | 3236 | 3186 | 3136 | 3087 | 3038 | 2989 | 2942 | 2894 | 2848 | 26 |
| 27 | 3391 | 3338 | 3287 | 3236 | 3185 | 3135 | 3086 | 3037 | 2989 | 2941 | 2894 | 2847 | 27 |
| 28 | 3390 | 3338 | 3286 | 3235 | 3184 | 3134 | 3085 | 3036 | 2988 | 2940 | 2893 | 2846 | 28 |
| 29 | 3389 | 3337 | 3285 | 3234 | 3183 | 3133 | 3084 | 3035 | 2987 | 2939 | 2892 | 2845 | 29 |
| 30 | 3388 | 3336 | 3284 | 3233 | 3183 | 3133 | 3083 | 3034 | 2986 | 2939 | 2891 | 2845 | 30 |
| 31 | 3387 | 3335 | 3283 | 3232 | 3182 | 3132 | 3082 | 3034 | 2985 | 2938 | 2890 | 2844 | 31 |
| 32 | 3386 | 3334 | 3282 | 3231 | 3181 | 3131 | 3082 | 3033 | 2985 | 2937 | 2890 | 2843 | 32 |
| 33 | 3386 | 3333 | 3282 | 3231 | 3180 | 3130 | 3081 | 3032 | 2984 | 2936 | 2889 | 2842 | 33 |
| 34 | 3385 | 3332 | 3281 | 3230 | 3179 | 3129 | 3080 | 3031 | 2983 | 2935 | 2888 | 2841 | 34 |
| 35 | 3384 | 3331 | 3280 | 3229 | 3178 | 3128 | 3079 | 3030 | 2982 | 2935 | 2887 | 2841 | 35 |
| 36 | 3383 | 3331 | 3279 | 3228 | 3178 | 3128 | 3078 | 3030 | 2981 | 2934 | 2887 | 2840 | 36 |
| 37 | 3382 | 3330 | 3278 | 3227 | 3177 | 3127 | 3078 | 3029 | 2981 | 2933 | 2886 | 2839 | 37 |
| 38 | 3381 | 3329 | 3277 | 3226 | 3176 | 3126 | 3077 | 3028 | 2980 | 2932 | 2885 | 2838 | 38 |
| 39 | 3380 | 3328 | 3276 | 3225 | 3175 | 3125 | 3076 | 3027 | 2979 | 2931 | 2884 | 2838 | 39 |
| 40 | 3379 | 3327 | 3276 | 3225 | 3174 | 3124 | 3075 | 3026 | 2978 | 2931 | 2883 | 2837 | 40 |
| 41 | 3378 | 3326 | 3275 | 3224 | 3173 | 3124 | 3074 | 3026 | 2977 | 2930 | 2883 | 2836 | 41 |
| 42 | 3378 | 3325 | 3274 | 3223 | 3173 | 3123 | 3073 | 3025 | 2977 | 2929 | 2882 | 2835 | 42 |
| 43 | 3377 | 3325 | 3273 | 3222 | 3172 | 3122 | 3073 | 3024 | 2976 | 2928 | 2881 | 2835 | 43 |
| 44 | 3376 | 3324 | 3272 | 3221 | 3171 | 3121 | 3072 | 3023 | 2975 | 2927 | 2880 | 2834 | 44 |
| 45 | 3375 | 3323 | 3271 | 3220 | 3170 | 3120 | 3071 | 3022 | 2974 | 2927 | 2880 | 2833 | 45 |
| 46 | 3374 | 3322 | 3270 | 3219 | 3169 | 3119 | 3070 | 3022 | 2973 | 2926 | 2879 | 2832 | 46 |
| 47 | 3373 | 3321 | 3270 | 3219 | 3168 | 3119 | 3069 | 3021 | 2973 | 2925 | 2878 | 2831 | 47 |
| 48 | 3372 | 3320 | 3269 | 3218 | 3168 | 3118 | 3069 | 3020 | 2972 | 2924 | 2877 | 2831 | 48 |
| 49 | 3371 | 3319 | 3268 | 3217 | 3167 | 3117 | 3068 | 3019 | 2971 | 2923 | 2876 | 2830 | 49 |
| 50 | 3371 | 3319 | 3267 | 3216 | 3166 | 3116 | 3067 | 3018 | 2970 | 2923 | 2876 | 2829 | 50 |
| 51 | 3370 | 3318 | 3266 | 3215 | 3165 | 3115 | 3066 | 3018 | 2969 | 2922 | 2875 | 2828 | 51 |
| 52 | 3369 | 3317 | 3265 | 3214 | 3164 | 3114 | 3065 | 3017 | 2969 | 2921 | 2874 | 2828 | 52 |
| 53 | 3368 | 3316 | 3264 | 3214 | 3163 | 3114 | 3064 | 3016 | 2968 | 2920 | 2873 | 2827 | 53 |
| 54 | 3367 | 3315 | 3264 | 3213 | 3163 | 3113 | 3064 | 3015 | 2967 | 2920 | 2873 | 2826 | 54 |
| 55 | 3366 | 3314 | 3263 | 3212 | 3162 | 3112 | 3063 | 3014 | 2966 | 2919 | 2872 | 2825 | 55 |
| 56 | 3365 | 3313 | 3262 | 3211 | 3161 | 3111 | 3062 | 3013 | 2965 | 2918 | 2871 | 2824 | 56 |
| 57 | 3365 | 3313 | 3261 | 3210 | 3160 | 3110 | 3061 | 3013 | 2965 | 2917 | 2870 | 2824 | 57 |
| 58 | 3364 | 3312 | 3260 | 3209 | 3159 | 3109 | 3060 | 3012 | 2964 | 2916 | 2869 | 2823 | 58 |
| 59 | 3363 | 3311 | 3259 | 3209 | 3158 | 3109 | 3060 | 3011 | 2963 | 2916 | 2869 | 2822 | 59 |
| 60 | 3362 | 3310 | 3259 | 3208 | 3158 | 3108 | 3059 | 3010 | 2962 | 2915 | 2868 | 2821 | 60 |

## PROPORTIONAL LOGARITHMS

| sec. ″ | h m 1° 34′ | h m 1° 35′ | h m 1° 36′ | h m 1° 37′ | h m 1° 38′ | h m 1° 39′ | h m 1° 40′ | h m 1° 41′ | h m 1° 42′ | h m 1° 43′ | h m 1° 44′ | h m 1° 45′ | sec. ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 2821 | 2775 | 2730 | 2685 | 2640 | 2596 | 2553 | 2510 | 2467 | 2424 | 2382 | 2341 | 0 |
| 1 | 2821 | 2775 | 2729 | 2684 | 2640 | 2596 | 2552 | 2509 | 2466 | 2424 | 2382 | 2340 | 1 |
| 2 | 2820 | 2774 | 2728 | 2683 | 2639 | 2595 | 2551 | 2508 | 2465 | 2423 | 2381 | 2339 | 2 |
| 3 | 2819 | 2773 | 2728 | 2683 | 2638 | 2594 | 2551 | 2507 | 2465 | 2422 | 2380 | 2339 | 3 |
| 4 | 2818 | 2772 | 2727 | 2682 | 2637 | 2593 | 2550 | 2507 | 2464 | 2421 | 2380 | 2338 | 4 |
| 5 | 2818 | 2772 | 2726 | 2681 | 2637 | 2593 | 2549 | 2506 | 2463 | 2421 | 2379 | 2337 | 5 |
| 6 | 2817 | 2771 | 2725 | 2681 | 2636 | 2592 | 2548 | 2505 | 2462 | 2420 | 2378 | 2337 | 6 |
| 7 | 2816 | 2770 | 2725 | 2680 | 2635 | 2591 | 2548 | 2504 | 2462 | 2419 | 2378 | 2336 | 7 |
| 8 | 2815 | 2769 | 2724 | 2679 | 2634 | 2590 | 2547 | 2504 | 2461 | 2419 | 2377 | 2335 | 8 |
| 9 | 2815 | 2769 | 2723 | 2678 | 2634 | 2590 | 2546 | 2503 | 2460 | 2418 | 2376 | 2335 | 9 |
| 10 | 2814 | 2768 | 2722 | 2678 | 2633 | 2589 | 2545 | 2502 | 2460 | 2417 | 2375 | 2334 | 10 |
| 11 | 2813 | 2767 | 2722 | 2677 | 2632 | 2588 | 2545 | 2502 | 2459 | 2417 | 2375 | 2333 | 11 |
| 12 | 2812 | 2766 | 2721 | 2676 | 2632 | 2588 | 2544 | 2501 | 2458 | 2416 | 2374 | 2333 | 12 |
| 13 | 2811 | 2766 | 2720 | 2675 | 2631 | 2587 | 2543 | 2500 | 2457 | 2415 | 2373 | 2332 | 13 |
| 14 | 2811 | 2765 | 2719 | 2675 | 2630 | 2586 | 2543 | 2499 | 2457 | 2414 | 2373 | 2331 | 14 |
| 15 | 2810 | 2764 | 2719 | 2674 | 2629 | 2585 | 2542 | 2499 | 2456 | 2414 | 2372 | 2331 | 15 |
| 16 | 2809 | 2763 | 2718 | 2673 | 2629 | 2585 | 2541 | 2498 | 2455 | 2413 | 2371 | 2330 | 16 |
| 17 | 2808 | 2763 | 2717 | 2672 | 2628 | 2584 | 2540 | 2497 | 2455 | 2412 | 2371 | 2329 | 17 |
| 18 | 2808 | 2762 | 2716 | 2672 | 2627 | 2583 | 2540 | 2497 | 2454 | 2412 | 2370 | 2328 | 18 |
| 19 | 2807 | 2761 | 2716 | 2671 | 2626 | 2582 | 2539 | 2496 | 2453 | 2411 | 2369 | 2328 | 19 |
| 20 | 2806 | 2760 | 2715 | 2670 | 2626 | 2582 | 2538 | 2495 | 2453 | 2410 | 2368 | 2327 | 20 |
| 21 | 2805 | 2760 | 2714 | 2669 | 2625 | 2581 | 2538 | 2494 | 2452 | 2410 | 2368 | 2326 | 21 |
| 22 | 2804 | 2759 | 2713 | 2669 | 2624 | 2580 | 2537 | 2494 | 2451 | 2409 | 2367 | 2326 | 22 |
| 23 | 2804 | 2758 | 2713 | 2668 | 2623 | 2580 | 2536 | 2493 | 2450 | 2408 | 2366 | 2325 | 23 |
| 24 | 2803 | 2757 | 2712 | 2667 | 2623 | 2579 | 2535 | 2492 | 2450 | 2408 | 2366 | 2324 | 24 |
| 25 | 2802 | 2756 | 2711 | 2666 | 2622 | 2578 | 2535 | 2492 | 2449 | 2407 | 2365 | 2324 | 25 |
| 26 | 2801 | 2756 | 2710 | 2666 | 2621 | 2577 | 2534 | 2491 | 2448 | 2406 | 2364 | 2323 | 26 |
| 27 | 2801 | 2755 | 2710 | 2665 | 2621 | 2577 | 2533 | 2490 | 2448 | 2405 | 2364 | 2322 | 27 |
| 28 | 2800 | 2754 | 2709 | 2664 | 2620 | 2576 | 2532 | 2489 | 2447 | 2405 | 2363 | 2322 | 28 |
| 29 | 2799 | 2753 | 2708 | 2663 | 2619 | 2575 | 2532 | 2489 | 2446 | 2404 | 2362 | 2321 | 29 |
| 30 | 2798 | 2753 | 2707 | 2663 | 2618 | 2574 | 2531 | 2488 | 2445 | 2403 | 2362 | 2320 | 30 |
| 31 | 2798 | 2752 | 2707 | 2662 | 2618 | 2574 | 2530 | 2487 | 2445 | 2403 | 2361 | 2319 | 31 |
| 32 | 2797 | 2751 | 2706 | 2661 | 2617 | 2573 | 2530 | 2487 | 2444 | 2402 | 2360 | 2319 | 32 |
| 33 | 2796 | 2750 | 2705 | 2660 | 2616 | 2572 | 2529 | 2486 | 2443 | 2401 | 2359 | 2318 | 33 |
| 34 | 2795 | 2750 | 2704 | 2660 | 2615 | 2572 | 2528 | 2485 | 2443 | 2400 | 2359 | 2317 | 34 |
| 35 | 2795 | 2749 | 2704 | 2659 | 2615 | 2571 | 2527 | 2484 | 2442 | 2400 | 2358 | 2317 | 35 |
| 36 | 2794 | 2748 | 2703 | 2658 | 2614 | 2570 | 2527 | 2484 | 2441 | 2399 | 2357 | 2316 | 36 |
| 37 | 2793 | 2747 | 2702 | 2657 | 2613 | 2569 | 2526 | 2483 | 2440 | 2398 | 2357 | 2315 | 37 |
| 38 | 2792 | 2747 | 2701 | 2657 | 2612 | 2569 | 2525 | 2482 | 2440 | 2398 | 2356 | 2315 | 38 |
| 39 | 2792 | 2746 | 2701 | 2656 | 2612 | 2568 | 2525 | 2482 | 2439 | 2397 | 2355 | 2314 | 39 |
| 40 | 2791 | 2745 | 2700 | 2655 | 2611 | 2567 | 2524 | 2481 | 2438 | 2396 | 2355 | 2313 | 40 |
| 41 | 2790 | 2744 | 2699 | 2654 | 2610 | 2566 | 2523 | 2480 | 2438 | 2396 | 2354 | 2313 | 41 |
| 42 | 2789 | 2744 | 2698 | 2654 | 2610 | 2566 | 2522 | 2480 | 2437 | 2395 | 2353 | 2312 | 42 |
| 43 | 2788 | 2743 | 2692 | 2653 | 2609 | 2565 | 2522 | 2479 | 2436 | 2394 | 2353 | 2311 | 43 |
| 44 | 2788 | 2742 | 2697 | 2652 | 2608 | 2564 | 2521 | 2478 | 2436 | 2394 | 2352 | 2311 | 44 |
| 45 | 2787 | 2741 | 2696 | 2652 | 2607 | 2564 | 2520 | 2477 | 2435 | 2393 | 2351 | 2310 | 45 |
| 46 | 2786 | 2741 | 2695 | 2651 | 2607 | 2563 | 2520 | 2477 | 2434 | 2392 | 2350 | 2309 | 46 |
| 47 | 2785 | 2740 | 2695 | 2650 | 2606 | 2562 | 2519 | 2476 | 2433 | 2391 | 2350 | 2308 | 47 |
| 48 | 2785 | 2739 | 2694 | 2649 | 2605 | 2561 | 2518 | 2475 | 2433 | 2391 | 2349 | 2308 | 48 |
| 49 | 2784 | 2738 | 2693 | 2649 | 2604 | 2561 | 2517 | 2474 | 2432 | 2390 | 2348 | 2307 | 49 |
| 50 | 2783 | 2738 | 2692 | 2648 | 2604 | 2560 | 2517 | 2474 | 2431 | 2389 | 2348 | 2306 | 50 |
| 51 | 2782 | 2737 | 2692 | 2647 | 2603 | 2559 | 2516 | 2473 | 2431 | 2389 | 2347 | 2306 | 51 |
| 52 | 2782 | 2736 | 2691 | 2646 | 2602 | 2558 | 2515 | 2472 | 2430 | 2388 | 2346 | 2305 | 52 |
| 53 | 2781 | 2735 | 2690 | 2646 | 2601 | 2558 | 2514 | 2472 | 2429 | 2387 | 2346 | 2304 | 53 |
| 54 | 2780 | 2735 | 2689 | 2645 | 2601 | 2557 | 2514 | 2471 | 2429 | 2387 | 2345 | 2304 | 54 |
| 55 | 2779 | 2734 | 2689 | 2644 | 2600 | 2556 | 2513 | 2470 | 2428 | 2386 | 2344 | 2303 | 55 |
| 56 | 2778 | 2733 | 2688 | 2643 | 2599 | 2556 | 2512 | 2470 | 2427 | 2385 | 2344 | 2302 | 56 |
| 57 | 2778 | 2732 | 2687 | 2643 | 2599 | 2555 | 2512 | 2469 | 2426 | 2384 | 2343 | 2302 | 57 |
| 58 | 2777 | 2731 | 2686 | 2642 | 2598 | 2554 | 2511 | 2468 | 2426 | 2384 | 2342 | 2301 | 58 |
| 59 | 2776 | 2731 | 2686 | 2641 | 2597 | 2553 | 2510 | 2467 | 2425 | 2383 | 2341 | 2300 | 59 |
| 60 | 2775 | 2730 | 2685 | 2640 | 2596 | 2553 | 2510 | 2467 | 2424 | 2382 | 2341 | 2300 | 60 |

## PROPORTIONAL LOGARITHMS

| sec. ″ | h m 1° 46′ | h m 1° 47′ | h m 1° 48′ | h m 1° 49′ | h m 1° 50′ | h m 1° 51′ | h m 1° 52′ | h m 1° 53′ | h m 1° 54′ | h m 1° 55′ | h m 1° 56′ | h m 1° 57′ | sec. ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 2300 | 2259 | 2218 | 2178 | 2139 | 2099 | 2061 | 2022 | 1984 | 1946 | 1908 | 1871 | 0 |
| 1 | 2299 | 2258 | 2218 | 2178 | 2138 | 2099 | 2060 | 2021 | 1983 | 1945 | 1907 | 1870 | 1 |
| 2 | 2298 | 2257 | 2217 | 2177 | 2137 | 2098 | 2059 | 2021 | 1982 | 1944 | 1907 | 1870 | 2 |
| 3 | 2298 | 2257 | 2216 | 2176 | 2137 | 2098 | 2059 | 2020 | 1982 | 1944 | 1906 | 1869 | 3 |
| 4 | 2297 | 2256 | 2216 | 2176 | 2136 | 2097 | 2058 | 2019 | 1981 | 1943 | 1906 | 1868 | 4 |
| 5 | 2296 | 2255 | 2215 | 2175 | 2135 | 2096 | 2057 | 2019 | 1980 | 1943 | 1905 | 1868 | 5 |
| 6 | 2296 | 2255 | 2214 | 2174 | 2135 | 2096 | 2057 | 2018 | 1980 | 1942 | 1904 | 1867 | 6 |
| 7 | 2295 | 2254 | 2214 | 2174 | 2134 | 2095 | 2056 | 2017 | 1979 | 1941 | 1904 | 1867 | 7 |
| 8 | 2294 | 2253 | 2213 | 2173 | 2133 | 2094 | 2055 | 2017 | 1979 | 1941 | 1903 | 1866 | 8 |
| 9 | 2294 | 2253 | 2212 | 2172 | 2133 | 2094 | 2055 | 2016 | 1978 | 1940 | 1903 | 1865 | 9 |
| 10 | 2293 | 2252 | 2212 | 2172 | 2132 | 2093 | 2054 | 2016 | 1977 | 1939 | 1902 | 1865 | 10 |
| 11 | 2292 | 2251 | 2211 | 2171 | 2132 | 2092 | 2053 | 2015 | 1977 | 1939 | 1901 | 1864 | 11 |
| 12 | 2291 | 2251 | 2210 | 2170 | 2131 | 2092 | 2053 | 2014 | 1976 | 1938 | 1901 | 1863 | 12 |
| 13 | 2291 | 2250 | 2210 | 2170 | 2130 | 2091 | 2052 | 2014 | 1975 | 1938 | 1900 | 1863 | 13 |
| 14 | 2290 | 2249 | 2209 | 2169 | 2130 | 2090 | 2051 | 2013 | 1975 | 1937 | 1899 | 1862 | 14 |
| 15 | 2289 | 2249 | 2208 | 2169 | 2129 | 2090 | 2051 | 2012 | 1974 | 1936 | 1899 | 1862 | 15 |
| 16 | 2289 | 2248 | 2208 | 2168 | 2128 | 2089 | 2050 | 2012 | 1973 | 1936 | 1898 | 1861 | 16 |
| 17 | 2288 | 2247 | 2207 | 2167 | 2128 | 2088 | 2050 | 2011 | 1973 | 1935 | 1898 | 1860 | 17 |
| 18 | 2287 | 2247 | 2206 | 2167 | 2127 | 2088 | 2049 | 2010 | 1972 | 1934 | 1897 | 1860 | 18 |
| 19 | 2287 | 2246 | 2206 | 2166 | 2126 | 2087 | 2048 | 2010 | 1972 | 1934 | 1896 | 1859 | 19 |
| 20 | 2286 | 2245 | 2205 | 2165 | 2126 | 2086 | 2048 | 2009 | 1971 | 1933 | 1896 | 1858 | 20 |
| 21 | 2285 | 2245 | 2204 | 2165 | 2125 | 2086 | 2047 | 2009 | 1970 | 1933 | 1895 | 1858 | 21 |
| 22 | 2285 | 2244 | 2204 | 2164 | 2124 | 2085 | 2046 | 2008 | 1970 | 1932 | 1894 | 1857 | 22 |
| 23 | 2284 | 2243 | 2203 | 2163 | 2124 | 2084 | 2046 | 2007 | 1969 | 1931 | 1894 | 1857 | 23 |
| 24 | 2283 | 2243 | 2202 | 2163 | 2123 | 2084 | 2045 | 2007 | 1968 | 1931 | 1893 | 1856 | 24 |
| 25 | 2283 | 2242 | 2202 | 2162 | 2122 | 2083 | 2044 | 2006 | 1968 | 1930 | 1893 | 1855 | 25 |
| 26 | 2282 | 2241 | 2201 | 2161 | 2122 | 2083 | 2044 | 2005 | 1967 | 1929 | 1892 | 1855 | 26 |
| 27 | 2281 | 2241 | 2200 | 2161 | 2121 | 2082 | 2043 | 2005 | 1967 | 1929 | 1891 | 1854 | 27 |
| 28 | 2281 | 2240 | 2200 | 2160 | 2120 | 2081 | 2042 | 2004 | 1966 | 1928 | 1891 | 1854 | 28 |
| 29 | 2280 | 2239 | 2199 | 2159 | 2120 | 2081 | 2042 | 2003 | 1965 | 1927 | 1890 | 1853 | 29 |
| 30 | 2279 | 2239 | 2198 | 2159 | 2119 | 2080 | 2041 | 2003 | 1965 | 1927 | 1889 | 1852 | 30 |
| 31 | 2279 | 2238 | 2198 | 2158 | 2118 | 2079 | 2041 | 2002 | 1964 | 1926 | 1889 | 1852 | 31 |
| 32 | 2278 | 2237 | 2197 | 2157 | 2118 | 2079 | 2040 | 2001 | 1963 | 1926 | 1888 | 1851 | 32 |
| 33 | 2277 | 2237 | 2196 | 2157 | 2117 | 2078 | 2039 | 2001 | 1963 | 1925 | 1888 | 1850 | 33 |
| 34 | 2276 | 2236 | 2196 | 2156 | 2116 | 2077 | 2039 | 2000 | 1962 | 1924 | 1887 | 1850 | 34 |
| 35 | 2276 | 2235 | 2195 | 2155 | 2116 | 2077 | 2038 | 2000 | 1961 | 1924 | 1886 | 1849 | 35 |
| 36 | 2275 | 2235 | 2194 | 2155 | 2115 | 2076 | 2037 | 1999 | 1961 | 1923 | 1886 | 1849 | 36 |
| 37 | 2274 | 2234 | 2194 | 2154 | 2114 | 2075 | 2037 | 1998 | 1960 | 1922 | 1885 | 1848 | 37 |
| 38 | 2274 | 2233 | 2193 | 2153 | 2114 | 2075 | 2036 | 1998 | 1960 | 1922 | 1884 | 1847 | 38 |
| 39 | 2273 | 2233 | 2192 | 2153 | 2113 | 2074 | 2035 | 1997 | 1959 | 1921 | 1884 | 1847 | 39 |
| 40 | 2272 | 2232 | 2192 | 2152 | 2113 | 2073 | 2035 | 1996 | 1958 | 1921 | 1883 | 1846 | 40 |
| 41 | 2272 | 2231 | 2191 | 2151 | 2112 | 2073 | 2034 | 1996 | 1958 | 1920 | 1883 | 1846 | 41 |
| 42 | 2271 | 2231 | 2190 | 2151 | 2111 | 2072 | 2033 | 1995 | 1957 | 1919 | 1882 | 1845 | 42 |
| 43 | 2270 | 2230 | 2190 | 2150 | 2111 | 2071 | 2033 | 1994 | 1956 | 1919 | 1881 | 1844 | 43 |
| 44 | 2270 | 2229 | 2189 | 2149 | 2110 | 2071 | 2032 | 1994 | 1956 | 1918 | 1881 | 1844 | 44 |
| 45 | 2269 | 2229 | 2188 | 2149 | 2109 | 2070 | 2032 | 1993 | 1955 | 1918 | 1880 | 1843 | 45 |
| 46 | 2268 | 2228 | 2188 | 2148 | 2109 | 2070 | 2031 | 1993 | 1955 | 1917 | 1879 | 1842 | 46 |
| 47 | 2268 | 2227 | 2187 | 2147 | 2108 | 2069 | 2030 | 1992 | 1954 | 1916 | 1879 | 1842 | 47 |
| 48 | 2267 | 2227 | 2186 | 2147 | 2107 | 2068 | 2030 | 1991 | 1953 | 1916 | 1878 | 1841 | 48 |
| 49 | 2266 | 2226 | 2186 | 2146 | 2107 | 2068 | 2029 | 1991 | 1953 | 1915 | 1878 | 1841 | 49 |
| 50 | 2266 | 2225 | 2185 | 2145 | 2106 | 2067 | 2028 | 1990 | 1952 | 1914 | 1877 | 1840 | 50 |
| 51 | 2265 | 2225 | 2184 | 2145 | 2105 | 2066 | 2028 | 1989 | 1951 | 1914 | 1876 | 1839 | 51 |
| 52 | 2264 | 2224 | 2184 | 2144 | 2105 | 2066 | 2027 | 1989 | 1951 | 1913 | 1876 | 1839 | 52 |
| 53 | 2264 | 2223 | 2183 | 2143 | 2104 | 2065 | 2026 | 1988 | 1950 | 1912 | 1875 | 1838 | 53 |
| 54 | 2263 | 2223 | 2182 | 2143 | 2103 | 2064 | 2026 | 1987 | 1950 | 1912 | 1875 | 1838 | 54 |
| 55 | 2262 | 2222 | 2182 | 2142 | 2103 | 2064 | 2025 | 1987 | 1949 | 1911 | 1874 | 1837 | 55 |
| 56 | 2262 | 2221 | 2181 | 2141 | 2102 | 2063 | 2024 | 1986 | 1948 | 1911 | 1873 | 1836 | 56 |
| 57 | 2261 | 2220 | 2180 | 2141 | 2101 | 2062 | 2024 | 1986 | 1948 | 1910 | 1873 | 1836 | 57 |
| 58 | 2260 | 2220 | 2180 | 2140 | 2101 | 2062 | 2023 | 1985 | 1947 | 1909 | 1872 | 1835 | 58 |
| 59 | 2260 | 2219 | 2179 | 2139 | 2100 | 2061 | 2023 | 1984 | 1946 | 1909 | 1871 | 1834 | 59 |
| 60 | 2259 | 2218 | 2178 | 2139 | 2099 | 2061 | 2022 | 1984 | 1946 | 1908 | 1871 | 1834 | 60 |

## PROPORTIONAL LOGARITHMS

| sec. ″ | 1h 58m | 1h 59m | 2h 0m | 2h 1m | 2h 2m | 2h 3m | 2h 4m | 2h 5m | 2h 6m | 2h 7m | 2h 8m | 2h 9m | 2h 10m | sec ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1834 | 1797 | 1761 | 1725 | 1689 | 1654 | 1619 | 1584 | 1549 | 1515 | 1481 | 1447 | 1413 | 0 |
| 1 | 1833 | 1797 | 1760 | 1724 | 1688 | 1653 | 1618 | 1583 | 1548 | 1514 | 1480 | 1446 | 1413 | 1 |
| 2 | 1833 | 1796 | 1760 | 1724 | 1688 | 1652 | 1617 | 1582 | 1548 | 1514 | 1479 | 1446 | 1412 | 2 |
| 3 | 1832 | 1795 | 1759 | 1723 | 1687 | 1652 | 1617 | 1582 | 1547 | 1513 | 1479 | 1445 | 1412 | 3 |
| 4 | 1831 | 1795 | 1758 | 1722 | 1687 | 1651 | 1616 | 1581 | 1547 | 1512 | 1478 | 1445 | 1411 | 4 |
| 5 | 1831 | 1794 | 1758 | 1722 | 1686 | 1651 | 1616 | 1581 | 1546 | 1512 | 1478 | 1444 | 1410 | 5 |
| 6 | 1830 | 1794 | 1757 | 1721 | 1686 | 1650 | 1615 | 1580 | 1546 | 1511 | 1477 | 1443 | 1410 | 6 |
| 7 | 1830 | 1793 | 1757 | 1721 | 1685 | 1650 | 1614 | 1580 | 1545 | 1511 | 1477 | 1443 | 1409 | 7 |
| 8 | 1829 | 1792 | 1756 | 1720 | 1684 | 1649 | 1614 | 1579 | 1544 | 1510 | 1476 | 1442 | 1409 | 8 |
| 9 | 1828 | 1792 | 1755 | 1719 | 1684 | 1648 | 1613 | 1578 | 1544 | 1510 | 1476 | 1442 | 1408 | 9 |
| 10 | 1828 | 1791 | 1755 | 1719 | 1683 | 1648 | 1613 | 1578 | 1543 | 1509 | 1475 | 1441 | 1408 | 10 |
| 11 | 1827 | 1791 | 1754 | 1718 | 1683 | 1647 | 1612 | 1577 | 1543 | 1508 | 1474 | 1441 | 1407 | 11 |
| 12 | 1827 | 1790 | 1754 | 1718 | 1682 | 1647 | 1612 | 1577 | 1542 | 1508 | 1474 | 1440 | 1407 | 12 |
| 13 | 1826 | 1789 | 1753 | 1717 | 1681 | 1646 | 1611 | 1576 | 1542 | 1507 | 1473 | 1440 | 1406 | 13 |
| 14 | 1825 | 1789 | 1752 | 1716 | 1681 | 1645 | 1610 | 1575 | 1541 | 1507 | 1473 | 1439 | 1405 | 14 |
| 15 | 1825 | 1788 | 1752 | 1716 | 1680 | 1645 | 1610 | 1575 | 1540 | 1506 | 1472 | 1438 | 1405 | 15 |
| 16 | 1824 | 1787 | 1751 | 1715 | 1680 | 1644 | 1609 | 1574 | 1540 | 1506 | 1472 | 1438 | 1404 | 16 |
| 17 | 1823 | 1787 | 1751 | 1715 | 1679 | 1644 | 1609 | 1574 | 1539 | 1505 | 1471 | 1437 | 1404 | 17 |
| 18 | 1823 | 1786 | 1750 | 1714 | 1678 | 1643 | 1608 | 1573 | 1539 | 1504 | 1470 | 1437 | 1403 | 18 |
| 19 | 1822 | 1786 | 1749 | 1713 | 1678 | 1642 | 1607 | 1573 | 1538 | 1504 | 1470 | 1436 | 1403 | 19 |
| 20 | 1822 | 1785 | 1749 | 1713 | 1677 | 1642 | 1607 | 1572 | 1538 | 1503 | 1469 | 1436 | 1402 | 20 |
| 21 | 1821 | 1785 | 1748 | 1712 | 1677 | 1641 | 1606 | 1571 | 1537 | 1503 | 1469 | 1435 | 1402 | 21 |
| 22 | 1820 | 1784 | 1748 | 1712 | 1676 | 1641 | 1606 | 1571 | 1536 | 1502 | 1468 | 1434 | 1401 | 22 |
| 23 | 1820 | 1783 | 1747 | 1711 | 1675 | 1640 | 1605 | 1570 | 1536 | 1502 | 1468 | 1434 | 1400 | 23 |
| 24 | 1819 | 1783 | 1746 | 1711 | 1675 | 1640 | 1605 | 1570 | 1535 | 1501 | 1467 | 1433 | 1400 | 24 |
| 25 | 1819 | 1782 | 1746 | 1710 | 1674 | 1639 | 1604 | 1569 | 1535 | 1500 | 1466 | 1433 | 1399 | 25 |
| 26 | 1818 | 1781 | 1745 | 1709 | 1674 | 1638 | 1603 | 1569 | 1534 | 1500 | 1466 | 1432 | 1399 | 26 |
| 27 | 1817 | 1781 | 1745 | 1709 | 1673 | 1638 | 1603 | 1568 | 1534 | 1499 | 1465 | 1432 | 1398 | 27 |
| 28 | 1817 | 1780 | 1744 | 1708 | 1673 | 1637 | 1602 | 1567 | 1533 | 1499 | 1465 | 1431 | 1398 | 28 |
| 29 | 1816 | 1780 | 1743 | 1708 | 1672 | 1637 | 1602 | 1567 | 1532 | 1498 | 1464 | 1431 | 1397 | 29 |
| 30 | 1816 | 1779 | 1743 | 1707 | 1671 | 1636 | 1601 | 1566 | 1532 | 1498 | 1464 | 1430 | 1397 | 30 |
| 31 | 1815 | 1778 | 1742 | 1706 | 1671 | 1635 | 1600 | 1566 | 1531 | 1497 | 1463 | 1429 | 1396 | 31 |
| 32 | 1814 | 1778 | 1742 | 1706 | 1670 | 1635 | 1600 | 1565 | 1531 | 1496 | 1463 | 1429 | 1395 | 32 |
| 33 | 1814 | 1777 | 1741 | 1705 | 1670 | 1634 | 1599 | 1565 | 1530 | 1496 | 1462 | 1428 | 1395 | 33 |
| 34 | 1813 | 1777 | 1740 | 1705 | 1669 | 1634 | 1599 | 1564 | 1529 | 1495 | 1461 | 1428 | 1394 | 34 |
| 35 | 1812 | 1776 | 1740 | 1704 | 1668 | 1633 | 1598 | 1563 | 1529 | 1495 | 1461 | 1427 | 1394 | 35 |
| 36 | 1812 | 1775 | 1739 | 1703 | 1668 | 1633 | 1598 | 1563 | 1528 | 1494 | 1460 | 1427 | 1393 | 36 |
| 37 | 1811 | 1775 | 1739 | 1703 | 1667 | 1632 | 1597 | 1562 | 1528 | 1494 | 1460 | 1426 | 1393 | 37 |
| 38 | 1811 | 1774 | 1738 | 1702 | 1667 | 1631 | 1596 | 1562 | 1527 | 1493 | 1459 | 1426 | 1392 | 38 |
| 39 | 1810 | 1774 | 1737 | 1702 | 1666 | 1631 | 1596 | 1561 | 1527 | 1493 | 1459 | 1425 | 1392 | 39 |
| 40 | 1809 | 1773 | 1737 | 1701 | 1665 | 1630 | 1595 | 1560 | 1526 | 1492 | 1458 | 1424 | 1391 | 40 |
| 41 | 1809 | 1772 | 1736 | 1700 | 1665 | 1630 | 1595 | 1560 | 1525 | 1491 | 1457 | 1424 | 1390 | 41 |
| 42 | 1808 | 1772 | 1736 | 1700 | 1664 | 1629 | 1594 | 1559 | 1525 | 1491 | 1457 | 1423 | 1390 | 42 |
| 43 | 1808 | 1771 | 1735 | 1699 | 1664 | 1628 | 1593 | 1559 | 1524 | 1490 | 1456 | 1423 | 1389 | 43 |
| 44 | 1807 | 1771 | 1734 | 1699 | 1663 | 1628 | 1593 | 1558 | 1524 | 1490 | 1456 | 1422 | 1389 | 44 |
| 45 | 1806 | 1770 | 1734 | 1698 | 1663 | 1627 | 1592 | 1558 | 1523 | 1489 | 1455 | 1422 | 1388 | 45 |
| 46 | 1806 | 1769 | 1733 | 1697 | 1662 | 1627 | 1592 | 1557 | 1523 | 1489 | 1455 | 1421 | 1388 | 46 |
| 47 | 1805 | 1769 | 1733 | 1697 | 1661 | 1626 | 1591 | 1556 | 1522 | 1488 | 1454 | 1420 | 1387 | 47 |
| 48 | 1805 | 1768 | 1732 | 1696 | 1661 | 1626 | 1591 | 1556 | 1522 | 1487 | 1454 | 1420 | 1387 | 48 |
| 49 | 1804 | 1768 | 1731 | 1696 | 1660 | 1625 | 1590 | 1555 | 1521 | 1487 | 1453 | 1419 | 1386 | 49 |
| 50 | 1803 | 1767 | 1731 | 1695 | 1660 | 1624 | 1589 | 1555 | 1520 | 1486 | 1452 | 1419 | 1386 | 50 |
| 51 | 1803 | 1766 | 1730 | 1694 | 1659 | 1624 | 1589 | 1554 | 1520 | 1486 | 1452 | 1418 | 1385 | 51 |
| 52 | 1802 | 1766 | 1730 | 1694 | 1658 | 1623 | 1588 | 1554 | 1519 | 1485 | 1451 | 1418 | 1384 | 52 |
| 53 | 1801 | 1765 | 1729 | 1693 | 1658 | 1623 | 1588 | 1553 | 1518 | 1485 | 1451 | 1417 | 1384 | 53 |
| 54 | 1801 | 1765 | 1728 | 1693 | 1657 | 1622 | 1587 | 1552 | 1518 | 1484 | 1450 | 1417 | 1383 | 54 |
| 55 | 1800 | 1764 | 1728 | 1692 | 1657 | 1621 | 1586 | 1552 | 1518 | 1483 | 1450 | 1416 | 1383 | 55 |
| 56 | 1800 | 1763 | 1727 | 1691 | 1656 | 1621 | 1586 | 1551 | 1517 | 1483 | 1449 | 1415 | 1382 | 56 |
| 57 | 1799 | 1763 | 1727 | 1691 | 1655 | 1620 | 1585 | 1551 | 1516 | 1482 | 1449 | 1415 | 1382 | 57 |
| 58 | 1798 | 1762 | 1726 | 1690 | 1655 | 1620 | 1585 | 1550 | 1516 | 1482 | 1448 | 1414 | 1381 | 58 |
| 59 | 1798 | 1761 | 1725 | 1690 | 1654 | 1619 | 1584 | 1550 | 1515 | 1481 | 1447 | 1414 | 1381 | 59 |
| 60 | 1797 | 1761 | 1725 | 1689 | 1654 | 1619 | 1584 | 1549 | 1515 | 1481 | 1447 | 1413 | 1380 | 60 |

# TABLE 74

## PROPORTIONAL LOGARITHMS

| Sec. | 2° 11′ | 2° 12′ | 2° 13′ | 2° 14′ | 2° 15′ | 2° 16′ | 2° 17′ | 2° 18′ | 2° 19′ | 2° 20′ | 2° 21′ | 2° 22′ | Sec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1380 | 1347 | 1314 | 1282 | 1249 | 1217 | 1186 | 1154 | 1123 | 1091 | 1061 | 1030 | 0 |
| 1 | 1379 | 1346 | 1314 | 1281 | 1249 | 1217 | 1185 | 1153 | 1122 | 1091 | 1060 | 1029 | 1 |
| 2 | 1379 | 1346 | 1313 | 1281 | 1248 | 1216 | 1184 | 1153 | 1121 | 1090 | 1059 | 1029 | 2 |
| 3 | 1378 | 1345 | 1313 | 1280 | 1248 | 1216 | 1184 | 1152 | 1121 | 1090 | 1059 | 1028 | 3 |
| 4 | 1378 | 1345 | 1312 | 1279 | 1247 | 1215 | 1183 | 1152 | 1120 | 1089 | 1058 | 1028 | 4 |
| 5 | 1377 | 1344 | 1311 | 1279 | 1247 | 1215 | 1183 | 1151 | 1120 | 1089 | 1058 | 1027 | 5 |
| 6 | 1377 | 1344 | 1311 | 1278 | 1246 | 1214 | 1182 | 1151 | 1119 | 1088 | 1057 | 1027 | 6 |
| 7 | 1376 | 1343 | 1310 | 1278 | 1246 | 1214 | 1182 | 1150 | 1119 | 1088 | 1057 | 1026 | 7 |
| 8 | 1376 | 1343 | 1310 | 1277 | 1245 | 1213 | 1181 | 1150 | 1118 | 1087 | 1056 | 1026 | 8 |
| 9 | 1375 | 1342 | 1309 | 1277 | 1245 | 1213 | 1181 | 1149 | 1118 | 1087 | 1056 | 1025 | 9 |
| 10 | 1374 | 1341 | 1309 | 1276 | 1244 | 1212 | 1180 | 1149 | 1117 | 1086 | 1055 | 1025 | 10 |
| 11 | 1374 | 1341 | 1308 | 1276 | 1243 | 1211 | 1180 | 1148 | 1117 | 1086 | 1055 | 1024 | 11 |
| 12 | 1373 | 1340 | 1308 | 1275 | 1243 | 1211 | 1179 | 1148 | 1116 | 1085 | 1054 | 1024 | 12 |
| 13 | 1373 | 1340 | 1307 | 1275 | 1242 | 1210 | 1179 | 1147 | 1116 | 1085 | 1054 | 1023 | 13 |
| 14 | 1372 | 1339 | 1307 | 1274 | 1242 | 1210 | 1178 | 1147 | 1115 | 1084 | 1053 | 1023 | 14 |
| 15 | 1372 | 1339 | 1306 | 1274 | 1241 | 1209 | 1178 | 1146 | 1115 | 1084 | 1053 | 1022 | 15 |
| 16 | 1371 | 1338 | 1305 | 1273 | 1241 | 1209 | 1177 | 1146 | 1114 | 1083 | 1052 | 1022 | 16 |
| 17 | 1371 | 1338 | 1305 | 1272 | 1240 | 1208 | 1177 | 1145 | 1114 | 1083 | 1052 | 1021 | 17 |
| 18 | 1370 | 1337 | 1304 | 1272 | 1240 | 1208 | 1176 | 1145 | 1113 | 1082 | 1051 | 1021 | 18 |
| 19 | 1369 | 1337 | 1304 | 1271 | 1239 | 1207 | 1175 | 1144 | 1113 | 1082 | 1051 | 1020 | 19 |
| 20 | 1369 | 1336 | 1303 | 1271 | 1239 | 1207 | 1175 | 1143 | 1112 | 1081 | 1050 | 1020 | 20 |
| 21 | 1368 | 1335 | 1303 | 1270 | 1238 | 1206 | 1174 | 1143 | 1112 | 1081 | 1050 | 1019 | 21 |
| 22 | 1368 | 1335 | 1302 | 1270 | 1238 | 1206 | 1174 | 1142 | 1111 | 1080 | 1049 | 1019 | 22 |
| 23 | 1367 | 1334 | 1302 | 1269 | 1237 | 1205 | 1173 | 1142 | 1111 | 1080 | 1049 | 1018 | 23 |
| 24 | 1367 | 1334 | 1301 | 1269 | 1237 | 1205 | 1173 | 1141 | 1110 | 1079 | 1048 | 1018 | 24 |
| 25 | 1366 | 1333 | 1301 | 1268 | 1236 | 1204 | 1172 | 1141 | 1110 | 1079 | 1048 | 1017 | 25 |
| 26 | 1366 | 1333 | 1300 | 1268 | 1235 | 1203 | 1172 | 1140 | 1109 | 1078 | 1047 | 1017 | 26 |
| 27 | 1365 | 1332 | 1300 | 1267 | 1235 | 1203 | 1171 | 1140 | 1109 | 1078 | 1047 | 1016 | 27 |
| 28 | 1365 | 1332 | 1299 | 1267 | 1234 | 1202 | 1171 | 1139 | 1108 | 1077 | 1046 | 1016 | 28 |
| 29 | 1364 | 1331 | 1298 | 1266 | 1234 | 1202 | 1170 | 1139 | 1107 | 1076 | 1046 | 1015 | 29 |
| 30 | 1363 | 1331 | 1298 | 1266 | 1233 | 1201 | 1170 | 1138 | 1107 | 1076 | 1045 | 1015 | 30 |
| 31 | 1363 | 1330 | 1297 | 1265 | 1233 | 1201 | 1169 | 1138 | 1106 | 1075 | 1045 | 1014 | 31 |
| 32 | 1362 | 1329 | 1297 | 1264 | 1232 | 1200 | 1169 | 1137 | 1106 | 1075 | 1044 | 1014 | 32 |
| 33 | 1362 | 1329 | 1296 | 1264 | 1232 | 1200 | 1168 | 1137 | 1105 | 1074 | 1044 | 1013 | 33 |
| 34 | 1361 | 1328 | 1296 | 1263 | 1231 | 1199 | 1168 | 1136 | 1105 | 1074 | 1043 | 1013 | 34 |
| 35 | 1361 | 1328 | 1295 | 1263 | 1231 | 1199 | 1167 | 1136 | 1104 | 1073 | 1043 | 1012 | 35 |
| 36 | 1360 | 1327 | 1295 | 1262 | 1230 | 1198 | 1167 | 1135 | 1104 | 1073 | 1042 | 1012 | 36 |
| 37 | 1360 | 1327 | 1294 | 1262 | 1230 | 1198 | 1166 | 1135 | 1103 | 1072 | 1042 | 1011 | 37 |
| 38 | 1359 | 1326 | 1294 | 1261 | 1229 | 1197 | 1165 | 1134 | 1103 | 1072 | 1041 | 1010 | 38 |
| 39 | 1359 | 1326 | 1293 | 1261 | 1229 | 1197 | 1165 | 1134 | 1102 | 1071 | 1041 | 1010 | 39 |
| 40 | 1358 | 1325 | 1292 | 1260 | 1228 | 1196 | 1164 | 1133 | 1102 | 1071 | 1040 | 1009 | 40 |
| 41 | 1357 | 1325 | 1292 | 1260 | 1227 | 1196 | 1164 | 1132 | 1101 | 1070 | 1039 | 1009 | 41 |
| 42 | 1357 | 1324 | 1291 | 1259 | 1227 | 1195 | 1163 | 1132 | 1101 | 1070 | 1039 | 1008 | 42 |
| 43 | 1356 | 1323 | 1291 | 1258 | 1226 | 1194 | 1163 | 1131 | 1100 | 1069 | 1038 | 1008 | 43 |
| 44 | 1356 | 1323 | 1290 | 1258 | 1226 | 1194 | 1162 | 1131 | 1100 | 1069 | 1038 | 1007 | 44 |
| 45 | 1355 | 1322 | 1290 | 1257 | 1225 | 1193 | 1162 | 1130 | 1099 | 1068 | 1037 | 1007 | 45 |
| 46 | 1355 | 1322 | 1289 | 1257 | 1225 | 1193 | 1161 | 1130 | 1099 | 1068 | 1037 | 1006 | 46 |
| 47 | 1354 | 1321 | 1289 | 1256 | 1224 | 1192 | 1161 | 1129 | 1098 | 1067 | 1036 | 1006 | 47 |
| 48 | 1354 | 1321 | 1288 | 1256 | 1224 | 1192 | 1160 | 1129 | 1098 | 1067 | 1036 | 1005 | 48 |
| 49 | 1353 | 1320 | 1288 | 1255 | 1223 | 1191 | 1160 | 1128 | 1097 | 1066 | 1035 | 1005 | 49 |
| 50 | 1352 | 1320 | 1287 | 1255 | 1223 | 1191 | 1159 | 1128 | 1097 | 1066 | 1035 | 1004 | 50 |
| 51 | 1352 | 1319 | 1287 | 1254 | 1222 | 1190 | 1159 | 1127 | 1096 | 1065 | 1034 | 1004 | 51 |
| 52 | 1351 | 1319 | 1286 | 1254 | 1222 | 1190 | 1158 | 1127 | 1096 | 1065 | 1034 | 1003 | 52 |
| 53 | 1351 | 1318 | 1285 | 1253 | 1221 | 1189 | 1158 | 1126 | 1095 | 1064 | 1033 | 1003 | 53 |
| 54 | 1350 | 1317 | 1285 | 1253 | 1221 | 1189 | 1157 | 1126 | 1095 | 1064 | 1033 | 1002 | 54 |
| 55 | 1350 | 1317 | 1284 | 1252 | 1220 | 1188 | 1157 | 1125 | 1094 | 1063 | 1032 | 1002 | 55 |
| 56 | 1349 | 1316 | 1284 | 1251 | 1219 | 1188 | 1156 | 1125 | 1093 | 1063 | 1032 | 1001 | 56 |
| 57 | 1349 | 1316 | 1283 | 1251 | 1219 | 1187 | 1156 | 1124 | 1093 | 1062 | 1031 | 1001 | 57 |
| 58 | 1348 | 1315 | 1283 | 1250 | 1218 | 1187 | 1155 | 1124 | 1092 | 1062 | 1031 | 1000 | 58 |
| 59 | 1347 | 1315 | 1282 | 1250 | 1218 | 1186 | 1154 | 1123 | 1092 | 1061 | 1030 | 1000 | 59 |
| 60 | 1347 | 1314 | 1282 | 1249 | 1217 | 1186 | 1154 | 1123 | 1091 | 1061 | 1030 | 0999 | 60 |

## PROPORTIONAL LOGARITHMS

| sec. ″ | h m 2° 23′ | h m 2° 24′ | h m 2° 25′ | h m 2° 26′ | h m 2° 27′ | h m 2° 28′ | h m 2° 29′ | h m 2° 30′ | h m 2° 31′ | h m 2° 32′ | h m 2° 33′ | h m 2° 34′ | sec. ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0999 | 0969 | 0939 | 0909 | 0880 | 0850 | 0821 | 0792 | 0763 | 0734 | 0706 | 0678 | 0 |
| 1 | 0999 | 0969 | 0939 | 0909 | 0879 | 0850 | 0820 | 0791 | 0762 | 0734 | 0705 | 0677 | 1 |
| 2 | 0998 | 0968 | 0938 | 0908 | 0879 | 0849 | 0820 | 0791 | 0762 | 0733 | 0705 | 0677 | 2 |
| 3 | 0998 | 0968 | 0938 | 0908 | 0878 | 0849 | 0819 | 0790 | 0762 | 0733 | 0704 | 0676 | 3 |
| 4 | 0997 | 0967 | 0937 | 0907 | 0878 | 0848 | 0819 | 0790 | 0761 | 0732 | 0704 | 0676 | 4 |
| 5 | 0997 | 0967 | 0937 | 0907 | 0877 | 0848 | 0818 | 0789 | 0761 | 0732 | 0703 | 0675 | 5 |
| 6 | 0996 | 0966 | 0936 | 0906 | 0877 | 0847 | 0818 | 0789 | 0760 | 0731 | 0703 | 0675 | 6 |
| 7 | 0996 | 0966 | 0936 | 0906 | 0876 | 0847 | 0817 | 0788 | 0760 | 0731 | 0702 | 0674 | 7 |
| 8 | 0995 | 0965 | 0935 | 0905 | 0876 | 0846 | 0817 | 0788 | 0759 | 0730 | 0702 | 0674 | 8 |
| 9 | 0995 | 0965 | 0935 | 0905 | 0875 | 0846 | 0816 | 0787 | 0759 | 0730 | 0702 | 0673 | 9 |
| 10 | 0994 | 0964 | 0934 | 0904 | 0875 | 0845 | 0816 | 0787 | 0758 | 0729 | 0701 | 0673 | 10 |
| 11 | 0994 | 0964 | 0934 | 0904 | 0874 | 0845 | 0815 | 0787 | 0758 | 0729 | 0701 | 0672 | 11 |
| 12 | 0993 | 0963 | 0933 | 0903 | 0874 | 0844 | 0815 | 0786 | 0757 | 0729 | 0700 | 0672 | 12 |
| 13 | 0993 | 0963 | 0933 | 0903 | 0873 | 0844 | 0815 | 0786 | 0757 | 0728 | 0700 | 0671 | 13 |
| 14 | 0992 | 0962 | 0932 | 0902 | 0873 | 0843 | 0814 | 0785 | 0756 | 0728 | 0699 | 0671 | 14 |
| 15 | 0992 | 0962 | 0932 | 0902 | 0872 | 0843 | 0814 | 0785 | 0756 | 0727 | 0699 | 0670 | 15 |
| 16 | 0991 | 0961 | 0931 | 0901 | 0872 | 0842 | 0813 | 0784 | 0755 | 0727 | 0698 | 0670 | 16 |
| 17 | 0991 | 0961 | 0931 | 0901 | 0871 | 0842 | 0813 | 0784 | 0755 | 0726 | 0698 | 0669 | 17 |
| 18 | 0990 | 0960 | 0930 | 0900 | 0871 | 0841 | 0812 | 0783 | 0754 | 0726 | 0697 | 0669 | 18 |
| 19 | 0990 | 0960 | 0930 | 0900 | 0870 | 0841 | 0812 | 0783 | 0754 | 0725 | 0697 | 0669 | 19 |
| 20 | 0989 | 0959 | 0929 | 0899 | 0870 | 0840 | 0811 | 0782 | 0753 | 0725 | 0696 | 0668 | 20 |
| 21 | 0989 | 0959 | 0929 | 0899 | 0869 | 0840 | 0811 | 0782 | 0753 | 0724 | 0696 | 0668 | 21 |
| 22 | 0988 | 0958 | 0928 | 0898 | 0869 | 0839 | 0810 | 0781 | 0752 | 0724 | 0695 | 0667 | 22 |
| 23 | 0988 | 0958 | 0928 | 0898 | 0868 | 0839 | 0810 | 0781 | 0752 | 0723 | 0695 | 0667 | 23 |
| 24 | 0987 | 0957 | 0927 | 0897 | 0868 | 0838 | 0809 | 0780 | 0751 | 0723 | 0694 | 0666 | 24 |
| 25 | 0987 | 0957 | 0927 | 0897 | 0867 | 0838 | 0809 | 0780 | 0751 | 0722 | 0694 | 0666 | 25 |
| 26 | 0986 | 0956 | 0926 | 0896 | 0867 | 0837 | 0808 | 0779 | 0750 | 0722 | 0693 | 0665 | 26 |
| 27 | 0986 | 0956 | 0926 | 0896 | 0866 | 0837 | 0808 | 0779 | 0750 | 0721 | 0693 | 0665 | 27 |
| 28 | 0985 | 0955 | 0925 | 0895 | 0866 | 0836 | 0807 | 0778 | 0750 | 0721 | 0693 | 0664 | 28 |
| 29 | 0985 | 0955 | 0925 | 0895 | 0865 | 0836 | 0807 | 0778 | 0749 | 0720 | 0692 | 0664 | 29 |
| 30 | 0984 | 0954 | 0924 | 0894 | 0865 | 0835 | 0806 | 0777 | 0749 | 0720 | 0692 | 0663 | 30 |
| 31 | 0984 | 0954 | 0924 | 0894 | 0864 | 0835 | 0806 | 0777 | 0748 | 0720 | 0691 | 0663 | 31 |
| 32 | 0983 | 0953 | 0923 | 0893 | 0864 | 0834 | 0805 | 0776 | 0748 | 0719 | 0691 | 0662 | 32 |
| 33 | 0983 | 0953 | 0923 | 0893 | 0863 | 0834 | 0805 | 0776 | 0747 | 0719 | 0690 | 0662 | 33 |
| 34 | 0982 | 0952 | 0922 | 0892 | 0863 | 0833 | 0804 | 0775 | 0747 | 0718 | 0690 | 0662 | 34 |
| 35 | 0982 | 0952 | 0922 | 0892 | 0862 | 0833 | 0804 | 0775 | 0746 | 0718 | 0689 | 0661 | 35 |
| 36 | 0981 | 0951 | 0921 | 0891 | 0862 | 0833 | 0803 | 0774 | 0746 | 0717 | 0689 | 0661 | 36 |
| 37 | 0981 | 0951 | 0921 | 0891 | 0861 | 0832 | 0803 | 0774 | 0745 | 0717 | 0688 | 0660 | 37 |
| 38 | 0980 | 0950 | 0920 | 0890 | 0861 | 0832 | 0802 | 0773 | 0745 | 0716 | 0688 | 0660 | 38 |
| 39 | 0980 | 0950 | 0920 | 0890 | 0860 | 0831 | 0802 | 0773 | 0744 | 0716 | 0687 | 0659 | 39 |
| 40 | 0979 | 0949 | 0919 | 0889 | 0860 | 0831 | 0801 | 0773 | 0744 | 0715 | 0687 | 0659 | 40 |
| 41 | 0979 | 0949 | 0919 | 0889 | 0859 | 0830 | 0801 | 0772 | 0743 | 0715 | 0686 | 0658 | 41 |
| 42 | 0978 | 0948 | 0918 | 0888 | 0859 | 0830 | 0801 | 0772 | 0743 | 0714 | 0686 | 0658 | 42 |
| 43 | 0978 | 0948 | 0918 | 0888 | 0858 | 0829 | 0800 | 0771 | 0742 | 0714 | 0685 | 0657 | 43 |
| 44 | 0977 | 0947 | 0917 | 0887 | 0858 | 0829 | 0800 | 0771 | 0742 | 0713 | 0685 | 0657 | 44 |
| 45 | 0977 | 0947 | 0917 | 0887 | 0857 | 0828 | 0799 | 0770 | 0741 | 0713 | 0685 | 0656 | 45 |
| 46 | 0976 | 0946 | 0916 | 0886 | 0857 | 0828 | 0799 | 0770 | 0741 | 0712 | 0684 | 0656 | 46 |
| 47 | 0976 | 0946 | 0916 | 0886 | 0856 | 0827 | 0798 | 0769 | 0740 | 0712 | 0684 | 0655 | 47 |
| 48 | 0975 | 0945 | 0915 | 0885 | 0856 | 0827 | 0798 | 0769 | 0740 | 0711 | 0683 | 0655 | 48 |
| 49 | 0975 | 0945 | 0915 | 0885 | 0855 | 0826 | 0797 | 0768 | 0739 | 0711 | 0683 | 0655 | 49 |
| 50 | 0974 | 0944 | 0914 | 0884 | 0855 | 0826 | 0797 | 0768 | 0739 | 0711 | 0682 | 0654 | 50 |
| 51 | 0974 | 0944 | 0914 | 0884 | 0855 | 0825 | 0796 | 0767 | 0739 | 0710 | 0682 | 0654 | 51 |
| 52 | 0973 | 0943 | 0913 | 0883 | 0854 | 0825 | 0796 | 0767 | 0738 | 0710 | 0681 | 0653 | 52 |
| 53 | 0973 | 0943 | 0913 | 0883 | 0854 | 0824 | 0795 | 0766 | 0738 | 0709 | 0681 | 0653 | 53 |
| 54 | 0972 | 0942 | 0912 | 0882 | 0853 | 0824 | 0795 | 0766 | 0737 | 0709 | 0680 | 0652 | 54 |
| 55 | 0972 | 0942 | 0912 | 0882 | 0853 | 0823 | 0794 | 0765 | 0737 | [illegible] | 0680 | 0652 | 55 |
| 56 | 0971 | 0941 | 0911 | 0881 | 0852 | 0823 | 0794 | 0765 | 0736 | 0708 | 0679 | 0651 | 56 |
| 57 | 0971 | 0941 | 0911 | 0881 | 0852 | 0822 | 0793 | 0764 | 0736 | 0707 | 0679 | 0651 | 57 |
| 58 | 0970 | 0940 | 0910 | 0880 | 0851 | 0822 | 0793 | 0764 | 0735 | 0707 | 0678 | 0650 | 58 |
| 59 | 0970 | 0940 | 0910 | 0880 | 0851 | 0821 | 0792 | 0763 | 0735 | 0706 | 0678 | 0650 | 59 |
| 60 | 0969 | 0939 | 0909 | 0880 | 0850 | 0821 | 0792 | 0763 | 0734 | 0706 | 0678 | 0649 | 60 |

PROPORTIONAL LOGARITHMS

| sec. ″ | 2h 35m | 2h 36m | 2h 37m | 2h 38m | 2h 39m | 2h 40m | 2h 41m | 2h 42m | 2h 43m | 2h 44m | 2h 45m | 2h 46m | sec ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0649 | 0621 | 0594 | 0566 | 0539 | 0512 | 0484 | 0458 | 0431 | 0404 | 0378 | 0352 | 0 |
| 1 | 0649 | 0621 | 0593 | 0566 | 0538 | 0511 | 0484 | 0457 | 0430 | 0404 | 0377 | 0351 | 1 |
| 2 | 0648 | 0621 | 0593 | 0565 | 0538 | 0511 | 0484 | 0457 | 0430 | 0403 | 0377 | 0351 | 2 |
| 3 | 0648 | 0620 | 0592 | 0565 | 0537 | 0510 | 0483 | 0456 | 0430 | 0403 | 0377 | 0350 | 3 |
| 4 | 0648 | 0620 | 0592 | 0564 | 0537 | 0510 | 0483 | 0456 | 0429 | 0402 | 0376 | 0350 | 4 |
| 5 | 0647 | 0619 | 0591 | 0564 | 0536 | 0509 | 0482 | 0455 | 0429 | 0402 | 0376 | 0349 | 5 |
| 6 | 0647 | 0619 | 0591 | 0563 | 0536 | 0509 | 0482 | 0455 | 0428 | 0402 | 0375 | 0349 | 6 |
| 7 | 0646 | 0618 | 0590 | 0563 | 0536 | 0508 | 0481 | 0454 | 0428 | 0401 | 0375 | 0349 | 7 |
| 8 | 0646 | 0618 | 0590 | 0562 | 0535 | 0508 | 0481 | 0454 | 0427 | 0401 | 0374 | 0348 | 8 |
| 9 | 0645 | 0617 | 0590 | 0562 | 0535 | 0507 | 0480 | 0454 | 0427 | 0400 | 0374 | 0348 | 9 |
| 10 | 0645 | 0617 | 0589 | 0562 | 0534 | 0507 | 0480 | 0453 | 0426 | 0400 | 0373 | 0347 | 10 |
| 11 | 0644 | 0616 | 0589 | 0561 | 0534 | 0507 | 0479 | 0453 | 0426 | 0399 | 0373 | 0347 | 11 |
| 12 | 0644 | 0616 | 0588 | 0561 | 0533 | 0506 | 0479 | 0452 | 0426 | 0399 | 0373 | 0346 | 12 |
| 13 | 0643 | 0615 | 0588 | 0560 | 0533 | 0506 | 0479 | 0452 | 0425 | 0399 | 0372 | 0346 | 13 |
| 14 | 0643 | 0615 | 0587 | 0560 | 0532 | 0505 | 0478 | 0451 | 0425 | 0398 | 0372 | 0346 | 14 |
| 15 | 0642 | 0615 | 0587 | 0559 | 0532 | 0505 | 0478 | 0451 | 0424 | 0398 | 0371 | 0345 | 15 |
| 16 | 0642 | 0614 | 0586 | 0559 | 0531 | 0504 | 0477 | 0450 | 0424 | 0397 | 0371 | 0345 | 16 |
| 17 | 0641 | 0614 | 0586 | 0558 | 0531 | 0504 | 0477 | 0450 | 0423 | 0397 | 0370 | 0344 | 17 |
| 18 | 0641 | 0613 | 0585 | 0558 | 0531 | 0503 | 0476 | 0450 | 0423 | 0396 | 0370 | 0344 | 18 |
| 19 | 0641 | 0613 | 0585 | 0557 | 0530 | 0503 | 0476 | 0449 | 0422 | 0396 | 0370 | 0343 | 19 |
| 20 | 0640 | 0612 | 0584 | 0557 | 0530 | 0502 | 0475 | 0449 | 0422 | 0395 | 0369 | 0343 | 20 |
| 21 | 0640 | 0612 | 0584 | 0557 | 0529 | 0502 | 0475 | 0448 | 0422 | 0395 | 0369 | 0342 | 21 |
| 22 | 0639 | 0611 | 0584 | 0556 | 0529 | 0502 | 0475 | 0448 | 0421 | 0395 | 0368 | 0342 | 22 |
| 23 | 0639 | 0611 | 0583 | 0556 | 0528 | 0501 | 0474 | 0447 | 0421 | 0394 | 0368 | 0342 | 23 |
| 24 | 0638 | 0610 | 0583 | 0555 | 0528 | 0501 | 0474 | 0447 | 0420 | 0394 | 0367 | 0341 | 24 |
| 25 | 0638 | 0610 | 0582 | 0555 | 0527 | 0500 | 0473 | 0446 | 0420 | 0393 | 0367 | 0341 | 25 |
| 26 | 0637 | 0609 | 0582 | 0554 | 0527 | 0500 | 0473 | 0446 | 0419 | 0393 | 0366 | 0340 | 26 |
| 27 | 0637 | 0609 | 0581 | 0554 | 0526 | 0499 | 0472 | 0446 | 0419 | 0392 | 0366 | 0340 | 27 |
| 28 | 0636 | 0608 | 0581 | 0553 | 0526 | 0499 | 0472 | 0445 | 0418 | 0392 | 0366 | 0339 | 28 |
| 29 | 0636 | 0608 | 0580 | 0553 | 0526 | 0498 | 0471 | 0445 | 0418 | 0391 | 0365 | 0339 | 29 |
| 30 | 0635 | 0608 | 0580 | 0552 | 0525 | 0498 | 0471 | 0444 | 0418 | 0391 | 0365 | 0339 | 30 |
| 31 | 0635 | 0607 | 0579 | 0552 | 0525 | 0497 | 0471 | 0444 | 0417 | 0391 | 0364 | 0338 | 31 |
| 32 | 0634 | 0607 | 0579 | 0551 | 0524 | 0497 | 0470 | 0443 | 0417 | 0390 | 0364 | 0338 | 32 |
| 33 | 0634 | 0606 | 0579 | 0551 | 0524 | 0497 | 0470 | 0443 | 0416 | 0390 | 0363 | 0337 | 33 |
| 34 | 0634 | 0606 | 0578 | 0551 | 0523 | 0496 | 0469 | 0442 | 0416 | 0389 | 0363 | 0337 | 34 |
| 35 | 0633 | 0605 | 0578 | 0550 | 0523 | 0496 | 0469 | 0442 | 0415 | 0389 | 0363 | 0336 | 35 |
| 36 | 0633 | 0605 | 0577 | 0550 | 0522 | 0495 | 0468 | 0442 | 0415 | 0388 | 0362 | 0336 | 36 |
| 37 | 0632 | 0604 | 0577 | 0549 | 0522 | 0495 | 0468 | 0441 | 0414 | 0388 | 0362 | 0336 | 37 |
| 38 | 0632 | 0604 | 0576 | 0549 | 0521 | 0494 | 0467 | 0441 | 0414 | 0388 | 0361 | 0335 | 38 |
| 39 | 0631 | 0603 | 0576 | 0548 | 0521 | 0494 | 0467 | 0440 | 0414 | 0387 | 0361 | 0335 | 39 |
| 40 | 0631 | 0603 | 0575 | 0548 | 0521 | 0493 | 0466 | 0440 | 0413 | 0387 | 0360 | 0334 | 40 |
| 41 | 0630 | 0602 | 0575 | 0547 | 0520 | 0493 | 0466 | 0439 | 0413 | 0386 | 0360 | 0334 | 41 |
| 42 | 0630 | 0602 | 0574 | 0547 | 0520 | 0493 | 0466 | 0439 | 0412 | 0386 | 0359 | 0333 | 42 |
| 43 | 0629 | 0602 | 0574 | 0546 | 0519 | 0492 | 0465 | 0438 | 0412 | 0385 | 0359 | 0333 | 43 |
| 44 | 0629 | 0601 | 0573 | 0546 | 0519 | 0492 | 0465 | 0438 | 0411 | 0385 | 0359 | 0332 | 44 |
| 45 | 0628 | 0601 | 0573 | 0546 | 0518 | 0491 | 0464 | 0438 | 0411 | 0384 | 0358 | 0332 | 45 |
| 46 | 0628 | 0600 | 0573 | 0545 | 0518 | 0491 | 0464 | 0437 | 0410 | 0384 | 0358 | 0332 | 46 |
| 47 | 0627 | 0600 | 0572 | 0545 | 0517 | 0490 | 0463 | 0437 | 0410 | 0384 | 0357 | 0331 | 47 |
| 48 | 0627 | 0599 | 0572 | 0544 | 0517 | 0490 | 0463 | 0436 | 0410 | 0383 | 0357 | 0331 | 48 |
| 49 | 0627 | 0599 | 0571 | 0544 | 0516 | 0489 | 0462 | 0436 | 0409 | 0383 | 0356 | 0330 | 49 |
| 50 | 0626 | 0598 | 0571 | 0543 | 0516 | 0489 | 0462 | 0435 | 0409 | 0382 | 0356 | 0330 | 50 |
| 51 | 0626 | 0598 | 0570 | 0543 | 0516 | 0489 | 0462 | 0435 | 0408 | 0382 | 0356 | 0329 | 51 |
| 52 | 0625 | 0597 | 0570 | 0542 | 0515 | 0488 | 0461 | 0434 | 0408 | 0381 | 0355 | 0329 | 52 |
| 53 | 0625 | 0597 | 0569 | 0542 | 0515 | 0488 | 0461 | 0434 | 0407 | 0381 | 0355 | 0329 | 53 |
| 54 | 0624 | 0596 | 0569 | 0541 | 0514 | 0487 | 0460 | 0434 | 0407 | 0381 | 0354 | 0328 | 54 |
| 55 | 0624 | 0596 | 0568 | 0541 | 0514 | 0487 | 0460 | 0433 | 0406 | 0380 | 0354 | 0328 | 55 |
| 56 | 0623 | 0596 | 0568 | 0541 | 0513 | 0486 | 0459 | 0433 | 0406 | 0380 | 0353 | 0327 | 56 |
| 57 | 0623 | 0595 | 0568 | 0540 | 0513 | 0486 | 0459 | 0432 | 0406 | 0379 | 0353 | 0327 | 57 |
| 58 | 0622 | 0595 | 0567 | 0540 | 0512 | 0485 | 0458 | 0432 | 0405 | 0379 | 0352 | 0326 | 58 |
| 59 | 0622 | 0594 | 0567 | 0539 | 0512 | 0485 | 0458 | 0431 | 0405 | 0378 | 0352 | 0326 | 59 |
| 60 | 0621 | 0594 | 0566 | 0539 | 0512 | 0484 | 0458 | 0431 | 0404 | 0378 | 0352 | 0320 | 60 |

## PROPORTIONAL LOGARITHMS

| sec. ″ | 2h 47m | 2h 48m | 2h 49m | 2h 50m | 2h 51m | 2h 52m | 2h 53m | 2h 54m | 2h 55m | 2h 56m | 2h 57m | 2h 58m | 2h 59m | sec. ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0326 | 0300 | 0274 | 0248 | 0223 | 0197 | 0172 | 0147 | 0122 | 0098 | 0073 | 0049 | 0024 | 0 |
| 1 | 0325 | 0299 | 0273 | 0248 | 0222 | 0197 | 0172 | 0147 | 0122 | 0097 | 0073 | 0048 | 0024 | 1 |
| 2 | 0325 | 0299 | 0273 | 0247 | 0222 | 0197 | 0171 | 0146 | 0121 | 0097 | 0072 | 0048 | 0023 | 2 |
| 3 | 0324 | 0298 | 0273 | 0247 | 0221 | 0196 | 0171 | 0146 | 0121 | 0096 | 0072 | 0047 | 0023 | 3 |
| 4 | 0324 | 0298 | 0272 | 0246 | 0221 | 0196 | 0171 | 0146 | 0121 | 0096 | 0071 | 0047 | 0023 | 4 |
| 5 | 0323 | 0297 | 0272 | 0246 | 0221 | 0195 | 0170 | 0145 | 0120 | 0096 | 0071 | 0046 | 0022 | 5 |
| 6 | 0323 | 0297 | 0271 | 0246 | 0220 | 0195 | 0170 | 0145 | 0120 | 0095 | 0071 | 0046 | 0022 | 6 |
| 7 | 0322 | 0297 | 0271 | 0245 | 0220 | 0194 | 0169 | 0144 | 0119 | 0095 | 0070 | 0046 | 0021 | 7 |
| 8 | 0322 | 0296 | 0270 | 0245 | 0219 | 0194 | 0169 | 0144 | 0119 | 0094 | 0070 | 0045 | 0021 | 8 |
| 9 | 0322 | 0296 | 0270 | 0244 | 0219 | 0194 | 0169 | 0143 | 0119 | 0094 | 0069 | 0045 | 0021 | 9 |
| 10 | 0321 | 0295 | 0270 | 0244 | 0218 | 0193 | 0168 | 0143 | 0118 | 0093 | 0069 | 0044 | 0020 | 10 |
| 11 | 0321 | 0295 | 0269 | 0244 | 0218 | 0193 | 0168 | 0143 | 0118 | 0093 | 0068 | 0044 | 0020 | 11 |
| 12 | 0320 | 0294 | 0269 | 0243 | 0218 | 0192 | 0167 | 0142 | 0117 | 0093 | 0068 | 0044 | 0019 | 12 |
| 13 | 0320 | 0294 | 0268 | 0243 | 0217 | 0192 | 0167 | 0142 | 0117 | 0092 | 0068 | 0043 | 0019 | 13 |
| 14 | 0319 | 0294 | 0268 | 0242 | 0217 | 0192 | 0166 | 0141 | 0117 | 0092 | 0067 | 0043 | 0018 | 14 |
| 15 | 0319 | 0293 | 0267 | 0242 | 0216 | 0191 | 0166 | 0141 | 0116 | 0091 | 0067 | 0042 | 0018 | 15 |
| 16 | 0319 | 0293 | 0267 | 0241 | 0216 | 0191 | 0166 | 0141 | 0116 | 0091 | 0066 | 0042 | 0018 | 16 |
| 17 | 0318 | 0292 | 0267 | 0241 | 0216 | 0190 | 0165 | 0140 | 0115 | 0091 | 0066 | 0042 | 0017 | 17 |
| 18 | 0318 | 0292 | 0266 | 0241 | 0215 | 0190 | 0165 | 0140 | 0115 | 0090 | 0066 | 0041 | 0017 | 18 |
| 19 | 0317 | 0291 | 0266 | 0240 | 0215 | 0189 | 0164 | 0139 | 0114 | 0090 | 0065 | 0041 | 0016 | 19 |
| 20 | 0317 | 0291 | 0265 | 0240 | 0214 | 0189 | 0164 | 0139 | 0114 | 0089 | 0065 | 0040 | 0016 | 20 |
| 21 | 0316 | 0291 | 0265 | 0239 | 0214 | 0189 | 0163 | 0139 | 0114 | 0089 | 0064 | 0040 | 0016 | 21 |
| 22 | 0316 | 0290 | 0264 | 0239 | 0213 | 0188 | 0163 | 0138 | 0113 | 0089 | 0064 | 0040 | 0015 | 22 |
| 23 | 0316 | 0290 | 0264 | 0238 | 0213 | 0188 | 0163 | 0138 | 0113 | 0088 | 0064 | 0039 | 0015 | 23 |
| 24 | 0315 | 0289 | 0264 | 0238 | 0213 | 0187 | 0162 | 0137 | 0112 | 0088 | 0063 | 0039 | 0015 | 24 |
| 25 | 0315 | 0289 | 0263 | 0238 | 0212 | 0187 | 0162 | 0137 | 0112 | 0087 | 0063 | 0038 | 0014 | 25 |
| 26 | 0314 | 0288 | 0263 | 0237 | 0212 | 0186 | 0161 | 0136 | 0112 | 0087 | 0062 | 0038 | 0014 | 26 |
| 27 | 0314 | 0288 | 0262 | 0237 | 0211 | 0186 | 0161 | 0136 | 0111 | 0087 | 0062 | 0038 | 0013 | 27 |
| 28 | 0313 | 0288 | 0262 | 0236 | 0211 | 0186 | 0161 | 0136 | 0111 | 0086 | 0062 | 0037 | 0013 | 28 |
| 29 | 0313 | 0287 | 0261 | 0236 | 0210 | 0185 | 0160 | 0135 | 0110 | 0086 | 0061 | 0037 | 0012 | 29 |
| 30 | 0313 | 0287 | 0261 | 0235 | 0210 | 0185 | 0160 | 0135 | 0110 | 0085 | 0061 | 0036 | 0012 | 30 |
| 31 | 0312 | 0286 | 0261 | 0235 | 0210 | 0184 | 0159 | 0134 | 0110 | 0085 | 0060 | 0036 | 0012 | 31 |
| 32 | 0312 | 0286 | 0260 | 0235 | 0209 | 0184 | 0159 | 0134 | 0109 | 0084 | 0060 | 0035 | 0011 | 32 |
| 33 | 0311 | 0285 | 0260 | 0234 | 0209 | 0184 | 0158 | 0134 | 0109 | 0084 | 0060 | 0035 | 0011 | 33 |
| 34 | 0311 | 0285 | 0259 | 0234 | 0208 | 0183 | 0158 | 0133 | 0108 | 0084 | 0059 | 0035 | 0010 | 34 |
| 35 | 0310 | 0285 | 0259 | 0233 | 0208 | 0183 | 0158 | 0133 | 0108 | 0083 | 0059 | 0034 | 0010 | 35 |
| 36 | 0310 | 0284 | 0258 | 0233 | 0208 | 0182 | 0157 | 0132 | 0107 | 0083 | 0058 | 0034 | 0010 | 36 |
| 37 | 0310 | 0284 | 0258 | 0232 | 0207 | 0182 | 0157 | 0132 | 0107 | 0082 | 0058 | 0033 | 0009 | 37 |
| 38 | 0309 | 0283 | 0258 | 0232 | 0207 | 0181 | 0156 | 0131 | 0107 | 0082 | 0057 | 0033 | 0009 | 38 |
| 39 | 0309 | 0283 | 0257 | 0232 | 0206 | 0181 | 0156 | 0131 | 0106 | 0082 | 0057 | 0033 | 0008 | 39 |
| 40 | 0308 | 0282 | 0257 | 0231 | 0206 | 0181 | 0156 | 0131 | 0106 | 0081 | 0057 | 0032 | 0008 | 40 |
| 41 | 0308 | 0282 | 0256 | 0231 | 0205 | 0180 | 0155 | 0130 | 0105 | 0081 | 0056 | 0032 | 0008 | 41 |
| 42 | 0307 | 0282 | 0256 | 0230 | 0205 | 0180 | 0155 | 0130 | 0105 | 0080 | 0056 | 0031 | 0007 | 42 |
| 43 | 0307 | 0281 | 0255 | 0230 | 0205 | 0179 | 0154 | 0129 | 0105 | 0080 | 0055 | 0031 | 0007 | 43 |
| 44 | 0306 | 0281 | 0255 | 0230 | 0204 | 0179 | 0154 | 0129 | 0104 | 0080 | 0055 | 0031 | 0006 | 44 |
| 45 | 0306 | 0280 | 0255 | 0229 | 0204 | 0179 | 0153 | 0129 | 0104 | 0079 | 0055 | 0030 | 0006 | 45 |
| 46 | 0306 | 0280 | 0254 | 0229 | 0203 | 0178 | 0153 | 0128 | 0103 | 0079 | 0054 | 0030 | 0006 | 46 |
| 47 | 0305 | 0279 | 0254 | 0228 | 0203 | 0178 | 0153 | 0128 | 0103 | 0078 | 0054 | 0029 | 0005 | 47 |
| 48 | 0305 | 0279 | 0253 | 0228 | 0202 | 0177 | 0152 | 0127 | 0103 | 0078 | 0053 | 0029 | 0005 | 48 |
| 49 | 0304 | 0279 | 0253 | 0227 | 0202 | 0177 | 0152 | 0127 | 0102 | 0077 | 0053 | 0029 | 0004 | 49 |
| 50 | 0304 | 0278 | 0252 | 0227 | 0202 | 0176 | 0151 | 0126 | 0102 | 0077 | 0053 | 0028 | 0004 | 50 |
| 51 | 0304 | 0278 | 0252 | 0227 | 0201 | 0176 | 0151 | 0126 | 0101 | 0077 | 0052 | 0028 | 0004 | 51 |
| 52 | 0303 | 0277 | 0252 | 0226 | 0201 | 0176 | 0151 | 0126 | 0101 | 0076 | 0052 | 0027 | 0003 | 52 |
| 53 | 0303 | 0277 | 0251 | 0226 | 0200 | 0175 | 0150 | 0125 | 0100 | 0076 | 0051 | 0027 | 0003 | 53 |
| 54 | 0302 | 0276 | 0251 | 0225 | 0200 | 0175 | 0150 | 0125 | 0100 | 0075 | 0051 | 0027 | 0002 | 54 |
| 55 | 0302 | 0276 | 0250 | 0225 | 0200 | 0174 | 0149 | 0124 | 0100 | 0075 | 0051 | 0026 | 0002 | 55 |
| 56 | 0301 | 0276 | 0250 | 0224 | 0199 | 0174 | 0149 | 0124 | 0099 | 0075 | 0050 | 0026 | 0002 | 56 |
| 57 | 0301 | 0275 | 0250 | 0224 | 0199 | 0174 | 0148 | 0124 | 0099 | 0074 | 0050 | 0025 | 0001 | 57 |
| 58 | 0300 | 0275 | 0249 | 0224 | 0198 | 0173 | 0148 | 0123 | 0098 | 0074 | 0049 | 0025 | 0001 | 58 |
| 59 | 0300 | 0274 | 0249 | 0223 | 0198 | 0173 | 0148 | 0123 | 0098 | 0073 | 0049 | 0025 | 0000 | 59 |
| 60 | 0300 | 0274 | 0248 | 0223 | 0197 | 0172 | 0147 | 0122 | 0098 | 0073 | 0049 | 0024 | 0000 | 60 |

## ABBREVIATIONS ADOPTED IN THE ADMIRALTY CHARTS, WITH EXPLANATORY NOTES.

### General Abbreviations.

| | |
|---|---|
| Anch$^{ge}$ | - *Anchorage.* |
| B. | - *Bay.* |
| B. (near a buoy) | *Black.* |
| Bat$^{y}$ | - *Battery.* |
| B$^{k}$ | - *Bank.* |
| C. | - *Cape.* |
| C.G. | - *Coast Guard.* |
| Cath. | - *Cathedral.* |
| Ch. | - *Church.* |
| Chan. | - *Channel.* |
| Cheq. (near a buoy.) | *Chequered.* |
| Col$^{d}$ | - *Coloured.* |
| Cr. | - *Creek.* |
| E.D. | - *Existence Doubtful.* |
| Fl$^{g}$ L$^{t}$ | - *Floating Light.* |
| Fms. | - *Fathoms.* |
| Ft. | - *Feet or Foot.* |
| G. | - *Gulf.* |
| G$^{t}$ | - *Great.* |
| H. | - *Hour.* |
| H$^{d}$ | - *Head.* |
| Ho. | - *House.* |
| H$^{r}$ | - *Harbour.* |
| H.S. (near a buoy) | *Horizontal Stripes.* |
| H.W. | - *High Water.* |
| H.W.F.&C. | *High Water, Full & Change.* |
| I. | - *Island.* |
| I$^{s}$ | - *Islands.* |
| Kn. | - *Knots.* |
| L. | - *Lake.* |
| Lat. | - *Latitude.* |
| Long. | - *Longitude.* |
| L$^{t}$ | - *Light.* |
| L$^{t}$ Alt. | - „ *Alternating.* |
| L$^{t}$ F.Fl. | - „ *Fixed and Flashing.* |
| L$^{t}$ F. | - „ *Fixed.* |
| L$^{t}$ Fl. | - „ *Flashing.* |
| L$^{t}$ Int. | - „ *Intermittent.* |
| L$^{t}$ Occ. | - „ *Occulting.* |
| L$^{t}$ Rev. | - „ *Revolving.* |
| L.W. | - *Low Water.* |
| m. (near a light) | *Nautical Mile.* |
| Mag$^{ne}$ | - *Magazine.* |
| Mag$^{c}$ | - *Magnetic.* |
| m.n. (near a light) | *Minutes.* |
| Mt. | - *Mountain.* |
| Np. | - *Neaps.* |
| Obs$^{n}$ Spot | *Observation Spot* + |
| P. | - *Port.* |
| P.D. | - *Position doubtful.* |
| P$^{k}$ | - *Peak.* |
| P$^{t}$ | - *Point.* |
| R. | - *River.* |
| R. (near a buoy) | *Red.* |
| R$^{f}$ | - *Reef.* |
| R$^{k}$ | - *Rock.* |
| S$^{d}$ | - *Sound.* |
| sec. (near a light) | *Seconds.* |
| Sh. | - *Shoal.* |
| Sp. | - *Springs.* |
| Str. | - *Strait.* |
| Tel. | - *Telegraph.* |
| Var$^{n}$ | - *Variation.* |
| Vil. | - *Village* |
| vis. (near a light) | *Visible.* |
| V.S. (near a buoy) | *Vertical Stripes* |
| W. (near a buoy) | *White.* |
| W$^{g}$ Pl. | - *Watering Place.* |

### Quality of the Bottom.

| | |
|---|---|
| b. | - *blue.* |
| blk. | - *black.* |
| br. | - *brown.* |
| brk. | - *broken.* |
| c. | - *coarse.* |
| cl. | - *clay.* |
| crl. | - *coral.* |
| d. | - *dark.* |
| f. | - *fine.* |
| g. | - *gravel.* |
| gl. | - *globigerina.* |
| gn. | - *green.* |
| grd. | - *ground.* |
| gy. | - *gray.* |
| h. | - *hard.* |
| m. | - *mud.* |
| oys. | - *oysters.* |
| oz. | - *ooze.* |
| peb. | - *pebbles.* |
| pt. | - *pteropod.* |
| r. | - *rock.* |
| rot. | - *rotten.* |
| s. | - *sand.* |
| sft. | - *soft.* |
| sh. | - *shells.* |
| spk. | - *speckled.* |
| st. | - *stones.* |
| stf. | - *stiff.* |
| w. | - *white.* |
| wd. | - *weed.* |
| y. | - *yellow.* |

All charts and plans are, where practicable, constructed upon the True Meridian, *i.e.*, the East and the West marginal lines are drawn parallel to the True Meridian.

Soundings are reduced to mean Low Water of ordinary Spring tides, and are expressed in fathoms (of 6 feet) and fractions of a fathom, or in feet and fractions of a foot, such being denoted in the title of the Chart.

The underlined figures on the dry banks represent in feet or fathoms the depth of water over them at High Water, or the heights of the banks above Low Water. The method adopted is explained in the Title of the Chart. This dual system is being abolished, and in future all underlined figures will indicate feet above Low Water.

The *Velocity* of Tide is expressed in knots and fractions of a knot. The *Period* of the Tide being shown thus: 1$^{st}$ Q$^{r}$., 2$^{nd}$ Q$^{r}$., 3$^{rd}$ Q$^{r}$., 4$^{th}$ Q$^{r}$., for 1st, 2nd, 3rd, and 4th quarters.

The *Rise* of Tide is measured from the mean Low Water level of Ordinary Springs. The *Range* of Tide is measured from the Low Water of one tide to the High Water of the following tide. *See* Diagram on p. 844.

All heights are given in feet above High Water Ordinary Springs, and in places where there is no tide, above the level of the sea. [Exceptions to this general rule are stated on the title of the chart.]

All bearings, including the direction of winds and currents, are magnetic, except when otherwise expressed. Bearings of lights are given *as seen from seaward*, and not from the lights.

The natural scale, or the proportion which the Chart scale bears to the earth (obtained by reducing the number of feet in the minute of latitude to inches, and dividing the product by the scale), is represented thus $\frac{1}{12,150}$.

A cable's length is assumed to be equal to 100 fathoms; it is the 10th part of a sea mile.

*Soundings upon Foreign Charts are expressed thus:—*

| | | | | | | |
|---|---|---|---|---|---|---|
| Austrian | (Faden) = 6·223 | English feet, or | 1·037 | English fathoms | | |
| Chilian | (Metro) = 3·281 | " | " 0·547 | " | " | |
| Danish and Norwegian | (Favn) = 6·175 | " | " 1·029 | " | " | |
| Dutch (European) | (Vadem) = 5·575 | " | " 0·929 | " | " | |
| " (East Indian) | " = 5·905 | " | " 0·984 | " | " | |
| French | (Brasse) = 5·329 | " | " 0·888 | " | " | |
| " | (Mètre) = 3·281 | " | " 0·547 | " | " | |
| Italian | " = 3·281 | " | " 0·547 | " | " | |
| Japanese | (Fathom) = 6·000 | " | " 1·000 | " | " | |
| Portuguese | (Braca) = 6·024 | " | " 1·000 | " | " | |
| German | (Mètre) = 3·281 | " | " 0·547 | " | " | |
| Russian, Sashine or Fathom | (Сажень) = 6·000 | " | " 1·000 | " | " | |
| Spanish | (Braza) = 5·492 | " | " 0·915 | " | " | |
| Swedish | (Famn) = 5·843 | " | " 0·974 | " | " | |
| United States | (Fathom) = 6·000 | " | " 1·000 | " | " | |

The Dutch *Elle*, the Spanish, Portuguese, and Italian *Metro*, and also the French *Mètre*, are identical.

CHARACTERISTICS MARKED AGAINST LIGHTS ON THE ADMIRALTY CHARTS.

F. Fixed. A continuous steady light.

FL. Flashing. Showing a single flash.

GP. FL. Group flashing. Showing groups of two or more flashes in succession (not necessarily of the same colour), separated by eclipses.

F. & FL. Fixed and flashing. Fixed light varied by a single white or coloured flash, which may be preceded and followed by a short eclipse.

F. & GP. FL. Fixed and group flashing. The same as the preceding, but with groups of flashes.

REV. Revolving. Light gradually increasing to full effect, then decreasing to eclipse. [*At short distances and in clear weather a faint continuous light may be observed.*]

OCC. Occulting. A steady light with, at regular intervals, one sudden and total eclipse.

GP. OCC. Group occulting. A steady light with, at regular intervals, groups of two or more sudden and total eclipses.

*The note attached to Revolving lights is in some cases applicable.*

ALT. Alternating. Lights of different colours (generally red and white) alternately, without any intervening eclipse.

---

The distance the Lights are visible is calculated from a height of 15 feet above the sea at H.W. Lt.-vessels belonging to the Trinity House, London, are coloured *red*, have their Name painted on their sides, carry a Ball at *each* mast-head, fire a gun if a ship is standing into danger, and sound either a GONG or FOG HORN in foggy weather. A *white* Lt. is exhibited from the fore-stay of each Lt.-vessel, 6 feet above the rail, to show in which direction the vessel is riding.

When Lt.-vessels or other craft are placed to mark the position of *wrecks*, they will be distinguished by having their *top-sides coloured green*, and will exhibit, by day—*Three balls from a yard*, 20 feet above the sea; *two placed vertically on the side that shipping may safely pass*, and one on the other side. By night—*Three fixed white Lts. similarly arranged*, but the ordinary riding Lt. will not be shown. Mariners will thus know on sighting a wreck-marking vessel that she is so employed; and that *they should pass on that side of her on which the two balls or two Lts. are shown.*

# GENERAL INDEX.

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## ALTITUDE TABLES.

**Computed for Intervals of Four Minutes** between the Parallels of Latitude 31° and 60° and Parallels of Declination 0° and 24°, designed for the Determination of the Position Line at all Hour Angles without Logarithmic Computation, by *Frederick Ball, M.A. (late Scholar of Exeter College, Oxford), Chaplain and Naval Instructor in His Majesty's Fleet* ... ... ... ... ... ... ... ... 15 0

Ditto, ditto, between the Parallels of Latitude 0° and 30° and Parallels of Declination 0° and 24° ... ... ... ... ... ... ... ... ... ... ... 15 0

Ditto, ditto, between the Parallels of Latitude 24° and 60° and Parallels of Declination 24° and 60° ... ... ... ... ... ... ... ... ... ... ... 15 0

**Altitude and Azimuth Tables,** for Facilitating the Determination of Lines of Position and Geographical Position at Sea. The simplest and readiest in solution. Spherical Traverse Tables for solving all problems of navigation. By *Lieut. Radler de Aquino* (Brasilian Navy). All sights for position are worked out by the same method *without logarithms*, with hardly any calculation. All the other problems in navigation are easily and rapidly solved by inspection without interpolation. This work has received the favourable endorsement of the United States Hydrographic Office. Stereotyped Edition... ... ... ... ... ... ... ... ... 10 6

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**Description of an Artificial Horizon,** invented by *Capt. A. B. Becher, R.N.,* with examples of its application, afloat and ashore (1857) ... ... ... ... 1 0

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## AZIMUTHS.

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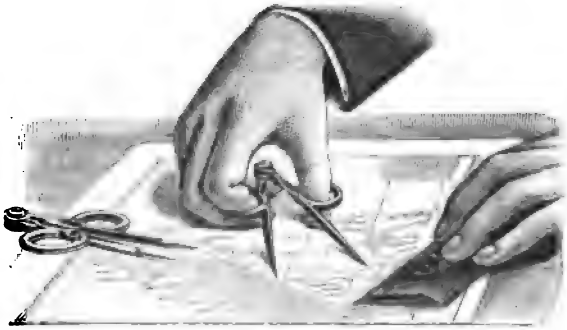
**The Wind in its Circuits:** with the explanation of the Origin and Cause of Circular Storms and Equinoctial Gales; illustrated with numerous Diagrams and a Chart of the Prevailing Winds of the World for Spring and Summer, by *Lieut. R. H. Armit, R.N.* (1870) ... ... ... ... ... ... ... ... ... ... 7 6

*See also* **Meteorology.**

## F. HOWARD COLLINS'S SINGLE-HANDED DIVIDERS.
### Specially Designed for Navigators.



The advantages of these Single-handed Dividers are that they can be picked up from the table by one hand alone, and the legs opened or closed by the finger and thumb of the same hand, without any other assistance whatever.

Navigators are thus enabled to work, and retain in position, the parallel ruler with one hand, while distances are being measured with the other. It is needless to say that this enables much time to be saved in laying off courses and distances, a matter for consideration in these days of steamers travelling a mile in less than two-and-a-half minutes.

The joint itself is of an entirely new form, being made a round ball. This is found to be a great advantage, and the best form for rolling between the thumb and fore-finger when "stepping" distances; as for instance, in measuring fifty miles by the legs being set to ten miles of the chart scale.

These Dividers are of the *best make* in German-silver, **price 7s. 6d. per pair in cardboard box,** and with special cleat and screws for fixing to the chart-room bulk-head to hold them when not in use.

"None seem to be quite on a level of excellence with these."—*Merchant Service Review.*

"The price is certainly a reasonable one."—*The Shipping World.*

| | | s. | d. |
|---|---|---|---|
| **BRASS DIVIDERS** .. ... ... ... ... ... ... | 6-inch, 2/6; 8-inch | 3 | 6 |

### FIELD'S PARALLEL RULERS.

| | | | |
|---|---|---|---|
| Boxwood ... ... ... ... | 24-inch, 18/; 21-inch, 15/; 18-inch, 11/; 15-inch | 8 | 0 |
| Ebony ... ... ... ... | 24-inch, 21/; 21-inch, 18/; 18-inch, 14/; 15-inch | 11 | 6 |

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# INCORRECT CHARTS.

## SPECIAL BOARD OF TRADE OFFICIAL NOTICES TO SHIPOWNERS.

### NOTICE TO SHIPOWNERS AND AGENTS.

The attention of the Board of Trade has frequently been called to cases in which British vessels have been endangered or wrecked through Masters attempting to navigate them by means of antiquated or otherwise defective Charts.

The Board of Trade desire, therefore, to direct the especial attention of Shipowners and their Servants and Agents to the necessity of seeing that the Charts taken or sent on board their Ships are corrected down to the time of sailing. Neglect to supply a Ship with proper Charts will be brought prominently before the Court of Inquiry in the event of a wreck occurring from that cause.

The Official Catalogue of Charts, plans and sailing directions, published by the Admiralty (issued annually in March), can be obtained free of charge on application to the Chart Agency, 145, Minories, London, E.C., or from any of the sub-agencies at the Home or Foreign Ports.

*Statement, showing the number of New British Admiralty Chart Published, Corrections made to the Chart Plates, and Quantities Printed, for the years* 1885, 1890, 1895, 1900, *and* 1905.

| | 1885 | 1890 | 1895 | 1900 | 1905 |
|---|---|---|---|---|---|
| New Chart Plates Engraved and Published ... ... | 54 | 76 | 114 | 102 | 110 |
| Chart Plates Improved by Additional Plans ... | 32 | 10 | 34 | 30 | 36 |
| Chart Plates Improved by Corrections and Additions | 186 | 130 | 163 | 224 | 196 |
| Corrections Made to the Chart Plates ... ... | 2,750 | 4,750 | 5,300 | 4,520 | 5,320 |
| Minor Corrections at the hands of the Draughtsmen | 29,800 | 37,270 | 30,046 | 35,500 | 60,499 |
| Total Number of Charts Printed ... ... ... | 272,115 | 297,120 | 312,638 | 580,207 | 689,930 |

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11.